CHAPTER ONE

Introduction

Traditionally, instructional designers are accustomed to determining objectives and designing evaluation methods and tools for assessing learning outcomes. In Web-based learning (WBL), similar procedures have often been applied to assessing the effectiveness and quality of the online learning techniques and online learning management systems (LMS). Such an evaluation can be seen as a process in the educational system that drives the student activity, online or off. Obviously, value in any instructional system comes from evaluation; what is evaluated in a course or a program is what is valued; what is valued becomes the focus of activity.

Researchers look at evaluation as an ongoing process aimed at improving learning outcomes and system performance. The evaluation process works generally on setting up appropriate criteria and high standards for learning quality; systematically gathering, analyzing, and interpreting evidence to determine how well performance and activity match those expectations and standards; and using the resulting information to document, explain, and improve this performance or activity (Angelo, 1995).

Faulkner (2000) describes two major types of evaluation: formative evaluation, which is conducted during system development in order to formulate and refine the system design, and summative evaluation which is conducted on existing functioning systems and aimed at assessing the overall user and system performance.

This study is aimed at developing and validating an evaluation instrument for a Web-based learning environment (WBLE) in the Syrian Virtual University (SVU). The online learning environments are complex environments using a variety of technologies and tools to overcome time and location restrictions. Khan (1997) pointed out that the WBLE is a hypermedia environment consisting of networked computer applications that enables learners to learn by distance and these networks "utilise the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported" (p. 6). In such learning environments, learners have the opportunity to be physically separated from teachers and from each other, and the opportunity to participate in the learning environment at their convenience.

As the number of web based learning environments increases, the need for appropriate evaluation methods increases as well. WBL generally deals with learners who have different backgrounds, as well as different mental and physical abilities; therefore, WBL is expected to be more flexible, usable, comprehensible and accessible. As with any new invention, WBL is expected to present differential value to learning compared with the conventional learning. Therefore, evaluation of WBLE is of incremental value.

While literature revealed significant evaluation studies that have emerged in the past few years exploring the weaknesses and strengths within the WBLEs, there appear to be voids within these studies. Some evaluators of Web-based learning environments have applied evaluation instruments that are practically devoted to conventional Web-based systems such as e-commerce (Balasubramaniam, Pries-Heje, & Baskerville, 2003;

Conallen, 1999; Murugesan & Ginige, 2001). These approaches, however, were too general and therefore inadequate for direct application to Web-based learning, because they do not deal with teaching and learning issues specific to online learning.

Furthermore, evaluation of Web-based learning cannot be done in the same manner as traditional software development, because it is embedded in a learning environment and must include issues specific to Web-based learning, in particular pedagogical considerations (Hadjerrouit, 2006). Many of these evaluation methods do not explicitly address the specific characteristics of Web-based learning, such as the learning environment and pedagogical considerations based on learning theories, learner-centered design, evaluation of learning, evolution and change (Frantiska, 2003; Horton & Lynch, 1999; McCormak & Jones, 1998; Montilva, Sandia, & Barrios, 2002; Retalis & Papasalouros, 2005). Other evaluators who were directly involved in Web-based learning environments had initiated their research on just a few aspects, such as evaluating the learning and student performance (Benigno & Trentin, 2000) or stating factors such as *technology*, *instructor*, and *previous use of technology* (Volery & Lord, 2000). The studies combining more critical factors and more thorough aspects involved in Web-based learning environments are rare.

Conducting evaluation from different perspectives was thought to be necessary within this incremental growth of reliance on learning by distance and using online courses around the world. It seemed that some criteria could not be reliably evaluated by students while others could not be reliably reflected upon by content experts (Kennedy, Petrovic, & Keppell, 1998)

Silius and Tervakari (2003) developed an evaluation instrument for a WBLE and advocated that the main issues within the evaluation instrument of WBLEs are Usability, Pedagogical usability, Accessibility, Information quality as well as Added value (UPAIAv). Such an evaluation instrument was applied effectively in the Tampere University of Technology and gave valuable results. However, this instrument lacks reliability and validity. First, the instrument lacks the factor analysis study which is necessary to determine to what extent the observed items belong to their underlying constructs. Second, the absence of a Structural Model which indicates the relationships among the constructs (latent variables); Usability, Pedagogy, Accessibility, Information quality and Added value.

Clearly, what is lacking in the Silius and Tervakari instrument is an analysis and confirmative process which may contribute to a validated evaluation instrument that can evaluate the WBLE thoroughly and effectively. Furthermore, the mentioned instrument lacks a causal structural model which depicts the intercorrelations among the constructs of UPAIAv. This inquiry is not designed to develop an evaluation instrument which can cover every aspect of WBLE, but the inquiry is purposed to unify all possible criteria in one unique instrument. The instrument is planned to be more thorough than available instruments as it seeks to cover the substantial life process of WBLE as far as possible. Using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) the researcher will develop an evaluation instrument which is expected to have reliable and validated constructs in such a way that such constructs could be generalizable in the field of WBLE evaluation.

The research cycle for developing the evaluation instrument involves two steps: (a) an exploratory step that puts forward the hypothesized measurement model(s) via the analysis of empirical data from a referent population; and (b) a confirmatory step that tests the hypothesized measurement model(s) against new data gathered from the same referent population.

The research sample of the study consisted of the SVU students. The research employed the quantitative method. An interview was conducted at the beginning of research to elicit a deep definition of the problem and state its dimensions. These interviews were conducted with a few lecturers, managers, and students.

Background of the Study

The WBLE has witnessed an educational revolutionary shift from the teaching paradigm to the learning (Pahl, 2003). As a result, students become more and more independent from the teacher, and education becomes more learner-centered. The introduction of the Internet for learning has been justified by its proponents for its potential to provide cost-effective and flexible learning for a diverse student population (Ryan, Scott, Freeman, & Patel, 2000, p. 13).

Web-Based Virtual Learning (WBVL) is considered one aspect of the Web-based learning environment. Cornford (2000) states that “The concept of the virtual university came to represent a number of different dimensions to the possibilities presented by on-line learning”. Students studying at the Virtual University (VU) generally use specified centers (computer labs) and thereby generally follow a program which may include lectures, tutorials, practical, laboratory, assignments, examinations, and work experience. Students who want help with assignments encounter staff members formally within class settings, and sometimes informally.

The evaluation process of WBLEs is regularly considered in the field. Various instruments and criteria have been indicated in literature to evaluate the WBLEs. Each one of those recommended different methods, factors and procedures. While they are not identical, they however share some common themes. Researchers note that usability is needed in a web site design literature as a crucial quality when determining the user satisfaction and initial impressions of an interface in such systems. Usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11, 1998). Therefore, the usability of e-learning application can significantly affect learning (Cobb, Neale, & Reynolds, 1998; Costabile et al., 2005).

The researchers share too that the Pedagogical usability has an intrinsic effect on WBL and many of them consider the pedagogical dimension as one of the major forces behind WBL, because it directly affects its implementation (Govindasamy, 2002; Hamid, 2002; Motschnig-Pitrik & Mallich, 2004; Nocols, 2003; Watson, 2001). Silius and Tervakari (2003) defined pedagogical usability as “The tools, content, interface and the tasks of the web-based learning environments that support various learners to learn in various learning contexts according to selected pedagogical objectives” (p. 3).

Often the term “pedagogical usability” is still rather connected to the term “usability” (Melis, Weber, & Andrès, 2003). Usability is one aspect of the overall acceptability of a computer system. According to Nielsen (1993) the overall acceptability of a computer system is a combination of its social acceptability and its practical acceptability. Social acceptability relates to instructional goals and philosophy of learning, while Practical acceptability includes some traditional categories such as cost, support, reliability and so forth, and also system usefulness.

According to Nielsen’s classification (1990, p. 148), the usefulness of a computer system relates to utility and usability. Utility refers to the design functionality, which should meet the user's needs, and usability refers to how well users are able to use the functions offered by the system (pp. 148-149). While literature points that both usability and utility are equally important, utility is not our interest for the current thesis.

Pedagogical usability, which is defined according to Nielsen's classification (1990, p. 148), is a sub-concept of utility, and technical usability is a sub-concept of usability (See Figure 1.1).

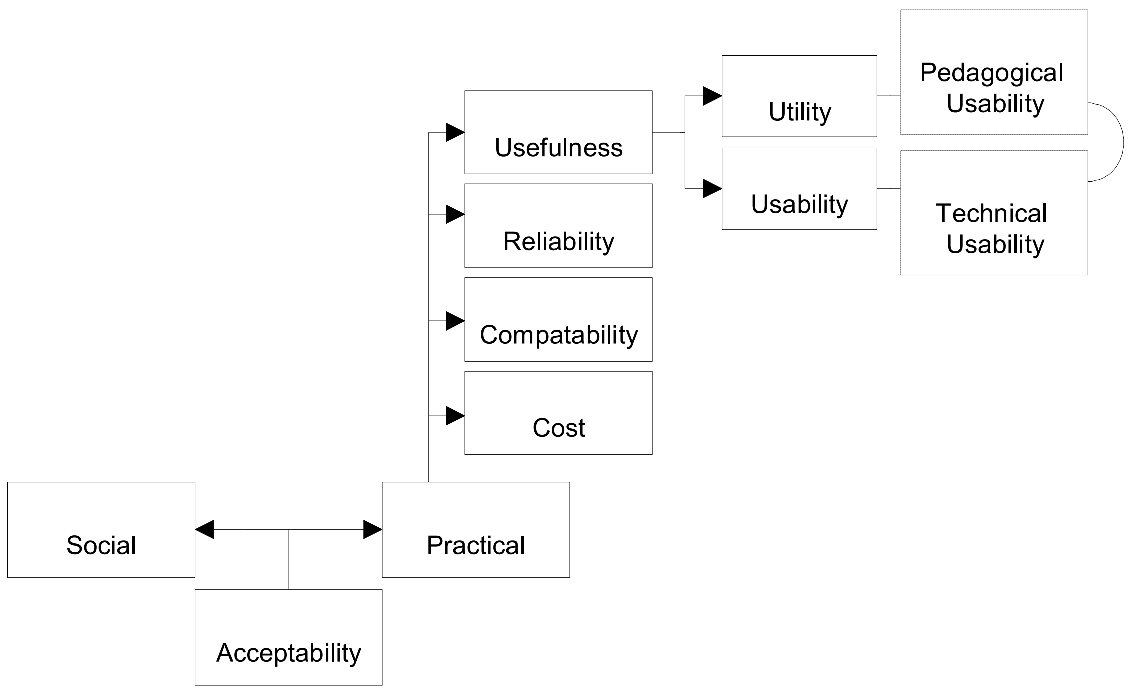

Figure1.1. Conceptual mapping of the technical and pedagogical usability (Nielsen's usability model, 1990, p. 190)

Literature reviews that the evaluation of usability is not enough; it is also important to evaluate the pedagogical usability of Web-based learning. "A Web-based learning environment may be usable but not pedagogical usable and vice versa." (cf. Albion, 1999; Labbate, 1996; Quinn, 1996; Squires, 1997). Therefore, considering both Usability and Pedagogical usability has led to an effective and efficient WBL.

The Accessibility of Web-based learning is viewed as having a high effect on the learning process in WBLE. Foley and Regan (2002) wrote: “An essential part of any web design today is designing for individuals with disabilities”. Storey, Phillips, Maczewski, and Wang (2002) recommended that universities consider deploying WBL tools to provide integration, standardization, flexibility and accessibility in tool/program choices.

System accessibility was defined as the ease with which people can locate specific computer systems (Kling & Elliot, 1994).

The interrelationships among usability, Pedagogical usability and accessibility are considered by some researchers. Ardito et al. (2006) pointed out that the evaluation of educational software must consider its usability as well as its accessibility and its didactic effectiveness.

The Information Quality is a criterion mark for any educational and informational system. That is, the information system quality plays an effective role in the success of the educational and informational system. According to the DeLone and McLean (1992) model, information system quality affects both the use of the information system and the users’ satisfaction with this use. Two dimensions of information system quality can be noted from the DeLone and McLean model: the information quality and the system quality. While information quality relates to the accuracy, completeness, currency and format (Nelson, Todd, & Wixom, 2005), the system quality indicates the accessibility, reliability, flexibility, integration and response time (Nelson et al., 2005). Indeed, many researchers were often interested in studying the information overload, the knowledgeable information, the information quality and the user interaction, communication and satisfaction with information (Bearne, Jones, & Sapsford-Francis, 1994).

The Added value is generally recognized as a parameter that explains and points to the differentiation between what quality of learning was before moving to the new learning environments and what quality currently is. The users involved in web-based learning environments consider critically how using web-based environments can add value to their teaching and learning. Obviously, using the Internet has added many new values to learning as Dwyer, Barbieri, and Doerr (1995) outlined:

> The web provides significant new functionality in transmitting information to the student and providing forums for exchange. The web is revolutionising some areas of study through increased opportunities for learning and alternative formats for information. (p. 897)

Nokelainen (2006) considered that knowing and evaluation of added value is an important aspect in the context of WBLE evaluation. However, some studies on comparing the conventional courses with computer-based or technology-enhanced courses yielded no significant difference in academic achievement (Russell, 1999).

The elements of added value in the WBLE differ significantly among learners based on their experiences and expectation of WBLE (Forsblom & Silius, 2002b). Those elements depend as well on the perceived teachers' added value of e-learning environments (Mahdizadeh et al., 2007).

Consequently, evaluating the Web-based learning environment (WBLE) which is one active aspect in the life cycle of WBLE development can be carried out using different factors. However, the literature indicates that usability, pedagogy, accessibility, information quality and added value (UPAIAv) are very critical factors for estimating the quality of WBLE.

An Overview of the SVU[1]

The SVU is a governmental academic institution, which provides an alternative (web-based) method of learning for Syrian and non-Syrian students. It was established in 2002 in the Ministry of Higher Education building in Damascus. The actual course offerings started in 2003. Students of SVU graduate with a university degree recognized by the Syrian Ministry of Education. The SVU has partnerships (affiliations) with a number of European and American universities (El-Sayed, 2006). Syrian students are attending courses via centers (computer labs) distributed in many cities in Syria and these centers are provided with computers, multimedia devices and DSL Internet connection.

Academic programs. SVU provides two kinds of academic programs: partnership programs (programs provided in cooperation with foreign universities); and domestic programs (programs authored by the SVU and taught by local Syrian professors). The partnership programs are often provided in English and taught by the universities that offer them. Upon completion these programs, students are awarded degrees that range from the associate degree to the PhD.

SVU Programs. There are undergraduate and postgraduate programs. The undergraduate programs have two types, the first one is 2-year (e.g. Higher National Diploma in Computing and Business Applications) and the second is 4-year (e.g., BSc program in Information Systems Engineering, Bachelor degree in Information Technology, etc.).

The postgraduate programs are 2-year (e.g., Master in Business Administration, Master degree in Quality Management, etc.)

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[1] This is downloaded officially from the SVU achieve.

Learning Model. Six learning modes are provided now in the SVU. These modes are: E-content / LMS, Virtual Classroom (Synchronous Sessions/WebDemo), Asynchronous sessions/Recorded, Asynchronous Communications (emails), Assessment Management System (AMS), and Student Information System (SIS).

Problem Statement

The SVU is experiencing some kinds of problems. The university's archive reveals many students' complaints that are documented online by university staff. Unfortunately, the resources about the university are quite rare. This could be due to its recent establishment. El-Sayed (2006) categorized such problems as follows:

> The most serious obstacle has been the lack of adequate Public Communication Infrastructure. A related obstacle is the cost of Internet Services in Syria (relative to the average income). Lack of community acceptance of Web-based Learning, as means of gaining knowledge, has been also a major obstacle in attracting students to SVU. Poor management coupled with bad planning, lack of well-designed marketing programs and lack of vision have contributed to negative feedback within the community about virtual learning. (p. 1)

The SVU archive (which is an electronic archive saved in the support department and in the content department at the university)--on the other hand-- addressed a lot of students' e-mails and that of some lecturers as well that express all kinds of complaints and dissatisfaction with many aspects of the learning environment at the SVU. This archive is analyzed and categorized consequently into Usability, Pedagogy, Accessibility, Information quality, and Added value. Table 1.1 offers a brief categorization of this archive.

Table 1.1

Some Examples of Problems at the SVU

Usability

- Some programs have many bugs (a management member and a lecturer wrote).
- The system is not easy to communicate with (this is shared by lecturers and students as well).
- The GUI (Graphical User Interface) is bad and not professional (one student wrote).
- We had a problem in receiving and sending emails (One student wrote).
- There is no "Undo" button in the Exam system site (This problem is repeated many times by students).

Pedagogy

- Some courses are not easy to learn (One student wrote).
- Some courses are static and rarely updated and maintained. (One student wrote).
- Some tutors' articles are bad. (One student wrote)

Added value

- I don't need to hear someone read to me what I have to learn – I can see it by myself-
- Some of our tutors they don't know English! (One student wrote)

Accessibility

- We have a problem with communications with tutors (One management member wrote)
- I can't access to some recorded sessions
- Some university courses are not easily accessible from home (One student wrote).
- The keyboard was not working in English in the Exam system site (in the mean time

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(table continues)

Table 1.1 (continued)

another student reported: we have a big problem in writing Arabic in the exam because the editor is not designed for Arabic)!

- I have a problem when downloading some sessions (One student wrote).

Information quality

- There is no quality control on the information (One student wrote).
- Why you didn't update the programs so quickly?! (One student wrote).

Source. (SVU' Archive, the Support and Content departments, 2006-2009)

Some of these problems are solved or on their way to being solved. However, this situation reflects one side of the problem and the other side which is perhaps more important is that the SVU has not submitted to any formal evaluation since the five years of its establishment. Hence it is timely to subject the SVU to professional review and evaluation after five years of its existence.

Interview

An informal interview was conducted with five lecturers teaching at the SVU and with ten students studying in SVU belonging to different centers around Syria (Damascus, Latakia and Aleppo); conversations were carried out and the information was gained through free-flowing discussions. The interview was conducted mainly to obtain further definition of the problem only. That is, the interview was planned to permit an in-depth exploration of the problem. Lecturers asserted some of the problems mentioned above in the archive. One more important result of the interview was that lecturers revealed that there is no evaluation instrument currently available in the SVU. They emphasized the importance of having such an evaluation instrument and recommended that the questionnaire be as short as possible to give students enough time to complete it. The lecturers welcomed the research and encouraged the researcher to proceed.

The interviews with students were helpful. Students asserted too on most of the problems mentioned above in the archive. They also added some other issues. Some complained of issues related to the limited number of available PCs in the SVU centers. Some complained about the way lecturers estimated their exams and projects. And many of them commented on some poor courses. All interviews with lecturers and students were recorded on a tape recorder and transcribed later for further analysis.

Purpose of Research

The research is ultimately purposed to develop and validate a theoretically sound instrument for evaluating the WBLE at the SVU. The evaluation instrument can be used by university society to evaluate most online learning environments in the SVU. It can be used to evaluate the students' reaction and satisfaction with learning. Such an evaluation instrument is expected to provide an appropriate questionnaire for use by SVU staff to measure the Usability, Pedagogy, Accessibility, Information quality and Added value of the WBLE. Furthermore, the research is intended to design a causal model which depicts the effect of Usability, Pedagogy, Accessibility and Information quality on Added value.

Research Objectives

This research will provide a validated evaluation instrument that will enable lecturers to evaluate effectively the WBLE according to its major components (UPAIAv). This consequently will contribute to guiding designers of WBLE toward concrete, usable, pedagogical, and accessible online courses. Furthermore, such an instrument is expected to add very good additional values to WBLE. This instrument will enable students as well to communicate better in such environments. The research will develop a model that will depict the relationships among the UPAIAv. The model will be a useful guide beyond the designers of WBLE as well.

The main objectives of this inquiry are:

1. To develop and validate an evaluation instrument for the WBLE in the SVU according to the UPAIAv that is currently missing and essentially needed in the process of developing the WBLE.
2. To develop a causal structural model for the UPAIAv.

Research Questions

To guarantee that WBLEs are delivering effective learning, the evaluation of WBLEs with regard to UPAIAv is expected to contribute eventually to better educational quality and higher user satisfaction.

This inquiry is planned to develop and validate a concrete evaluation instrument which guarantees better and more effective UPAIAv for WBLEs and subsequently to evaluate the current UPAIAv of WBLEs at the SVU. The evaluation process will lead to development of a structural model for UPAIAv. Eventually, this enquiry attempts to fill the gap that exists in the literature of WBLE evaluation. The primary research questions are:

1. What constructs of Web-based learning Environment are relevant to the Syrian Virtual University's Web-Based Learning Environment?
2. What is the reliability and validity of the SVU-Instrument in measuring the Web-based Learning Environment?
3. To what extent, if any, does the hypothesized a priori model fit sample data? (What is the causal structure of the SVU's Web-based learning environment?)

4. To what extent, if any, do usability, pedagogy, accessibility, and information quality measures have significant direct and indirect influence on the added value of the Web based learning environment?

Definitions of Parameters and Terms

Computer-Based Learning Environment (CBLE)

The idea to support the learning process by the use of computers (Computer-Based Teaching, CBT) has led to many variants and acronyms (Maurer, 2001; Schulmeister, 1997, p. 93) such as CBE, CBI, CAT, CAI, CAL, CBL, CML, CMT, ICAI, or ITS. They accentuate respectively the base (B) of a computer (C) or an intelligent (I), interactive (I) system (S) to aid (A), assist (A), manage (M), or support (S) education (E), instruction (I), learning (L), teaching (T), training (T), or tutoring (T). The CBL is considered in this thesis to sum up all those acronyms.

Class Web Site

This term refers to a Web site that is accessible through the Internet. A class Web site typically the electronic white board which contains units related materials for students to access and, if needed, print out. These units may include an outline, lecture notes, learning activities, assignment requirements, lecturer’s contact details, reading materials, additional resources such as data sheets, and so on. It may also provide access to online communication facilities including email, class bulletin board, chat and whiteboard. Thus, a class Web site may simply be a Web site created by the lecturer or it may be built within an online Learning Management System (LMS), such as Blackboard, Moodle, and so forth (McCormack & Jones, 1998).

Online Learning

Online learning refers to students' active engagement (or interactive) with the learning materials via the Internet, intranet or other electronic means (e.g., mobile phone). Currently, online learning is often referred to educational materials or courses delivered primarily via the Internet to students at remote locations, including their homes. Students can learn at their own convenience or work collaboratively with other students (e.g., on class projects) using online communication facilities (e.g., email, class bulletin board, chat, whiteboard) (Khan, 1997; Siragusa, 2005).

Web Page

A web page or webpage is a document or/and an information resource that is suitable for the World Wide Web and can be accessed through a web browser. This document is usually created in HTML or XHTML format, and may provide navigation to other web pages via hypertext links. Style sheets, scripts and images, and so forth, are information resources included frequently in Web pages (W3C, 1994-2008).

Structural Equation Modeling (SEM)

SEM is a multivariate extension of the multiple linear regression models which enables a researcher to test a set of regression equations simultaneously (Hoyle & Panter, 1995). SEM is a powerful technique that helps us test whether the supposed model is established upon an underlying theory and can fit the collected data.

Exploratory Factor Analysis (EFA)

Exploratory factor analysis (EFA) is the first statistical procedure seeking mainly to define the factors and reduce data. Byrne (2001) wrote that the EFA is designed for the situation where the links between latent and observed variables are unknown or uncertain. Essentially, the EFA is used in the research to define the underlying constructs for items in the evaluation instrument.

Confirmatory Factor Analysis (CFA)

CFA is the second statistical technique used to verify the factor structure of a set of observed variables. CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists. The researcher uses knowledge of the theory, empirical research, or both, postulates the relationship pattern a priori and then tests the hypothesis statistically (Blunch, 2008).

The AMOS Program

AMOS is an acronym for “Analysis of Moment Structures” or “analysis of mean and covariance structures” (Byrne, 2001). It is a program to assist with SEM. The AMOS Graphics will provide us with all the tools that we will ever need in creating and working with SEM path diagrams.

Theoretical Instrument

Various elements and factors have been recognized in the literature as critical for evaluation of Web-based learning environments (refer to Chapter Two, pp. 35-42). However, the construction process used in this inquiry for the evaluation instrument for WBLE is planned to be multidisciplinary, which is very meaningful in defining the factors critical in the planning of the WBLE. Such factors are considered partially or totally by many researchers (Coman, 2002; Elissavet & Economides, 2003; Hadjerrouit, 2006; Lee, Kahn, Strong, & Wang, 2002; Nichols, 1995; Nielsen, 1993; Nokelainen, 2006; Silius &

Tervakari, 2003; Volery & Lord, 2000) and applied effectively by Silius and Tervakari (2003-2005) in the Tampere University of Technology and gave a valuable results. The critical factors are Usability, Pedagogical usability, as well as Accessibility, Information quality and Added value (UPAIAv). These components are like electrons running in the space of the WBLE evaluation; evaluation of any component alone is a partial evaluation procedure. For evaluating the Usability, it is also important to evaluate the Pedagogical usability of WBL. A Web-based learning environment may be Usable but not Pedagogically usable and vice versa (cf. Albion, 1999; Labbate, 1996; Quinn, 1996; Squires, 1997). Accessibility is not sufficient to ensure Pedagogical usability. A WBLE may be accessible but not pedagogically usable. Besides, having added value does not lead necessarily to good usability and pedagogy. Silius and Tervakari (2003) have advocated that learning material delivered via the web may have poor Usability and poor Pedagogical usability but it still can produce some Added value for certain individuals. On the other hand, usable information is one aspect of Information quality. Knowledgeable information is another aspect of Information quality and pedagogical usability as well. However, given the fact that no debate of UPAIAv can fit all aspects of the WBLE, the universal Usability and Accessibility, Pedagogical usability, Added value, and Information quality have emerged as an important issue and a topic for computing research.

Thus, in order to investigate the research questions, this study explores relevant theories in diverse areas behind the universal UPAIAv:

Usability

This study considered the theme of universal usability as it is closer to the teaching and learning field and that exist in any system comprising technology and human users.

Universal usability is generic and technical. As such, the generic usability principles (*Learnability*, *Efficiency*, *Memorability, Errors,* and *Satisfaction)* developed by ISO (1998) and Nielsen (1993-2003) are considered as they are applicable to most educational software and web-based learning. These principles have been considered to guide the research to evaluate the generic usability of the learning system and unit at the SVU.

Several studies for evaluating technical usability have emerged over the last few years (e.g., Chalmers, 2003; Chin, Diehl, & Norman, 1988; Nielsen, 1993, 1994; Lin, Choong, & Salvendy, 1997; Preece, Rogers, & Sharp, 2002; Shneiderman, 1998; Tognazzini, 2003). Technical usability is found to be related to how a Web-based learning system is convenient, practicable, and usable for the learners (Hadjerrouit, 2006; Nokelainen, 2006). Specifically, many factors affect the technical usability of Web-based learning systems and are considered in evaluating the technical usability of the WBLE, namely: Performance, Navigation tools, User Interface Layout and Design, Information Architecture (Structure), Content, and Media elements. The user interaction is considered within each of mentioned components.

These dimensions are widely used in the evaluation process of technical usability of the system learning and unit (Nielsen, 1993-2003; Nokelainen, 2004; Hadjerrouit, 2006).

Pedagogy

Hadjerrouit (2006) indicated that pedagogical principles rooted in learning theories should exert stronger influences on Web-based learning. Literature revealed that there are three schools of thought, which have been widely used and explored to provide guidance for instructional practice: Behaviorism, cognitivism, and constructivism (Gros, 2002; Phye, 1997; Piaget, 1977; Skinner, 1976; Steffe & Gale, 1995; Vygotsky, 1986; Wilson, 1998; cited in Hadjerrouit, 2006, p. 122).

Mishra (2002) divides the roles of learning theories (behaviorism, cognitivism, and constructivism) over the content, learning support, and learning activities respectively, in such a way putting a secondary and primary role over each theory. Practically, Mishra acknowledges the necessity for adapted instrument for WBLE planning which makes use of the three learning theories. Therefore, a suitable combination of these learning theories has guided the process of designing the evaluation part of the Pedagogical usability of WBL.

Pedagogical usability is one of the major forces behind WBL, because it directly affects its implementation (Govindasamy, 2002; Hamid, 2002; Motschnig-Pitrik & Mallich, 2004; Nocols, 2003; Watson, 2001). The pedagogical usability criteria developed by Nokelainen (2006) are considered in this inquiry as Nokelainen contends that his criteria have complemented those criteria developed previously by other researchers (Albion, 1999; Quinn, 1996; Reeves, 1994; Squires & Preece, 1996, 1999; Horila, Nokelainen, Syvanen, & Overlund, 2002). The criteria are Learner Control, Learner Activity, Cooperative or Collaborative Learning, Applicability, Added Value, Motivation, Valuation of Previous Knowledge, Flexibility, and Feedback. These criteria guided the evaluation process of pedagogical usability of WBLE.

Accessibility

Accessibility refers to the ease with which people can access the education system and locate specific system functions. However, the study considered the universal accessibility, which encompassed as a result a wide range of learners. As such, the study considered for evaluation of the universal accessibility, those guidelines created by the World Wide Web Consortium (W3C): *Perceivable* - Content, *Operable* - Interface components, *Understandable* – Content, and controls, and *Robust* – Content.

These guidelines guided the evaluation process of universal accessibility of the WBLE.

Information Quality (IQ)

Information quality studies the quality of the content of information systems and distributed courses. The dimensions of information quality that guided this research are Intrinsic IQ, Contextual IQ, Representational IQ, and Accessibility IQ developed by Lee et al. (2002). These dimensions formed comprehensive criteria for evaluating the IQ.

Added Value

The acquired values behind using the WBLE are found connected to the individual's context (Silius & Tervakari, 2003). To evaluate such added values behind using the WBLE, the following areas are considered: The Flexibility of organization of education, The Quality of teaching, The Skills of learning and communications, and The Innovative use of information and communication technologies in education (Forsblom & Silius 2002a, 2002b; Silius & Tervakari, 2003). These principles have guided the evaluation process of Added value of WBLE.

Conceptual Instrument

The current research is developmental as the researcher aims at developing an evaluation instrument for a WBLE. Literature revealed two types of developmental research: Type 1 development research often concentrates on the production aspect of the instructional system design (ISD) approach (Driscoll, 1991), and Type 2 development research typically addresses the design, development, and evaluation processes themselves rather than a demonstration of such processes (van den Akker, 1999).

This developmental research is to some extent from the Type 2. The current developmental research has three main phases, namely Analysis, Design, and Evaluation. These phases are processes in which the output of each is an input for the next. See Figure 1.2.

The analysis phase has two parts. The first part involves analyzing the current fact of the online learning process in the SVU. The process included analyzing the SVU archive and making informal interviews with lecturers and students as well. The SVU archive is rich with information about the learning process in SVU. Unstructured interviews with lecturers introduced their points and perception toward the existing learning situation in SVU and toward the importance of having an evaluation instrument in SVU. The students contributed for further definition of the problem in the SVU. The second part of analysis focused on reviewing the evaluation literature of the Web-based learning environment. The process considered analyzing the literature for the critical factors that most affect the quality of WBLE. Next, the review considered analyzing the available evaluation instruments involved in evaluating the WBLE and the way those instruments are constructed and validated. A comprehensive review of those critical factors and instruments was done.

The results of the analysis process are released as a detailed document describing the critical factors that affect the quality of WBLE and the methods that contribute to the construction and validation of the evaluation instrument for a WBLE.

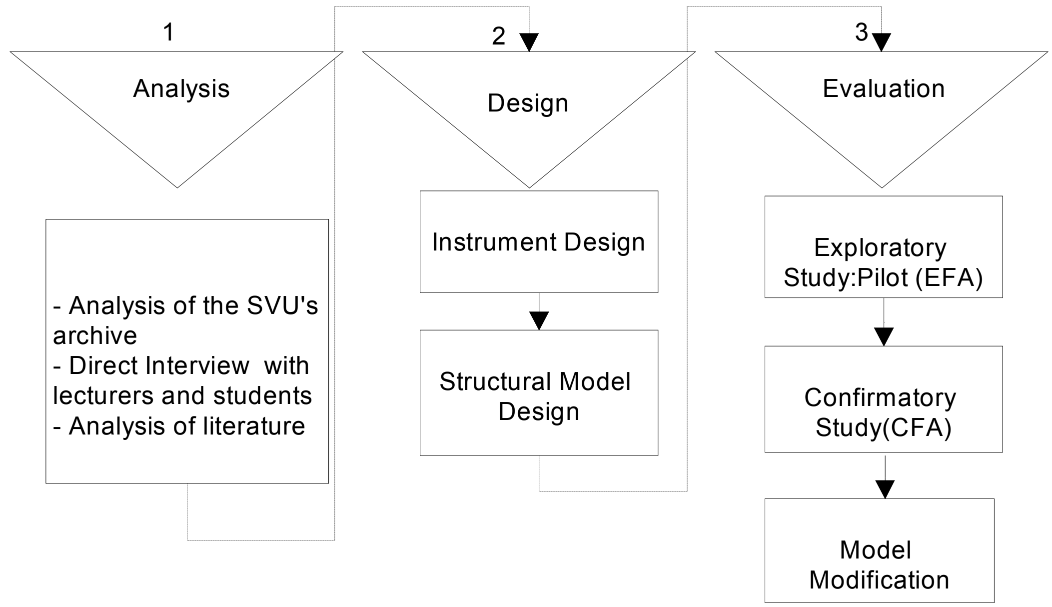


Figure 1.2. The development research design.

The Design phase consists of two parts. First, based on results of the analysis process and literature is to develop the evaluation instrument which will consider the universal elements of UPAIAv. Second is to design the default causal structural model for UPAIAv (see Figure 1.2). From one side, the model will indicate the supposed mutual relationships among the latent constructs: Usability, Pedagogy, Accessibility, and Information quality as well as Added value. After that, the model will indicate to the causal structure of the Usability, Pedagogy, Accessibility, and Information quality on the Added value from the other side. The results of this process are a questionnaire and priori model.

The Evaluation phase consists of three parts. First is to run the questionnaire on the first random sample of the SVU students and conduct the exploratory factor analysis (EFA). The results will point to what extent the observed variables in the evaluation instrument are linked to their underlying constructs (factors). The EFA will determine the items for each specific factor as well as factorial structure of the instrument. Second is to run the modified questionnaire on the second random sample of the SVU students and conduct the confirmatory factor analysis (CFA). This step will confirm the previous factorial structure derived from the EFA procedure. Furthermore, using the structural equation modelling (SEM) and the Analysis of Moment Structures software (AMOS-Version 16.0) will validate the instrument and structural model and will help to confirm the priori model that depicts the relationships among exogenous and endogenous variables. The Statistical Package for the Social Sciences (SPSS) will be used for some descriptive purposes (e.g., reliability). The result of this process is a thorough report about the instrument validation (using exploratory and confirmatory factor analysis) and structural model (e.g., what are the direct and indirect effects among supposed factors, what are the effects of usability, pedagogy, accessibility, and information quality on added value? etc.).

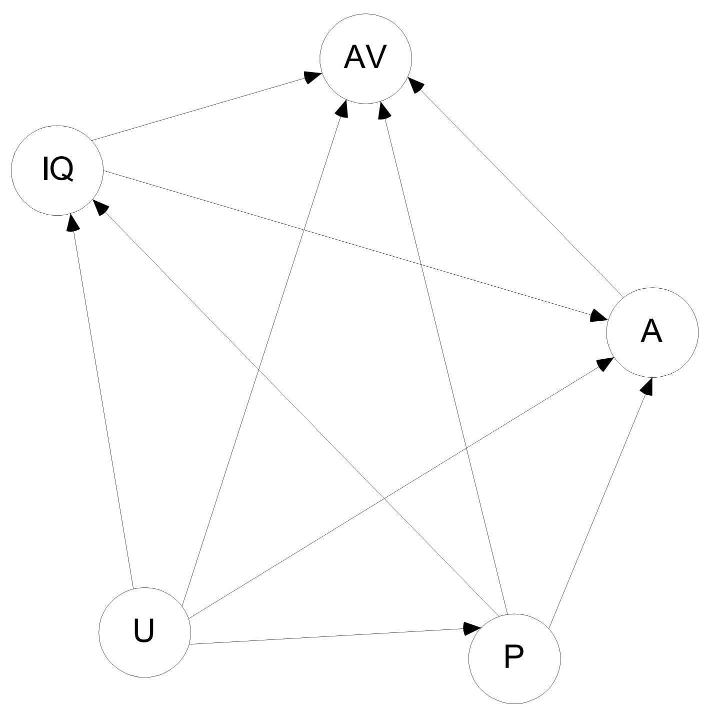


Figure 1.3. The priori model.

Significance of the Study

The ability to evaluate the knowledge acquisition and retention rate of learners, and the capacity of the learning management system (LMS) are of incremental value in the WBLE field. Nichols (1995) predicted that:

> The potential benefit from formulating evaluation methodologies for the Web [for instructional materials] depends on whether or not the Web will become a permanent medium or a passing fad. In fact, the Web will likely soon become the most popular medium for the delivery of distance education type materials.

This study is the first standard research going to be processed on the evaluation of the SVU since five years of its establishment. Furthermore, the researcher will develop a multidisciplinary evaluation instrument which is currently unavailable and needed in the SVU. The researcher will develop and validate a causal model which postulates the possible intercorrelationships within the constructs UPAIAv and the effect of each one of those on the added value.

Thus, this study will provide an evaluation instrument that will enable lecturers to evaluate effectively the WBLE according to its major components (the UPAIAv). The instrument will enable students as well to express themselves better regarding any problems that exist in such environments.

The evaluation process of the SVU in regard to the UPAIAv will provide valuable information as to what extent the SVU considers the standards and rules concerning the UPAIAv principles, which are recognized in literature. The findings of the research will provide guidelines as well in respect to the UPAIAv that is expected to help designers of online learning at the SVU to prioritize the design process and produce concrete online learning environments. Consequently, the evaluation process will provide information on the quality of online learning at the SVU. The study will provide information on the extent of learner satisfaction with such learning and their recommendations for improvement of the teaching-learning process. Furthermore, the study will provide information based on lecturers' views on how online learning at the SVU could be improved as well.

As stated earlier, the studies which combined all the five terms UPAIAv in one unique instrument are rare. The expected multidisciplinary evaluation instrument would be based on exact guidelines in respect to the UPAIAv. It will offer procedures on how the WBLE would comply with the standards and rules of designing effective online learning concerning the UPAIAv. All people involved in online learning at the SVU can use it; these include the members involved in evaluating online learning, the designers of online learning, and lecturers who are just delivering online learning. Even learners can use it as an information resource. Such an instrument will simply be a guide for most of them.

Thus, the information generated by the evaluation instrument would be potentially useful to the online learning evaluators, designers, lecturers and learners as well. The evaluation instrument will contribute to overcoming some difficulties and obstacles which may appear in the design process of online learning.

The study could also contribute to other existing research in the area of WBLE. Hence, findings of this study would be a significant contribution to the educational research in Syria as there had been no similar study conducted in the local context.

Scope of the Study

This study spans five areas: usability, pedagogy, accessibility, information quality and added value of the Web-based learning environment. Existing literature, theories and models, and evaluation instruments are used as the foundations of this study. This is done smoothly to set the context and background information of the study and create a general frame of reference for the rest of the study.

First, background information is given on the learning environments, with focus on:

- The learning environments that directly affect the WBLE.
- The existing evaluation instruments related to evaluation of WBLE.
- A summary of the critical factors (UPAIAv) that affect the quality of WBLE.
- A number of evaluation methods relating to UPAIAv are investigated.
- A set of appropriate criteria relating to UPAIAv is derived.

Second, an evaluation instrument is designed. This involved the use of a query technique, namely, questionnaire and a priori model is depicted.

Third, data were run through two stages, Pilot and real.

Fourth, a comprehensive analysis was done using structural equation modeling (SEM) and the AMOS software to validate the evaluation instrument.

Fifth, a thorough discussion is curried out to report the findings.

Delimitations and Limitations

Evaluation of the WBLE at the SVU regarding the UPAIAv is a huge process. Therefore, the researcher decided to concentrate on the specific issues that most affect the quality of the WBLE. These are the UPAIAv. The following will highlight some of the cases that affected the whole process.

The development process of the evaluation instrument in regard to the usability was narrowed to concentrate more on the universal usability of the user interface (e.g., the usability basic attributes). Besides, the evaluation process of the technical usability was narrowed to focus on the general aspects of the learning platform. Problems related to servers and broken links have not been discussed in detail but will be mentioned and recommended for further research.

Development process of the evaluation instrument with regard to accessibility was restricted to focus more on the term universal accessibility by making WBLE accessible to potential students with a wide range of abilities and disabilities. This direction is reflected to some extent in the World Wide Web Consortium (WCAG 1.0 & WCAG 2.0) Guidelines.

The questionnaire schedules are written in English. For those students unfamiliar with English, a translation in Arabic was provided. The translation process could lose some meanings for specific terms in the field of WBLE. Therefore, these issues were given extra attention to minimize their effects.

The size of sample depends on the number of participants who will freely agree to participate in the questionnaire survey. There was a little fear of not getting the exact number of sample subjects. This fear was eliminated because of the cooperation of the management, lecturers and students.

Finally, there was some fear that some participants would not fill the questionnaires honestly or answer satisfactorily for some reason. Therefore, the researcher with cooperation of the teaching staff sat down with many groups of students to help them act seriously with the questionnaire. The researcher explained to the students how the findings of the research will contribute to enhanced quality of the learning process in the university.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The procedure of reviewing the literature can be summarized in two steps. First is to review the major discipline areas of this inquiry and second is to state, from these areas, which elements are best fit for answering the research questions of my thesis. Therefore, the very beginning steps for developing and validating an evaluation instrument for a Web-based learning environment (WBLE) requires thorough review of the literature regarding those critical factors for developing an evaluation instrument; especially those specified in Chapter One (the usability, pedagogical usability, accessibility, information quality as well as added value (UPAIAv)) and after that to elicit the major focus components which best contribute in quality of the WBLE. The validation procedures for the development process of an evaluation instrument will be under focus too.

Thus, the organization of this chapter into four main sections is as illustrated in the following diagram:

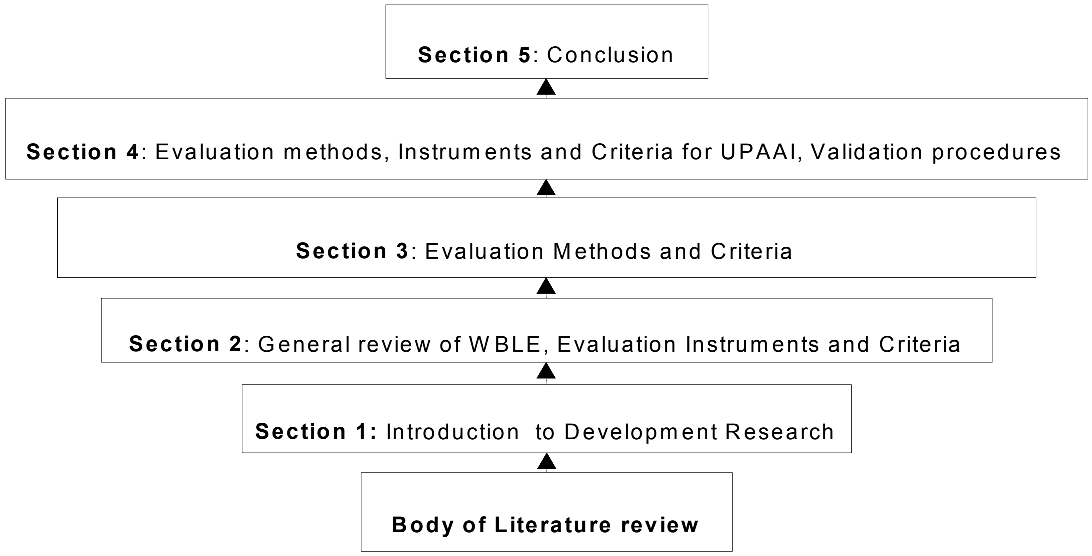


Figure 2.1. The systematic design of the Literature Review

Section One: Introduction to Development Research

Development, in its most generic sense, implies growth, evolution, and change. In the field of instructional technology, development refers to the process of producing instructional materials. Seels and Richey (1994) defined development research as "the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness." (p. 127). As such, development research attempts to produce the models and principles that guide the design, development, and evaluation processes. The scope of development in a research context can be seen in Table 2.1.

Table 2.1

The Scope of Development in a Research Context

Design	Development	Utilization & Maintenance
Analysis and Planning for Development, Evaluation, Utilisation, & Maintenance	Production & Formative Evaluation	Usage, Management, Summative, & Confirmative Evaluation.

Source. (Richey et al., 2004)

Types of Development Research

Literature revealed the existence of two types of development research: the first one includes the processes of description, analysis and evaluation; while the second includes processes of general analysis of design, development, or evaluation (Richey, Klein, & Nelson, 2004).

Type 1 development research studies often concentrate on the production aspect of the instructional system design (ISD) approach (the Analysis, Design, Development, Implementation, and Evaluation). On the other hand, Type 2 development research typically addresses the design, development, and evaluation processes themselves rather than a demonstration of such processes. The key differences between type 1 and type 2 studies that focus on a particular aspect of the total process are that the goals of type 2 studies tend to be more generalized, striving to enhance the ultimate models employed in these procedures. Type 1 research, on the other hand, is more confined to the analysis of the given project. Table 2.2 introduces a summary of these two types of developmental research.

Table 2.2

Summary of the Two Types of Developmental Research

	Type 1	Type 2
Emphasis	Study of specific product or program design, development &/or evaluation projects	Study of design development, or evaluation processes, tools, or models
Product	Lessons learned from developing specific product and analyzing the conditions that facilitate their use	New design, development, and evaluation procedures &/or models, and conditions that facilitate their use
	Context-Specific Conclusions ⇨ ⇨ ⇨ ⇨ ⇨ ⇨ ⇨ ⇨ ⇨ ⇨ ⇨	Generalized Conclusions

Source. (Richey et al., 2004)

The Methodology of Developmental Research

Multiple research methods are employed in developmental research studies. See Table 2.3 which outlines those methodologies according to the two types of developmental research.

Table 2.3

Common Research Methods Employed In Developmental Research

Developmental research type	Function/phase	Research Methodologies Employed
	Product design and development	Case study, In-depth interview, Field observation, Document analysis
Type1	Product evaluation	Evaluation, Case study, Survey, In-depth interview, Document analysis
	Validation of tool or technique	Evaluation, Experimental, Expert review, In-depth interview, Survey
	Model development	Literature review, Case study, Survey, Delphi, Think-aloud protocols
Type2	Model use	Survey, In-depth interview, Case study, Field observation, Document analysis
	Model validation	Experimental, In-depth interview, Expert review, Replication

Source. (Richey et al., 2004)

Collecting, Analyzing, and Reporting Data in Developmental Research

The validity of the conclusions in developmental research often depends on the richness of the data set as well as the quality of the research design. Typical types of data collected in development research relate to:

- Documentation of the design, development, and evaluation tasks, including profiling the design and development context and collecting data.

- Documentations of the conditions under which the development and implementation took place.
- Identifications of the results of predesign needs assessments, formative, summative, and confirmative evaluations.

Data analysis and synthesis in a developmental study are likely to be descriptive data presentations, interviews, and observations. Traditional quantitative data analysis techniques are used as well. The best techniques for reporting development data, however, have not been firmly established.

Section Two: General Review of WBLE, Evaluation Instruments and Criteria

WBLE Overview

A WBLE is a networked computer application that enables people to learn from a distance (Pantel, 1997). Learners can be physically separated from teachers and from each other, and they can participate in the learning environment at their convenience. It can be considered the place where learners and teachers interact (Teles, 1993).

WBLE includes many learning models and tools such as online course, discussion forum, chat, email, videoconferencing, and also live lectures (video-streaming). WBL may also provide static pages such as printed course materials, and so forth.

Learning Environments That Directly Influence Web-Based Learning

Web-based learning is affected by many factors which are mainly divided between technology and learning material design. The evaluation instruments recognized in literature have been rooted deeply in these two areas. Based on Hadjerrouit (2006, p. 127), the identification of the learning environment that directly influences Web-based learning can be characterized as the context of the system, which can best be described by six dimensions: the course content, learner, legal and ethical, technical, pedagogical, and usability issues. Table 2.4 gives a succinct explanation for each dimension.

Table 2.4

The Learning Environment Dimensions

Dimension	Description
Course content	Refers to the content of WBL that is delivered online.
Learner	It refers to the learners' characteristics that affect the development and use of WBL.
Legal and ethical dimension	It refers to the legal and ethical environment of WBL
Technical	It refers to the information technology infrastructure dimension, which relates to the hardware and the software environment of WBL.
Pedagogical	It is rooted in the learning theories, which should exert stronger influences on WBL.
Usability	It refers to the user interface dimension, which is a central feature of WBL.

Source. (Hadjerrouit, 2006, pp.126-127)

Thus, Hadjerrouit suggest six dimensions to be considered in any instrument aims to evaluate the WBLE.

Kerdprasop and Kerdprasop (2008) outlined that WBLE can be characterized by four basic factors: *Content* (subject matter, learning activities, etc.), *Structure* (subject display format, time tabling, curriculum, etc.), *Strategy* (knowledge modelling, instructional design, etc.) and *Support* (learning devices, technology, etc.)

Silius and Tervakari (2003) suggested more specific factors in the WBLE. They advocated that the main issues within the evaluation instrument for a WBLE are Usability, Pedagogical usability, Accessibility, Information quality as well as Added value (UPAIAv).

E-learning has been viewed as synonymous with web-based learning (WBL), (Khan, 2001). Volery and Lord (2000) reported three critical success factors in e-learning: *technology* (ease of access and navigation, interface design and level of interaction); *instructor* (attitudes towards students, instructor technical competence and classroom interaction); and *previous use of technology* (from a student's perspective).

Coman (2002) meanwhile reported three factors that affect the E-learning delivery: *Pedagogy of System Design* (pedagogy of the system is derived from specific learning theory), *The Subject Domain* (The subject domain presents the particular dynamic that many of the concepts require practical demonstration in order to be fully understood by the students), and The *Learning Environment* (in this case it refers to the interactive dynamics that exist, and how they are enabled in this learning context.)

Lee and Jamaluddin (2009) developed and validated an instrument to asses the E-learning environment. Factor analysis, both exploratory and confirmatory, was performed on the data and the results indicate that in assessing the E-Learning environment there are six distinct factors: technology, course content, teaching and learning material, teaching and learning environment, learning strategies, and support.

Evaluation Tools and Instruments

Evaluation instruments are developed to gain deep understanding of the WBLE. Instruments are recognized in literature as application generators that are directly related to a specific domain. Instruments generate applications by customization. They are not applications themselves; they are more complex constructs. Instruments are built for flexibility and generality, trying to cover a whole domain instead of particular problems (Seels & Richey, 1994). Some common evaluation instruments are discussed in the next section. Those instruments are chosen based on the nature of the learning management system at the Syrian Virtual University and their close relationships to the dimensions of Usability, Pedagogical usability, Accessibility, Information quality, and Added value. These discussions aim to highlight the main factors included in such instruments.

An evaluation instrument for hypermedia courseware. Elissavet and Economides (2003) developed an evaluation instrument for hypermedia courseware (Courseware is a relatively recent appellation for CBL, which refers to the use of computers for the delivery of instruction in an interactive mode.). Their instrument is concerned with both social and practical acceptability of hypermedia courseware (Nielsen, 1990). Given that a piece of hypermedia courseware is socially acceptable, its practical acceptability is examined through the evaluation of the following four sectors: *Evaluation of* content (six categories; validity and authority, accuracy, uniqueness, appropriateness, scope, and coverage.); *Presentation and organization of the content* (two categories of pedagogical factors; instructional model (structure, learners' control, accommodation of individuals differences, and cooperative learning) and interface design factors (interactivity, navigation, feedback and screen design)); *Technical support and update processes* (four categories of content durability over time; updating, modifying, adding procedures; probability of the product;

and technical coverage); and finally the *Evaluation of learning* (two categories of learning outcomes and learning process (Usability: five categories; easy to learn, efficient to use, easy to remember, few errors, and pleasant to use). See Figure 2.2.

The instrument has the form of a suitability scale questionnaire with five points, where figure (1) is assigned to strongly agree and figure (5) to strongly disagree. The figure (0) is given for those questionnaire items that cannot be evaluated, as they do not apply during the evaluation of that particular hypermedia courseware. The main result, as researchers pointed out, is that not all of the factors have the same weight, and content is the most important of all.

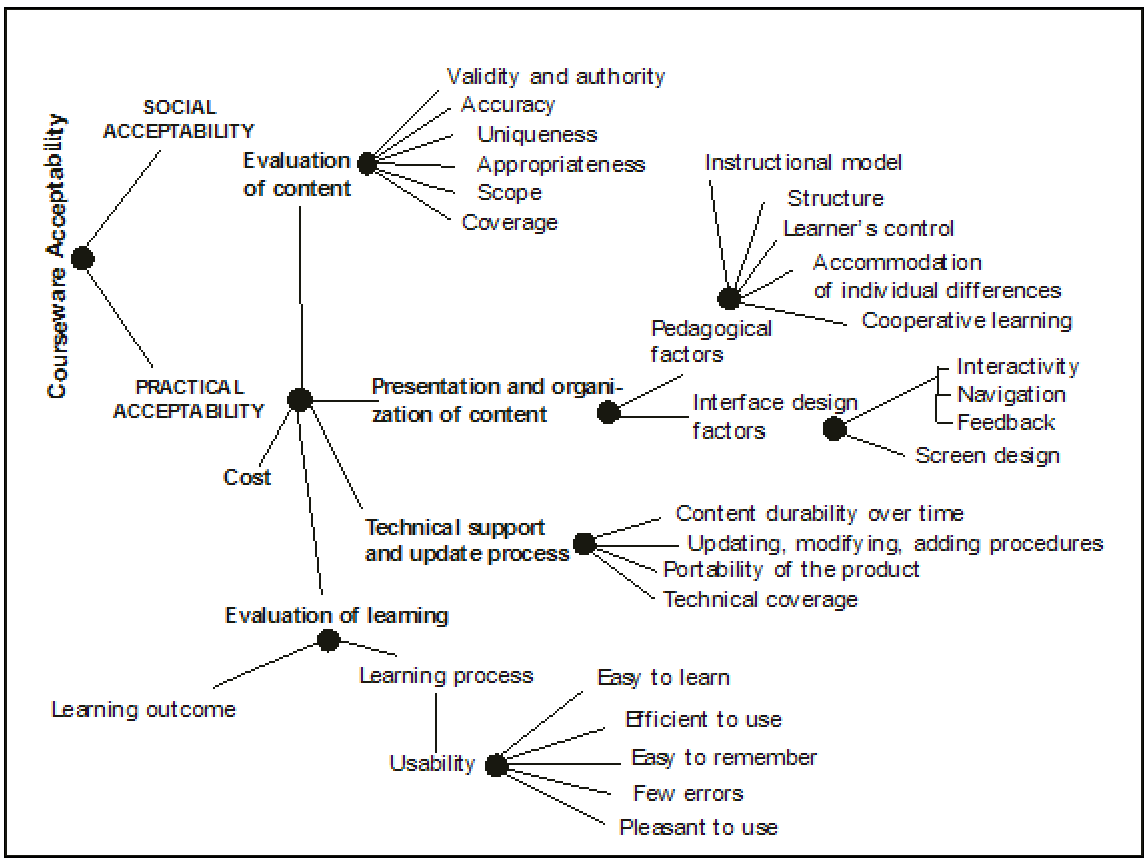


Figure 2.2. Diagram of the Evaluation Instrument (Elissavet & Economides, 2003)

The Web-based learning environment instrument (WEBLEI). Chang and Fisher (1998) developed an instrument aimed at capturing students' perception of the Web-based learning environment. There are four aspects in this instrument: *Emancipatory activities* (three categories of convenience, efficiency and autonomy), *Co-participatory activities* (six categories of flexibilities, reflection, quality, interaction, feedback and collaboration), *Qualia* (six categories of enjoyment, confidence, accomplishments, success, frustration and tedium) and *Information structure and design activities* (five categories of relevance and scope of content, validity of content, accuracy and balance of content, navigation, and aesthetic and affective aspects).

The Web-based evaluation tool. Silius and Tervakari (2003) developed a multidisciplinary evaluation instrument for WBLE to help evaluators control the evaluation process and gather essential information. They state that *"The multidisciplinary evaluation tool takes systematically into consideration the most important factors of accessibility, information quality, usability and pedagogical usability."* (p. 6). The pedagogical usability section in the first stage includes criteria to evaluate the support of the organization of the teaching and studying. The usability section includes sections to evaluate visual design, the use of multimedia elements, technical issues, support for online reading and navigation, error prevention and support for recovery from errors. Silius and Tervakari declared that teachers who are not necessarily expert in usability, accessibility or pedagogical usability can use the evaluation tool. See Figure 2.3.

Questions are accompanied by rating scale (1= poor to 5= excellent; N/A "Not Applicable", "Don't know"). Alternatives for answers are "always", "often", "sometimes", "rarely" "never". Depending on the questions, each alternative can have different scores, for example, "always" can be scored 1 or 5.

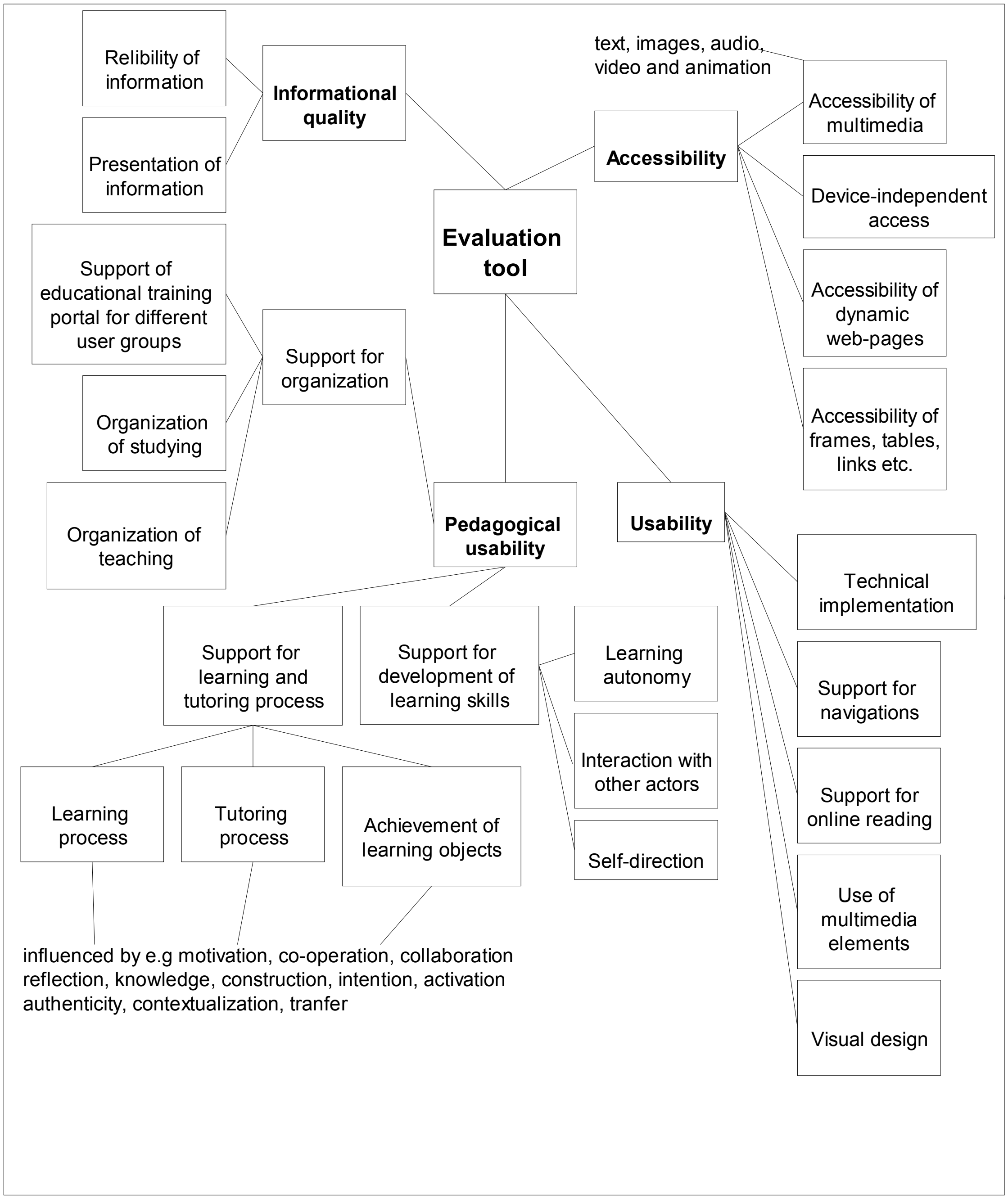


Figure 2.3. A Multidisciplinary Tool for the Evaluation of Usability, Pedagogical Usability, Accessibility and Information Quality of Web-Based Courses. (Silius & Tervakari, 2003)

As a result, the arguments stated above (Hadjerrouit, Silius & Tervakari, etc.) are not identical yet they share some common themes. This is the case with the evaluation instruments too. The usability, pedagogical usability, accessibility, information quality and added value are general dimensions of these common themes.

The following section will present an overview of these factors namely usability, pedagogical usability, accessibility, information quality and added value as recognized in literature:

Usability Overview

The next paragraph gives some of the more recent definitions of usability.

ISO standard. The document ISO[2] 9126 (1991) defines Usability as, "A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users."

The above definition is related to two dimensions, the ease of use and the measurement of such use.

In a subsequent update, the document ISO 9241-11 (1998) Guidance on Usability defines Usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

Effectiveness is the accuracy and completeness with which users achieve specified goals.

Efficiency refers to the resources expended in relation to the accuracy and completeness with which users achieve goals.

[2] the International Organization for Standardisation

Satisfaction is the comfort and acceptability of use. See Table 2.5 which illustrates this definition.

The definition above links the product usability with the user's achievement of goals and quality of such achievement and states the attributes of this quality as well. Herein, the definition deals with the usability as part of the system quality. Besides, the definition emphasizes that the usability is dependent on the context of use.

Usability-basic attributes. Nielsen (1993) declared the same characteristics mentioned above (effectiveness, efficiency and satisfaction) of usability and presented in 2003 an advanced definition of usability with five dimensions asserting again that *Usability* is defined by five quality components calling them attributes. Nielsen, in his argument, adds extra attributes to usability, which are learnability and error recovery. See Table 2.5 for more details.

Table 2.5

The Usability Five Quality Attributes

Attributes	Characteristics
Learnability:	How easy is it for users to accomplish basic tasks the first time they encounter the design?
Efficiency	Once users have learned the design, how quickly can they perform tasks?
Memorability	When users return to the design after a period of not using it, how easily can they re-establish?
Error Correction	How many errors do users make, how severe are these?
Satisfaction:	How pleasant is it to use the design?

Source. (Nielsen, 1993-2003)

Nielsen’s attributes form a thorough methodology for measuring the usability of any educational system. Many researchers have considered them when conducting their evaluation (Storey, Phillips, Maczewski, & Wang, 2002).

The importance of usability. The following arguments clarify the importance of usability according to the users, developers, and management staff.

Foraker Design (2002-2005) argues that usability is important from the user’s perspective because it can make the difference between performing a task accurately and completely or not, and enjoying the process or being frustrated. From the developer’s perspective; Foraker argues that usability is also important because it can mean the difference between the success or failure of a system. From a management viewpoint, Foraker argues that the software with poor usability can reduce workforce productivity to a level of performance worse than without the system.

Nielsen and Loranger (2006) summarize these issues when they reported that on the web, usability is a necessary condition for survival. If a website is difficult to use, users *leave*. If the homepage fails to clearly state what the site offers or what users can do on the site, users *leave*. If users get lost on a website, they *leave*. If website information is hard to read or does not answer users’ key questions, they *leave*. Leaving is the first reaction when users encounter a difficulty.

Universal usability. Universal usability is nowadays a concern for many researchers. The idea behind universal usability was to design a WBLE in such a way that it can fit a wide range of people. It refers to the design of information and communications products and services that are usable for every citizen (Schneiderman, 1998). Schneiderman has advocated the concept of universal usability ("usable by all") as closely related to the concepts of universal accessibility ("accessible by all") and universal design ("design for all"). These three concepts altogether cover, from the user's end to the developer's end, the three important research areas of information and communications technology (ICT): use, access, and design.

Challenges to universal usability. While the idea of universal usability was brilliant, the literature revealed some challenges:

1. Supporting a broad range of hardware, software, and network access.
2. Accommodating individual differences among users.
3. Bridging the knowledge gap between what users know and what they need to know about a specific system. (Schneiderman, 1998)

Principles of universal Usability design. Based on the challenges above, the key to universal usability is recognizing the diversity of the user population, user needs, and technical issues as well. Literature reveals, intuitionally, there is no "average" user on whom a system should be based. However, in some cases, it is possible to accommodate technology variety and individual differences in one system; multi-layer designs are the most promising approach to achieving universal usability (Schneiderman, 1998; Van der Meij, & Carroll, 1995). That is, when a single design cannot accommodate a large fraction of the user population, multiple versions or adjustment controls should be available to users. For example, a novice user can be provided with only a few options; after gaining confidence and experience, the user can choose to progress to higher levels of tasks and the accompanying interface.

Usability in context of WBLE. Kukulska-Hulme and Shields (2004) found out that several layers of usability were used in the literature of Web usability as follows: *Context specific usability* relates to the requirements of particular disciplines and courses; *Academic usability* deals with educational issues, such as pedagogical strategy; *General usability* issues are common to most websites and include aspects such as clear navigation and accessibility for users with special needs; *Technical usability* addresses issues such as broken links and server reliability.

The current literature review will focus much more on the common aspects of those layers of usability which fit with the wide context of WBLE.

Pedagogy Overview

The Oxford dictionary (2006) defines pedagogy as "the profession, science, or theory of teaching". It is recognized in literature as the profession of the designers of learning to introduce an effective and efficient learning unit and to make the functions of the learning system facilitate the learning unit being delivered as well.

Pedagogical usability. Silius and Tervakari (2003, p. 3) used the term "pedagogical usability" to denote whether, "The tools, content, interface and the tasks of the web-based learning environments support various learners to learn in various learning contexts according to selected pedagogical objectives." Thus, according to Silius and Tervakari, the space of pedagogical usability is related to many aspects; such as systems tools, course content, user interface, and so forth, which are necessary for the learners' support in various contexts of learning.

According to Silius and Tervakari (2002) the pedagogical usability can be divided into three main categories, namely:

1. Support for organization of the teaching and studying.
2. Support for learning and tutoring processes.
3. Support for the development of learning skills.

The above categories of pedagogical usability are based on many considerations. They depend on how great a share of teaching occurs "in the web", and how much occurs in face-to-face situations, and how much web-based learning is used in the teaching as a whole. They depend on to what extent participants are diverse too.

The importance of pedagogy. The pedagogical dimension is one of the major forces behind Web-based learning, because it directly affects its implementation (Govindasamy, 2002; Hamid, 2002; Motschnig-Pitrik & Mallich, 2004; Nocols, 2003; Watson, 2001). Moreover, pedagogical principles rooted in learning theories should exert stronger influences on Web-based learning, mostly because they offer a springboard for pedagogical innovation and far more scope for realizing possible learning benefits than Web-based learning without a pedagogical foundation (Hadjerrouit, 2006).

Pedagogy and learning theories. Hadjerrouit (2006) argued that the very constitutive base of the Web-based learning environment is a pedagogical foundation based on learning theories. Literature revealed that theories could be related to three main commonly accepted paradigms: Behaviourism, cognitivism, and constructivism (Gros, 2002; Mergel, 1998; Phye, 1997; Piaget, 1977; Skinner, 1976; Steffe & Gale, 1995; Vygotsky, 1986; Wilson, 1998).

Throughout this discussion, a synthesis of these theories and models is considered to underpin the development of pedagogical principles and the resulting implications to instructional design for online learning. Following is a brief review of these theories, specifically in the context of the online learning environments.

Behaviourism theories. Behaviourists' fundamental tenets were that only behavior could be observed and, therefore, human learning could only be studied through observations of responses to direct stimuli (Smith & Ragan, 1999, p. 19; Venezky & Osin, 1991, p. 75). This is done regularly without referring to mental processes. Therefore, the theory of behaviorism recognized only the overt behaviors that can be observed and measured (Good & Brophy, 1990).

The key concepts of behaviorism. In terms of instruction, behaviorism assumes that the goal of learning is to efficiently transmit knowledge from the instructor to the learners (Hadjerrouit, 2006). Therefore, the instructor is clearly central in the learning process. According to behaviorists, learning occurs when learners exhibit the appropriate response to specific stimuli (Smith & Ragan, 1999).

Today's computer environment allows for small learning steps, immediate feedback providing positive reinforcement to correct responses, and encouragement to continue when an incorrect response is given (Venezky & Osin, 1991, p. 76).

The behaviorist model has however been criticized for stimulating surface learning and knowledge reproduction. However, as Hadjerrouit (2006) argues, behaviorist learning is suitable for novice learners, as they need transferable knowledge from the instructor.

Cognitivism theories. Unlike behaviorism, cognitivism is based on the thought process behind the behavior. Changes in behavior are observed, and used as indicators as to what is happening inside the learner's mind (Schuman, 1996). The thought process includes simple propositions, schema, general rules, general skills, automatic skills, and mental models (Kyllonen & Shute, 1989).

Key concepts of cognitive theory. Cognitivism frames learning as an active construction process whereby learners take information from the environment, and construct their own knowledge based upon prior knowledge and experience (Hadjerrouit, 2006).

The knowledge construction process requires cognitive skills, such as analysis and reasoning skills, and meta-cognitive skills, such as reflection and self-evaluation, and analogical thinking (Hadjerrouit, 2006). The instructor's role is not as transmitter of knowledge; instead the instructor should try to encourage students to construct hypotheses, make decisions, and discover principles by themselves (Bruner, 1966).

Cognitive learning theories have been revealed as having the greatest influence on the development of instructional design theories and models, placing a greater focus on the learner and less focus on factors within the environment (Smith & Ragan, 1999, p. 20; Venezky & Osin, 1991, p. 76).

Constructivism theories. Constructivism recognizes that "knowledge is partly constructed by individuals, but it is also derived from social relationships through participation in social activities with others" (Hadjerrouit, 2006, p. 122). This perspective is closely associated with many contemporary theories, most notably the developmental theories of Vygotsky and Bruner (Kim, 2001). Vygotsky (1978) argued that "The central fact about our psychology is the fact of mediation" (p. 166). Vygotsky's argument led to the understanding of the importance of culture, language and context in the process of knowledge construction. Vygotsky (1986) clarified that the way learners construct knowledge, think, reason, and reflect, is uniquely shaped by their relationships with others. Hadjerrouit (2006) commented that knowledge is created as it is shared, and the more it is shared, the more it is learned. Accordingly, learning occurs as learners exercise, test, and improve their knowledge through discussion, dialogue, collaboration, and information sharing.

The key concepts of constructivism. Constructivism is based on specific assumptions mainly related to reality, knowledge, and learning. To understand and apply models of instruction that are rooted in the constructivism theory, it is reasonable to know the premises that underlie them:

According to the constructivist view, *Reality* is constructed through human activity; *Knowledge* is constructed from experience, while *learning* is an active and social process (Ernest, 1995; Gredler, 1997; McMahon, 1997; Prawat & Floden, 1994).

Learning theories and instructional design theories and models. Whereas learning theories attempt to describe how learning occurs without addressing what actions the learner needs to perform to facilitate learning, instructional theories, on the other hand, present explicit guidance to help people learn and develop (Reigeluth, 1999, p. 5).

*Instructional design theories***.** Thus, instructional design theories are more concerned with improving rather than describing learning. The four major components for traditional instructional design theories are Motivation, Structure, Sequence, and Reinforcement (Bruner, 1966, pp. 40-42; 1985; Sprinthall et al., 1994, pp. 243-247). In short, learners should be motivated, the learning material should be structured smoothly, the learning aspects should be sequenced clearly and finally the reward and punishment procedures should be administered adequately throughout the process of teaching and learning. However, constructivists emphasize the design of learning environments rather than the instructional sequence. Given this argument, Jonassen (1994, p. 37) suggests certain constructivist principles. See Table 2.6.

Table 2.6

Principles of Constructivist Design

Design Principles	Guidelines
Construction of knowledge	It is based on internal and social negotiations. Internal negotiations are based on an individual's mental models, which are used to explain, infer, predict and reflect ideas. Social negations refer to the process of sharing reality with others.
Provision of a meaningful and authentic context for learning	Where appropriate, the problems presented should be based on situations that could be encountered in the real world.
Collaboration among learners with the educator as a coach/mentor	Educators should encourage peer-to-peer learning.

Note. (Jonassen, 1994, p. 37)

Instructional Design Models. Dorin, Demmin, and Gabel (1990) looked at a model as a mental picture that helps us understand something we cannot see or experience directly. Furthermore, models are successful aids used to help us depict and subsequently understand the systematic and reflective process of applying instructional design and learning theories and philosophies for designing instructional materials, activities, information resources and evaluation (Siragusa, 2005; Smith & Ragan, 1999).

Systems approach to instructional design. Literature revealed that many models of instructional system design generally involve setting goals and objectives, analyzing resources, devising a plan of action and continuous evaluation/modification of the program (Saettler, 1990). Smith and Ragan (1999) developed an instructional design model consisting of three main stages: analysis, development and evaluation. The Smith and Ragan model was basically developed based on the common model created by Dick and Carey's (1978) systematic approach for designing instruction. Dick, Carey, and Carey (2001) have redeveloped the model which became widely known and utilized sharing common attributes in addition to recent trends in education including constructivism (Gagne et al., 1992, pp. 21-2; Smith & Ragan, 1999, p. 7). See Figure 2.4.

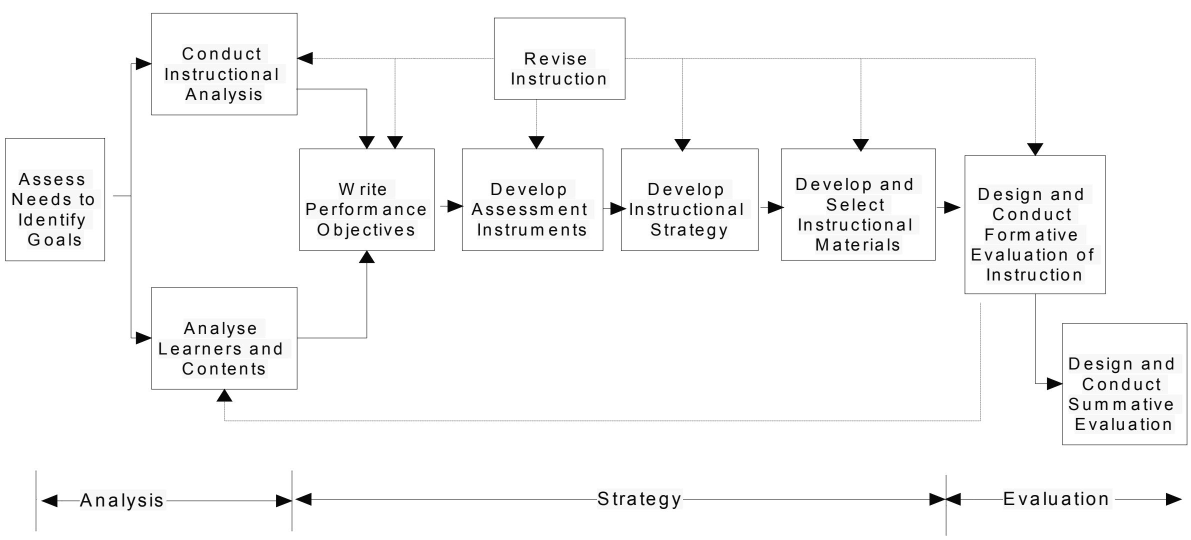


Figure 2.4. Model for designing instruction (Dick, Carey, & Carey, 2001, pp. 2-3).

Information-processing model. It describes learning as a series of transformations of information through a series of suggested structures within the brain (Smith & Ragan, 1999, p. 20). People are believed to be processors of information. They take information as input, apply mental operators to it, and produce information as output (Mayer, 1996). See Figure 2.5.

Therefore, designers of instruction need to be aware of the development of the learner's schema, as the information-processing theory argued (for example, designers must consider the learner' prior knowledge (schemas) in order for new knowledge to find a place in the learners' long-term memory). The role of the teacher under the information processing model consists of setting learning goals, planning learning outcomes, preparing and sequencing learning materials, delivering instruction to the learners, assigning activities, evaluating the students' products and giving feedback (Pantel, 1997).

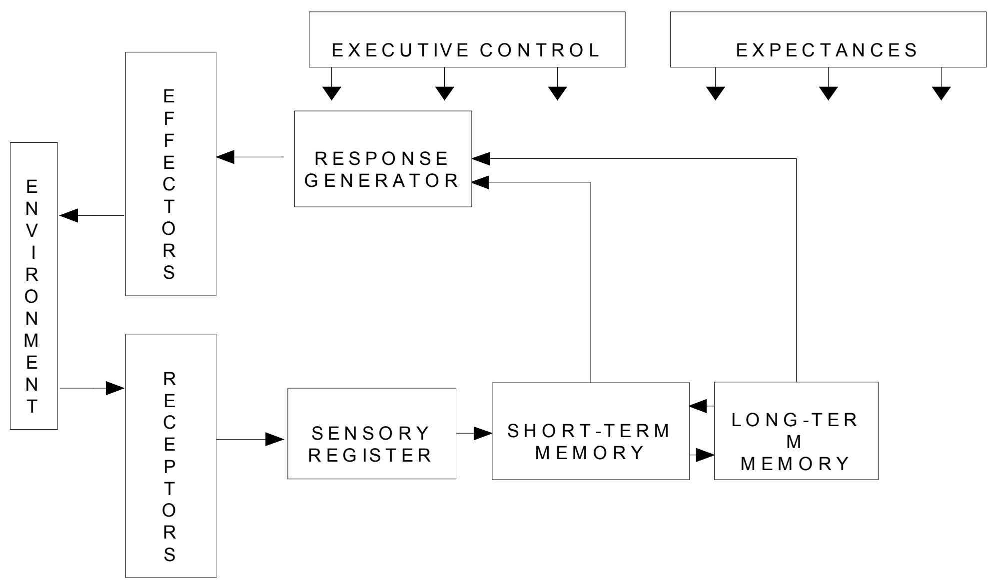


Figure 2.5. Information-Processing Model (Gagne & Drriscoll, 1988, p.13).

Web-based instructional design (WBID) Model. The (WBID) model was developed by Davidson-Shivers and Rasmussen (2006). It contains the basic stages of analysis, evaluation, design and development, and implementation that are also found common to other ID models but in different order. See Figure 2.6.

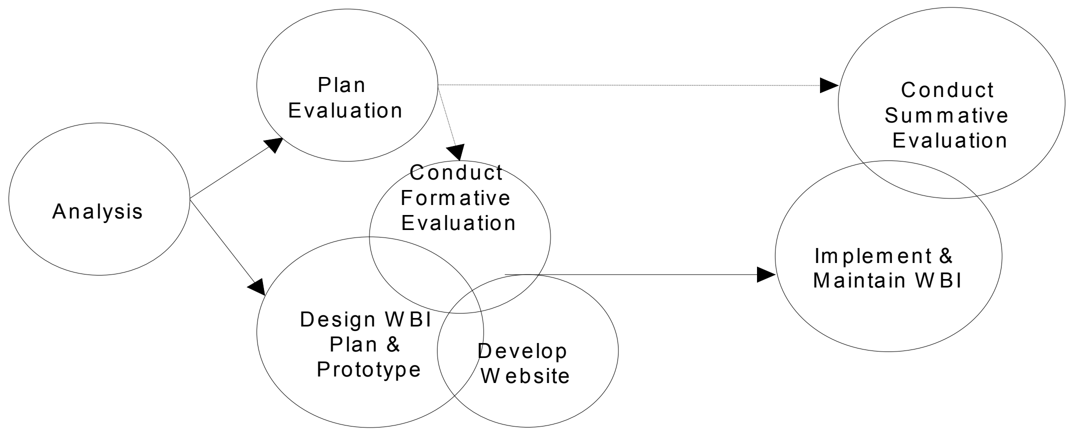


Figure 2.6. Web-Based Instructional Design (WBID) Model (Davidson-Shivers & Rasmussen, 2006)

The WBID model begins with the analysis stage, moves to the evaluation planning, followed by the concurrent design and development, and then implementation and maintenance. Evaluation becomes an integral part of WBID because, after the initial planning, formative evaluation is carried out as it is incorporated into the concurrent design and development stage. At the final stage of WBID, the summative evaluation plans are carried out in conjunction with the implementation and maintenance stage.

The impact of learning theories on instructional design. The design of any instruction usually involves the use of instructional theories, design models and strategies, to help learners develop knowledge and skills (Dijkstra, 2001, p. 282).

The models of Behaviorism. Many aspects of behaviorism engagement in educational technology were recognized in literature such as Programmed instruction**,** Computer-Assisted Instruction (CAI), and so forth. The developers of programmed instruction analyzed instructional tasks, breaking them down into their subtasks, and then devising the steps necessary to bring the learner to a desired performance level, while the developers of CAI have considered so far the drill-and-practice form for learning (Saettler, 1990).

The models of cognitivism. The new models of cognitivism addressed component processes of learning such as knowledge coding and representation, information storage and retrieval as well as the incorporation and integration of new knowledge with previous information (Saettler, 1990).

Based on the above, both behaviorism and cognitivism supported the practice of analyzing a task and breaking it down into manageable chunks, establishing objectives, and measuring performance based on those objectives (Mergel, 1998).

The models of constructivism. As mentioned before, constructivism promoted a more open-ended learning experience. Jonassen (1991) argued that the learning environments can facilitate purposeful knowledge construction through: Providing multiple representations of reality, Presenting of authentic tasks, Provision of real world, Fostering reflective practice, Enabling the context, and Supporting of collaborative construction of knowledge through social negotiation.

So, the design of learning environments for constructivists is not so much concerned with sequencing prescribed material. Rather, it is concerned with creating a learning environment that facilitates the development of higher-order thinking processes such as critical thinking, creative thinking, reflective thinking and metacognition. In such an environment, learners are given significant cognitive responsibilities. They engage in analysis, synthesis, problem solving, experimentation and creativity. They also learn to examine topics from multiple perspectives.

Learning theories and their impact on instructional designs and models to web-based learning. E-learning is an instructional methodology that uses information and communications technology (ICT) to support learning (Gill, 2003). Since the Web has established itself as the main delivery medium in e-learning, it is important that sound principles of ID are followed when developing Web-based learning environments (Ruffini, 2000). Instructors, therefore, should use the Web to enable learners to process information in ways that inform authentic inquiry or activity (Oliver, 2000).

The web-based learning environment (WBLE) has been developed first by instructional designers using traditional instructional design models such as the instructional systems design (Dick & Carey, 2001), and later by the cognitive flexibility theory (Spiro, Feltovich, Jacobson, & Coulson, 1991), and recently by constructivist-learning environment (Jonassen, 1999). As mentioned previously, the traditional instructional design models (like that developed by Dick & Carey, 2001; Smith & Ragan, 1999) focused on a systematic approach to designing instruction. However, Dargan (2003) contended, "Neither Dick and Carey nor Smith and Ragan addressed web-based learning, or how the instructional design model is affected by the use of the Internet to deliver or supplement instruction" (p. 4.)

Literature revealed that advanced technology (the Web) has enabled designers to move toward a more social constructivist approach to design the instruction like the hypertext and hypermedia. Those allowed for a branched design rather than a linear format of instruction (Jonnassen, McAlleese, & Duffy, 1993).

Furthermore, many of these approaches still lack a few important issues related to the implementing phase on the Web. Nam and Smith-Jackson (2007) argued that:

> Many of the developmental approaches lack two important considerations needed for implementing Web-based learning applications: (1) integration of the user interface design with instructional design and (2) development of the evaluation instrument to improve the overall quality of Web-based learning support environments. (p. 24)

Although, human-computer interface has always been viewed as having a critical factor to the success of Web-based instruction (Henke, 1997; Plass, 1998), the current instructional design principles and models do not explicitly address usability issues of the human-computer interface (Nam & Smith-Jackson, 2007).

Nam and Smith-Jackson (2007) classified the design models into three main categories: Objectivist Instructional Design Models (OIDMs) (which include behaviorism and cognitivism); Constructivist Instructional Design Models (CIDMs); and Mixed approach to Instructional Design (MID). However, as different instructional design situations such as different learners and learning environments may require different learning theories and thus different instructional design models, the mixed approach to instructional design proposes all learning theories according to instructional design situations (Schwier, 1995). In their 'Continuum of Knowledge Acquisition Model' Jonassen et al. (1993) noted that the initial knowledge acquisition is better served by instructional techniques based upon traditional instructional design models whereas constructivist-learning environments are most effective for advanced knowledge acquisition. (See Figure 2.7)

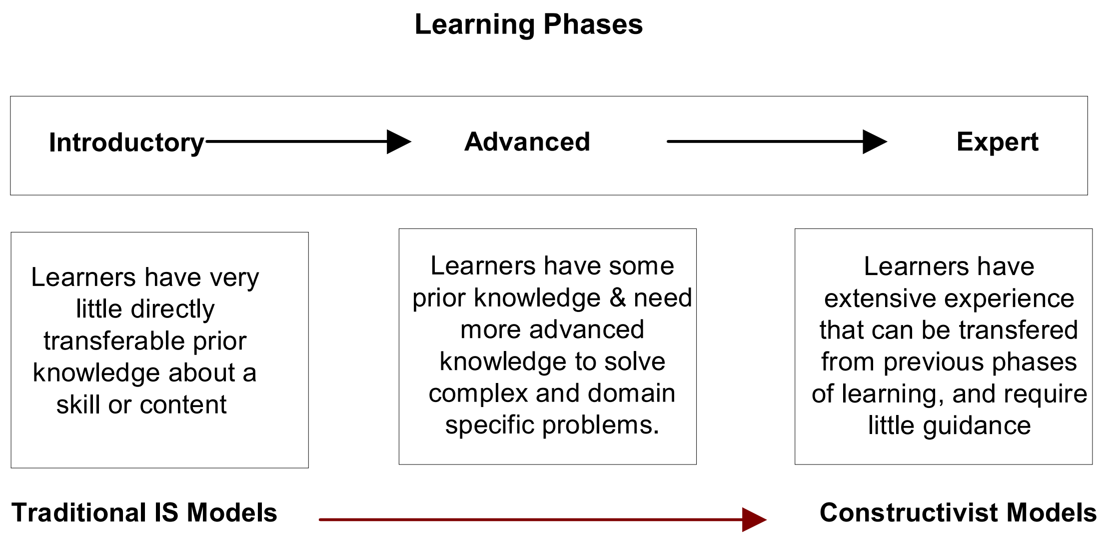


Figure 2.7. Continuum of Knowledge Acquisition Model (Jonassen et al., 1993)

This philosophy was advocated by many researchers. Mishra (2002) has developed a framework where the three learning theories and their basic instructional approaches have been used. (See Figure 2.8)

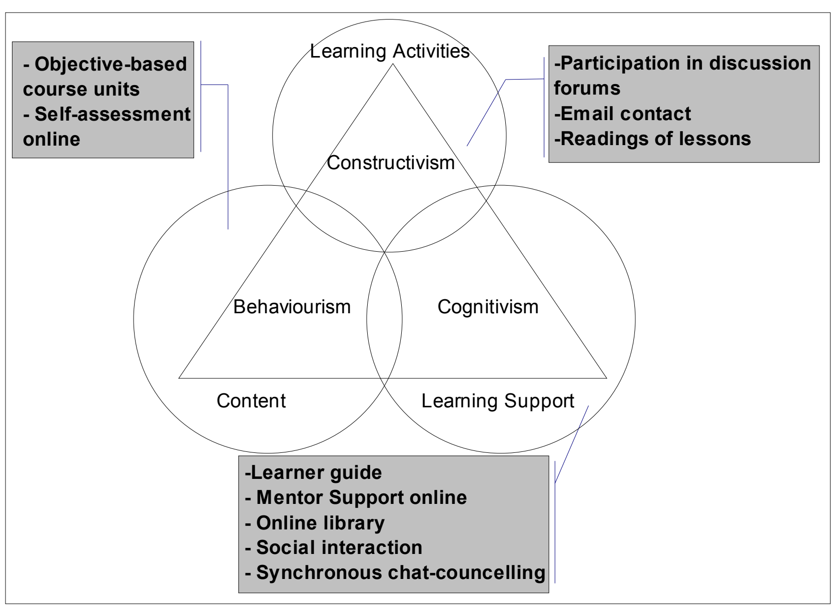


Figure 2.8. Design framework for Online Learning Environment (Mishra, 2002)

Mishra divides the roles of learning theories (behaviorism, cognitivism, and constructivism) over the content, learning support, and learning activities respectively, such that a secondary and primary role is put over each theory. Practically, Mishra acknowledges the necessity for an adapted framework for WBLE planning which makes use of the three learning theories.

Accessibility Overview

Accessibility is the ability of learners with different characteristics and abilities to access an educational system. It is found in literature as an important parameter toward the equality of citizens specially those individuals with disabilities. However, system accessibility was defined as the ease with which people can locate specific computer systems (Kling & Elliot, 1994). Moreover, designing for individuals with disabilities is considered an essential part of any web design today (Foley & Regan, 2002). Indeed, this case occupies today an axis of interest to designers to make learners with disabilities share with others in learning with WBLE.

Based on literature review, accessibility involves two key issues: first, how users with disabilities access electronic information, and second, how web content designers and developers enable web pages to function with assistive devices used by individuals with disabilities (Macromedia Corporation, 2007).

General paradigm of difficulties with learners with disabilities in WBLE. The barriers that disabled users may have in accessing Web information have been categorized in different ways. However, most share common features such as *Visual*, *Auditory*, *Motor*, and *Cognitive* disabilities (Nielsen, 1996). See Table 2.7.

Table 2.7

Types of Accessibility Difficulties for Users with Disabilities

Visual Disabilities

- Irrelevant combinations of background and foreground colors may results in unreadable pages for color-blind users.
- Long pages are problematic since it is harder for a blind user to scan.
- There are still many Web pages without ALTs (alternative text for images).
- Some literal descriptions for images (ALTs) are useless for Web pages unless the user is an art critic.
- The absolute font sizes will be a problem for some users.

Auditory Disabilities

Audio files without ALTs are causing problems for learners with auditory disabilities.

Motor Disabilities

Motor disabilities are related to computer and Internet skills; e.g., many users have difficulty with detailed mouse movements and may have problems holding down multiple keyboard keys simultaneously.

Cognitive Disabilities

- Learners vary in their spatial reasoning skills and in their short-term memory capacity.
- Some learners, too, have difficulty visualizing the structure of information.
- Learners with dyslexia may have problems reading long pages.
- As most user interface's search engine requires the user to type in keywords as search terms, users with spelling disabilities (and foreign-language users) will obviously often fail to find what they want.

Source. Nielsen (1996).

Most researchers are agreed that identifying information quality is an essential aspect of WBLE. To achieve quality in electronic information, it is necessary to ensure that one is retrieving all of the relevant information, and then to determine what of the retrieved information is valuable; and what information is free of bias, propaganda, or omissions (Fenton, 1997).

The importance of accessibility. Accessibility is a common problem the learners face regardless of their abilities. Learners must be able easily to focus on learning materials without having to make an effort to figure out how to access them (Lohr, 2000). This suggests that accessibility probably plays an increasing role in successful WBLE.

Universal accessibility. Universal accessibility lies actually behind the theme of universal design. The universal design (UD) of WBLE was viewed in literature as a process of making WBLE accessible to potential students with wide range of abilities and disabilities: “accessibility implies the global requirement for access to information by individuals with different abilities, requirements and preferences, in a variety of contexts of use” (Stephanidis et al., 1997). It is important to emphasize that universal design was intended only to extend the standard design principles in such a way they may include learners with different abilities and disabilities and not to claim that it addresses all the accessibility problems of learners with disabilities. In addition, the interest is not just towards increasing the numbers of learners involved in WBLE, but otherwise toward improving the levels of those learners as well (Foraker Design, 2002-2005).

Information Quality Overview

Information quality is multilink information related to different areas in the WBLE. Audio, video, graphics, and text all are some aspects of information existing in the WBLE. Furthermore, some researchers have studied the correlation between information quality and levels of user interaction and communication.

Defining informational quality. Information quality (IQ) is recognized generally as a term to describe the quality of the content of information systems. Besides, information quality assurance is recognized as a confidence that particular information meets some context specific to quality requirements. Thereby, "Information quality" was recognized as an important element in the WBLE evaluation process to measure the value provided to the user of that information. However, information quality is a variable element in the environment of learning.

Dimensions of information quality. The generally accepted list of elements used in assessing subjective Information Quality are those put forth in by Lee, Kahn, Strong, and Wang (2002), *Intrinsic IQ*, *Contextual IQ*, *Representational IQ*, and *Accessibility IQ*. Intrinsic IQ implies that information has quality in its own right. Contextual IQ highlights the requirement that IQ must be considered within the context of the task. Representational and accessibility IQ emphasize the importance of computer systems that store and provide access to information.

The Importance of information quality. Most researchers are agreed that identifying information quality is an essential aspect of WBLE. To achieve quality in electronic information, it is necessary to be sure that one is retrieving all of the relevant information, and then to determine what of the retrieved information is valuable; and what information is free of bias, propaganda, or omissions (Fenton, 1997).

The next section will focus on the evaluation methods and criteria of those marked in literature for UPAIAv.

Added Value Overview

Added values point to those new qualities of learning which come alive because of using digital techniques such as computers, WWW, digital learning material, and so forth. Meanwhile, studies predict that these values resulting from using the WWW are expected to be greater in qualitative and quantitative terms than currently extracted from traditional learning. Nokelainen (2006) wrote:

> When computers and digital learning material are used in a learning situation, it is expected that this is done to introduce identifiable added value to the learning in comparison to, for example, printed material, and material produced by the teacher or the students themselves. (p. 181).

However, the idea of "added value" results not only from using the digital techniques alone but also from that magnificent sharing between the high efficiency techniques of learning and digital techniques (Nokelainen, 2006). Nokelainen (2006) shaped the real dimension of added value against traditional learning when he argued:

> While many of the "innovations" that have been executed in computer environments have their equivalents in the world of traditional education…. The added value of computers in this case is technical, because it gives the students a chance to work simultaneously on several different things and save each phase of their work on their own workspace. In a classroom, the activity is more limited and inflexible. (p. 181).

The argument above links apparently between added values and the characteristics of the digital learning container. Moreover, added value has been recognized in the context of using the WBLE as a medium for sharing with teaching methods as pedagogy for learning. Silius and Tervakari (2003, p. 5) wrote: "The combination of new teaching media (the WEB) and the teaching method should produce some special value added for learners, teachers and organizations compared to traditional teaching."

Categories of added value. Silius and Tervakari (2003, p. 5) have approached the study of added values in a WBL and teaching into categories:

1. The flexible organization of learning,
2. The improvement of teaching quality,
3. The development of learning and communication skills by using WBLEs,
4. The innovative use of information and communication technologies in education. (Forsblom & Silius, 2002a, 2002b)

The importance of added value. Literature revealed that added value is one area for evaluation of WBLE in order to make known that this context of learning presents considerable new value of learning comparing with the traditional context of learning. It is, in other words, one parameter of measuring the quality of WBLE.

Section Three: Evaluation Methods and Criteria

This section is focused on determining the evaluation methods for a WBLE in respect to UPAIAv and to highlight subsequently the major aspects used in each one.

Usability Evaluation Methods (UEMs)

What is usability evaluation? Usability evaluation is concerned with gathering information about the usability of a system in order either to improve its interface or to assess it (Preece, 1993). The usability evaluation method as defined by Fitzpatrick (1999) states that "A usability evaluation method is a systematic procedure for recording data relating to end-user interaction with a software product or system".

More specifically, the main goals of evaluation are (Dix et al., 2004, p. 319):

- To assess the extent of the system functionality;
- To assess the effect of the interface on the user; and
- To identify the specific problems with the system.

Evaluation thus involves the user, the tasks, and ease of use of the system. This corresponds with the instrument of usability as discussed previously.

According to various authors, several methods for studying usability were implemented in the field of WBLE (Fitzpatrick, 1999; Shneiderman & Plaisant, 2005; Holzinger, 2005). Holzinger (2005) groups usability evaluation methods into two categories, classified according to whether end users will be involved or not: Inspection Methods (Heuristic Evaluation, Cognitive Walkthrough, and Action Analysis) and Test Methods (Thinking Aloud, Field Observation, and Querying the User). For more descriptions of each, see Table 2.8.

However, the choice among those can be confusing. The main reason behind this confusion is the non-existence of a universally accepted set of rules. The inspection methods do not require end users, whereas test methods do (Holzinger, 2005). While testing the end user is crucial to know the user satisfaction and interaction with a learning unit, therefore, the test methods were under consideration. Furthermore, the review of literature in respect to the usability evaluation methods will focus only on those methods that to some extent relate to the research questions of the present study.

Table 2.8

General Descriptions Of Usability Evaluation Methods

Method	Description
Heuristic Methods	The use of a team of usability evaluation specialists to review a product or prototype in order to confirm its compliance with recognised usability principles and practice.
Cognitive Walkthroughs	A step-by-step evaluation of a design by a cognitive psychologist in order to identify potential user psychological difficulties with the system.
Action Analysis	Evaluators closely inspect the individual actions that a user performs when completing a task.
Thinking Aloud	It allows the evaluator to know what is going through the user's mind when the user thinks aloud while using the system.
Observation	The evaluator acts as the observer of users as they interact with the system.
Querying the user: Questionnaire & Interview	Questionnaire is the use of a set of items (questions or statements) to capture statistical data relating to user profiles, skills, experience, requirements, opinions, preferences and attitudes. Interview is a formal consultation or meeting between usability evaluation specialist and user(s) to obtain information about work practices, requirements, opinions, and attitudes.

Source. (Fitzpatrick, 1999; Holzinger, 2005; Shneiderman & Plaisant, 2005)

Evaluating the Usability of WBLE. We mentioned earlier in the literature review that technical usability is classified as a sub-concept of usability.

Technical usability. Literature revealed that several studies for the evaluation of technical usability have emerged over the last few years (e.g., Chalmers, 2003; Chin, Diehl, & Norman, 1988; Lin, Choong, & Salvendy, 1997; Nielsen, 1993, 1994; Preece, Rogers, & Sharp, 2002; Shneiderman, 1998; Tognazzini, 2003).

Nokelainen (2006) wrote:

> When evaluating technical usability, the basic assumption is that it should be easy to learn to use the central functions of the system and the functions are efficient and convenient in use. Another assumption is that error responses to incorrect operation of the software should help teach the user to use the system as intended so that the error will not be repeated. (p. 178).

The above argument by Nokelainen draws up three dimensions for evaluating the technical usability: the system is easy to use and learn; system is functioning efficiently; and system has relevant and timely feedback for error response.

However, Nokelainen's argument considers part of Nielsen's (1993) usability attributes which are Learnability, Efficiency, Memorability, Errors and Satisfaction. Similarly with regard to the system ease of use, the TAM-model of Davis (1989) advocated that the actual system use is influenced by the perceived usefulness and perceived ease of use. And therefore, this will be helpful in applied contexts for forecasting and evaluating user acceptance of information technology.

Hadjerrouit (2006, p. 130) argued that "Technical usability involves techniques and methods for ensuring a trouble-free interaction with the Web-based learning system…. technical usability is related to how the Web-based learning system is convenient, practicable, and usable for the learners...” The above argument connects technical usability with users’ interaction and states conditions for the system to be convenient, practicable, and usable.

However, there are many factors affecting the technical usability of Web-based learning systems. Two major criteria were recognized:

First, Nielsen (1993-2000) addresses the following factors:

1. Site Structure, 2. Local Search, 3. Navigation and Linking, 4. Screen Appearance, and 5. Interactivity.

Second, the IBM Web design guidelines focus on five major factors to keep track of Web usability: 1. Structure, 2. Navigation, 3. Visual Layout, 4. Textual Content, and 5. Media Elements. (IBM, 2000). See Table 2.9.

It is apparent that similarities and intersections exist among Nielsen’s factors and the IBM guidelines. However, there are some differences. Nielsen has considered the Interactivity between learners and User Interface as an important element of measuring the technical usability of WBLE.

In addition to the factors above that affect the technical usability, some techniques have real presence such as the site map:

Site map. A site map is like a diagram of the site. Its main benefit is to give users an overview of the site’s areas at a single glance by dedicating an entire page to a visualization of the information architecture. If the site map is too big, the users probably lose their ability to grasp the map as a whole. Therefore, it should be small and simple. Furthermore, the site map is not a navigational challenge (Nielsen, 2002); otherwise, it becomes complicated and hard to follow. So, the site map may be evaluated mainly in terms of simplicity and flexibility.

Table 2.9

The Web Design Guidelines

Characteristics	Guidelines
Structure	• Develop a user-centred structure for your site • Create a flow diagram • List the elements and links for each page of the diagram • Design hierarchies of breadth rather than depth
Navigation	• Provide feedback that tells users where they are in your site • Use navigation elements consistently • Provide persistent links to the home page and to high-level site categories • Ensure that image maps are accessible to vision-impaired users • Include a "skip to main content" link at the top of each page • Test the navigation design
Text	• Create effective headings and place important information first • Keep links separate from narrative text blocks • Design for default browser fonts • Make paragraph text flush left • Test for readability • Provide a means for users to print groups of related pages
Content	• Identify information content • Plan content that uses Web technology in unique and appropriate ways • Design your site so that it is accessible to a full range of users • Plan to give users content that will format correct in their browsers • Obtain URLs that will enable users to find your site easily
Visual layout and elements	• Design within boundaries of an "image-safe" area • Design in a style that will appeal to your audience's tastes • Test the visual design • Establish and/or comply with your organisation's design conventions

Table 2.9 *(continued)*

Visual layout and elements	• Maintain consistent visual identity • Present your message efficiently and avoid clutter • Draw attention to new or greatly changed content • Avoid requiring users to scroll in order to determine page contents • Avoid requiring the use of horizontal scroll bars • Use the top and left areas of the page for navigation and identity
Media	• Provide user controls • Provide text equivalents for visual and auditory content • Inform users of the content and size of media objects • Use animations to attract attention • Create animations that enhance explanation • Use repetitive loops sparingly

Source. (IBM, 2000)

Evaluating the universal usability of WBLE. Evaluating the universal usability of WBLE became a crucial concern. Shneiderman (1998) proposed a collection of principles to improve the usability of user Interface design that are derived heuristically from experience and applicable in most interactive systems. He calls them the "Eight Golden Rules of Interface Design": 1. Strive for consistency, 2. Enable frequent users to use shortcuts, 3. Offer informative feedback, 4. Design dialog to yield closure, 5. Offer simple error handling, 6. Permit easy reversal of actions, 7. Support internal locus of control; and 8. Reduce short-term memory load.

Next, Nokelainen (2004) developed ten general dimensions of the technical usability criteria for digital learning materials: Accessibility, Learnability and Memorability, User Control, Help, Graphical layout, Reliability, Consistency, Efficiency, Memory Load and

Errors. These dimensions relate so far to Nielsen's usability attributes discussed earlier in this chapter.

Pedagogy Evaluation Methods

Schrum (1998) indicates that "Pedagogical issues include the identification of learning goals, philosophical changes in teaching and learning, reconceptualizations of the teacher's role, evaluation of student and instructor, and the stimulation of interactivity." (p. 56). However, certain learning models have been proposed for supporting and/or evaluating e-learning environments, including web-based learning. Thus, the following section is purposed to depict those pedagogical evaluation methods and to highlight their effective dimensions consequently.

The effective dimensions of interactive learning on the WWW. Reeves and Reeves (1997, pp. 59-64) elaborated a model of ten effective dimensions for interactive learning on the World Wide Web. The dimensions range from a pure instructivist (objectivist) structure to radical constructivism. See Figure 2.9 that illustrates the philosophy of these dimensions.

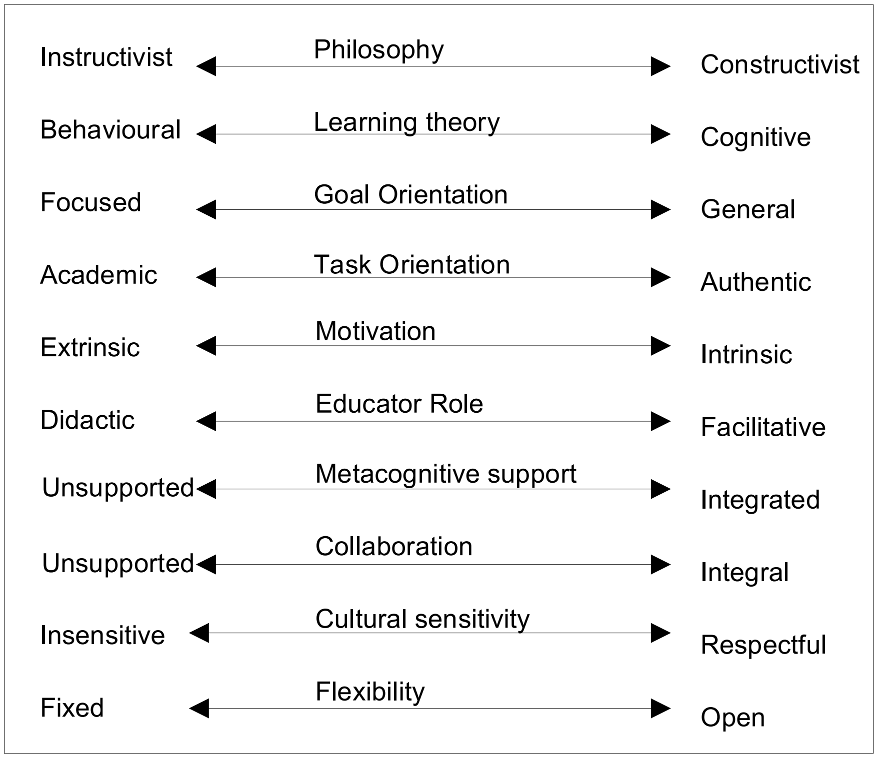


Figure 2.9. The Ten Continuum of Reeves' Model for Effective Interactive Learning. (Reeves & Reeves, 1997, pp. 60-64)

Pedagogical usability criteria. As presented in an earlier section, literature has revealed that to evaluate the pedagogy, one has to check whether tools, content, interface, tasks of WBLE support learners to learn in various learning contexts according to specific pedagogical objectives. The most common elements of pedagogical usability criteria presented by various researchers (Albion, 1999; Horila, Nokelainen, Syvanen, & Overlund, 2002; Quinn, 1996; Reeves, 1994; Squires & Preece, 1996, 1999) and cited by Nokelainen (2006, p. 181) could be seen in Table 2.10.

Table 2.10

Pedagogical Usability Criteria

Reeves (1994) "Pedagogical dimensions" b	Quinn (1996) "Educational design heuristics" b	Squires & Preece (1996) "JIGSAW model" a	Albion (1999) "Content heuristics" b	Squires & Preece (1999) "Learning with software heuristics" b	Horila, Nokelainen, Syvänen & Överlund (2002) "Pedagogical usability of digital learning environments" c
1. Learner control	1. Clear goals and objectives	1. Specific learning tasks	1. Establish-ment of context	1. Appropriate levels of learner control	1. Learnability
2. Pedagogical philosophy	2. Context meaningful to domain and learner	2. General learning tasks	2. Relevance to professional practice	2. Navigational Fidelity	2. Graphics and layout
3. Underlying psychology	3. Content clearly and multiply represented and multiply navigable	3. Applica-tion operation tasks	3. Representati on of professional responses to issues	3. Match between designer and learner models	3. Technical requirements

(table continues)

Table 2.10 *(continued)*

4. Goal orientation	4. Activities Scaffolded	4. General system operation tasks	4. Relevance of reference materials	4. Prevention of peripheral cognitive errors	4. Intuitive efficiency
5. Experiential value (Authenticity)	5. Elicit learner understandings		5. Presentation of video resources	5. Understandable and meaningful symbolic representation	5. Suitability for different learners and different situations
6. Teacher role	6. Formative evaluation		6. Assistance is supportive rather than prescriptive	6. Support personally significant approaches to learning	6. Ease of use: Technical and pedagogical approach
7. Program flexibility	7. Performance should be ‘criteria referenced’		7. Materials are engaging	7. Strategies for the cognitive error recognition, diagnosis and recovery	7. Interactivity
8. Value of errors	8. Support for transference and acquiring 'self learning' skills		8. Presentation of resources	8. Match with curriculum	8. Objectiveness

(table continues)

Table 2.10 *(continued)*

9. Cooperative learning	9. Support for collaborative learning	9. Overall Effective-ness of materials	9. Sociality
10. Motivation			10. Motivation
11. Epistemology			11. Added value for Teaching
12. User activity			
13. Accommo-dation of individual differences (Scaffolding)			
14. Cultural Sensitivity			

Source. (Nokelainen, 2006).

a = Theoretical model. b = Theoretical model and heuristic checklist. c = Theoretical model and subjective end-user inventory.

Nokelainen (2006) stated that the existing criteria for the assessment of the pedagogical usability of digital learning materials (as seen in Table 2.26) neglect partially the role of learner's activity, added value of digital learning material, learning motivation and feedback related to user input. He argued that none of the existing criteria included such concepts as valuation of previous knowledge and role of pre-testing and diagnostics. Meanwhile he introduced a new model with ten dimensions. See Table 2.11

Table 2.11

Criteria for Pedagogical Usability for Evaluating the Digital Learning Material

Dimension	Description
Learner Control	Learning a new topic requires the learner's memory to be burdened to an optimal level (Miller, 1956; Shneiderman, 1998, p. 355).
Learner Activity	A teacher's "didactic role" in a learning situation may strongly scaffold the learners' own activity, and, correspondingly, the learners' independent activity may be increased when the teacher stays in the background, as a "facilitator" (Reeves, 1994).
Cooperative/ Collaborative Learning	Learning takes place in groups in which the members gather and structure information, in which case the system or learning material should offer the learner tools that can be used to communicate and negotiate different approaches to a learning problem (Jonassen, 1995).
Applicability	The skills or learned knowledge should be transferable to other contexts (Quinn, 1996; Reeves, 1994).
Added Value	When computers and digital learning material are used in a learning situation, it is expected to introduce definite added value to the learning.
Motivation	Key concepts of motivation include incentives, self-regulation, expectations, attributions of failure and success, performance or learning goals, as well as intrinsic or extrinsic goal orientation (Reeves, 1994; Ruohotie & Nokelainen, 2003).
Valuation of Previous Knowledge	Learning material must take into account individual differences in skills and knowledge and encourages them to take advantage of it during studies.
Flexibility	The learner should be given a chance to navigate freely through the learning material.
Feedback	The system or learning material should provide the student with encouraging and immediate feedback (Albion, 1999; Quinn, 1996).

Source. (Nokelainen, 2006)

However, there are additional dimensions recognized by Siragusa (2005) that are important for evaluating the pedagogy of WBLE such as Structure/Organization, Content, Interaction, and the Lecturer' role:

Structure/Organization. The way the content of learning material is structured and displayed is of high importance for learners to learn. The structure of an online learning environment should follow the principles of instructional theories (Reigeluth, 1999).

Content. The content of the learning materials that students worked through forms the main body of learning. Content includes the subject/course content, assignments, activities, case studies, lecturer/tutorial/laboratory notes, reading materials, tests, and so on. The developer of online learning should decide which content is relevant to instructional goal and in what sequence it should follow.

Interaction. Learners' interaction with each other, with their instructor, and within the online learning material determine to some extent their level of learning. Northrup (2001, p. 5) wrote, "Interaction doesn't just happen. It must be designed intentionally into the web-based course." Therefore, the developer of online learning should design procedures that aim to acquire such interactions.

Lecturer's role. Teacher' role was not the same within learning theories. It has been seen as essential in improving online learning. Siragusa (2005) has argued, "Instructional materials with appropriate pedagogical design for delivery over the Internet, in combination with the lecturer's willingness to participate in the online learning experience, contribute towards students' motivation to succeed with their learning in this environment" (p. 8).

Empirical evaluation of the criteria. The previous pedagogical usability criteria were applied using a self-evaluation questionnaire that employed a Likert scale starting from 1 (strongly disagree) – 5 (strongly agree), 6 (not applicable), 7 (don't know). The instrument contained 92 multiple-choice items. The teacher and learners/students each have their own versions of the evaluative statements (Nokelainen, 2004). The results show that the measurement instrument was effective and able to evaluate the usability and pedagogical usability of the learning platform and learning unit.

Pedagogical usability criteria based on learning theories. We previously found that a pedagogical usability built on learning theory is important and essential for the design of a pedagogical and usable Web-based learning.

The learning process as argued earlier was based on three types of learning: behaviorist, cognitive constructivist, and, social constructivist (Hadjerrouit, 2006). Moreover, many researchers were agreed that a suitable combination of learning theories is a good entrance to pedagogical and usable Web-based learning (Hadjerrouit, 2006; Nam & Smith-Jackson, 2007). See Table 2.12, which offers criteria to be considered when designing Web-based learning.

Table 2.12

Pedagogical Usability Criteria Based On Learning Theories

With respect to *behaviorism*:

- Break down the subject matter into small learning units (lessons) and logically discrete instructional steps.
- Provide a well-structured presentation of information.
- Allow easy accessibility of information.
- Provide powerful explanation of the information

(Mayes & Fowler, 1999)

With respect to the *cognitive constructivist*:

- Authentic task-based activities and exercises taken from real-world situations.
- Well-designed examples that students may follow when they perform task-based activities.
- The presentation of knowledge from previous versions of the course that students may reuse.
- The recording of learning material that is intrinsically motivating.
- The multiple representation of information using various media elements.
- Evaluation procedures that are embedded in the learning process.
- Links to interactive educational software (animations, simulations, multimedia, etc.)

Feedback from instructor to the learners towards solutions to authentic problems.

(Wilson, 1998).

(table continues)

Table 2.12 *(Continued)*

With respect to the *social constructivist*

- Arena for collaborative assignments to produce a shared project report, or solution to a problem.
- Forum for dialogue through Web-enabled discussions with the instructor and fellow students
- Online submission of compulsory project work and online instructors' feedback as well.
- Shared workspaces containing resources to all students. Such workspaces would allow collaborative work on shared tasks.
- Spaces that can be tailored according to the situational needs. This includes students having the rights to add, modify, customize, manage, and delete items themselves.
- Links to online databases, online journals, software libraries, interest groups, etc. (Kunz, 2004).

Source. (Hadjerrouit, 2006, p. 131)

The above criteria were considered to some extent in Nokelainen' pedagogical usability criteria. Furthermore, the Nokelainen pedagogical usability dimensions could be elaborated based on the guidelines of learning theories as reflected in the previous Hadjerrouit criteria**.**

Accessibility Evaluation Methods

The most common view of evaluation of accessibility came from the World Wide Web Consortium (W3C), which has developed comprehensive Web Content Accessibility Guidelines (WCAG 1.0 & WCAG 2.0 Guidelines) that tell how to design websites that are accessible to people with different abilities and disabilities. These guidelines were used frequently in the evaluation field of accessibility of WBLE. See Table 2.13.

Table 2.13

Web Content Accessibility Guidelines 2.0

Principle	Guideline
1. *Perceivable* - Content	1.1 Provide text alternatives for any non-text content. 1.2 Provide synchronized alternatives for multimedia. 1.3 Create content that can be presented in different ways without losing information or structure. 1.4 Make it easier for people with disabilities to see and hear content including separating foreground from background.
2. *Operable* - Interface components	2.1 Make all functionality available from a keyboard. 2.2 Provide users with disabilities enough time to read and use content. 2.3 Do not create content that is known to cause seizures. 2.4 Provide ways to help users with disabilities navigate, find content and determine where they are.
3. *Understandable* - Content and controls	3.1 Make text content readable and understandable. 3.2 Make Web pages appear and operate in predictable ways. 3.3 Help users avoid and correct mistakes.

(table continues)

Table 2.13 *(Continued)*

4: *Robust* -Content	4.1 Maximize compatibility with current and future user agents, including assistive technologies. 4.2 Ensure that content is accessible or provide an accessible alternative.

Source. The World Wide Web Consortium (W3C)

Furthermore, literature asserted that information accessibility is not separate from the usability and approachability: “When system is usable, it is accessible” (Ardito et al., 2006). In addition, the evaluation process of educational software must consider its usability as well as its ***accessibility*** and its didactic effectiveness (Ardito et al., 2006). Accessibility is best conducted when arguing the usability and pedagogy of CBLE and WBLE together. This finds its reality too if we came back to the guidelines for accessibility which are mentioned above (The World Wide Web Consortium (W3C)) and see how they are related to the content and interface components.

Universal accessibility. We introduced previously in Section Two that universal accessibility lies behind the theme of universal design. The general principles of such universal design for universal accessibility were focused on flexibility, simplicity and intuitiveness, error minimization, provision of redundant modalities, and avoidance of side effects.

Information Quality Evaluation Methods

Literature revealed that having information quality in the WBLE is not separate from having usable, pedagogical, and accessible learning environments. Fenton (1997) argued that in order for learners to have information quality, three things are necessary:

- Gaining full and appropriate access to the available information.
- Making full use of the retrieval mechanisms, which requires an understanding of how these mechanisms work. Such retrieval mechanisms are the Search engines and directories.
- Evaluation of the quality of the information.

The relationship between information quality and information accessibility is clear. Accessibility is one condition for information quality but by itself it is not enough.

However, as presented earlier in Section Two, there are four dimensions related to the informational quality. They are Intrinsic IQ, Contextual IQ, Representational IQ, and Accessibility IQ. These dimensions formed comprehensive criteria for evaluating the IQ. See Table 2.14.

Table 2.14

Informational Quality' Criteria

Dimension		Description
Intrinsic IQ	Accuracy	Information is legitimate or valid according to some stable reference.
	Objectivity	Information is unbiased and impartial.
	Believability	Learners accept information as correct.
	Reputation	Information or its source is in high standing.
Contextual IQ	Relevancy	Information is applicable and helpful/applicable in a given activity.
	Timeliness	Time elapsed from the last update to a source is normal.
	Completeness	Information object matches the precision and completeness needed in the context of a given activity.
	Amount of information	The size of the query result is in normal standards.
Representational IQ	Interpretability	Information conforms to technical ability of the learner.
	Understandability	The user easily comprehends information.
	Concise representation	The structure of the information matches the information itself.
	Consistent representation	Concepts and meanings are the same in different contexts.
Accessibility IQ	Accessibility	The feasible query is correctly answered in a given time range.
	Ease of operations	The system operations are manipulated easily.
	Access security	Information is passed privately from learners to the information source and back.

Source. (Lee, Kahn, Strong, & Wang, 2002)

The above criteria have employed the questionnaire as an instrument to measure the IQ. All items were measured on a scale from 0 to 10 where 0 is not at all and 10 is completely (Lee et al., 2002).

Added Value Evaluation Methods

As added values were recognized in the form of creative use of the digital learning and techniques (Nokelainen, 2006, p. 184); some methods were recognized in literature to evaluate the added value in these two contexts of digital learning and system techniques.

Evaluation of the added value in WBLEs. The evaluation methods recognized in literature were more connected to the individual's context and have considered all those involved in the WBLE process: the attitudes, expectations and experiences of learners, teachers and other actors (Silius & Tervakari, 2003, p. 5).

As mentioned earlier, those added values were classified into four categories, and the evaluation processes, which are recognized in literature, have centered on these four categories as well. See Table 2.15.

Table 2.15

Added Value Criteria

Dimension		Description
The flexible organization of education	Understanding time and space	Teachers must flexibly plan the interactive activities and the course structure.
	Interdisciplinary and vertical study opportunities	Learners should be given the opportunity to choose learning modes.
	Access to digital materials	Learners must be informed and provided access to electronic resources.
The improvement of teaching quality	The design of learning environments and course structures	Lecturers must be skilled in using the tools and characteristics of the learning environments.
	The quality of teaching materials	Learners' opinions must be considered.
The development of learning and communication skills using web-based learning environments	Collaborative web-based learning	The lecturers' and learners' opinions toward the various ways of interactivity offered by the WBLE tools must be considered.
	Individualized self-directive web-based learning	Learners must be given control over learning. The collaborative and individualized teaching must be used adequately and consistently.
The innovative use of information and communication technologies in teaching	Technological expertise	Lecturers should have the technological expertise needed to capture the environment tools.

Source. (Silius & Tervakari, 2003)

Section Four: The Use of Structural Equation Modeling (SEM) in the Construction and Validation Process of the Evaluation Instrument

Structural Equation Modeling

The use of SEM in developmental research has increased and grown dramatically during recent years. Ullman (2001) described SEM as a combination of exploratory factor analysis and multiple regression. Thus, researchers conduct SEM when constructing a model or an instrument.

Justification for using SEM. Use of SEM is growing rapidly in literature and in different fields. Researchers use SEM to estimate the relationships between latent variables, to compare models (to determine which one best fits the data) or disprove models; to explore direct, indirect and total effects; to explore multivariate relationships in an integrated manner, and so forth (Streiner, 2006).

Basic composition. The general SEM model can be decomposed into two sub models: a *measurement model* (defines relations between the observed and unobserved variables) and a *structural model* (defines relations among the unobserved variables).

Statistical Software Programs that Assist with SEM

Literature reveals that many of software programmes help with SEM. AMOS is one of these programs.

Analysis of Moment Structures (AMOS). AMOS is a program to assist with SEM. AMOS is an acronym for “Analysis of Moment Structures” or “analysis of mean and covariance structures”. AMOS Graphics provide us with all the tools that we will ever need in creating and working with SEM path diagrams.

Factor analysis

Factor analysis is often used to construct scales in the social sciences. DeCoster (1998) defined factor analysis as a collection of methods used to examine how underlying constructs influence the responses on a number of measured variables. This allows numerous intercorrelated variables to be condensed into fewer dimensions, called factors. Basically, there are two types of factor analysis, exploratory and confirmatory.

Exploratory factor analysis. Exploratory factor analysis (EFA) is the first statistical procedure seeking mainly to define the factors and reduce data. Byrne (2001) wrote that the EFA is designed for the situation where the links between latent and observed variables are unknown or uncertain. Essentially, the EFA is used in the research to define the underlying constructs for items in the evaluation instrument.

Extraction methods. Many statistical procedures exist to identify the appropriate number of factors underlying a set of items (e.g., SPSS has Principal Components Extraction, Unweighted Least Squares, Generalized Least Squares, Maximum Likelihood, Principal Axis Factoring, Alpha Factoring, and Image Factoring). By default the Principal Components Extraction is the default method of extraction in many popular statistical software packages, including SPSS and SAS (Costello & Osborne, 2005). It is simple and until more recently was considered the appropriate method for exploratory factor extraction.

Principal components extraction (PCE). In Principal Components Analysis, the inter item correlation coefficient matrix is analyzed to help in exploring the inter-relationships between the items. The purpose of this procedure is to determine if the items can be grouped together to represent a smaller set of underlying factors.

Number of Factors Retained. After extraction the researcher must decide how many factors to retain for rotation. The default in most statistical software packages is to retain all factors with eigenvalues (Eigenvalues are the variances of the factors) greater than 1.0 (Nunnally, 1978). Therefore the best choice for researchers is the scree test. This involves examining the graph of the eigenvalues and looking for the natural bend or break point in the data where the curve flattens out. The number of data points above the "break" is usually the number of factors to retain (Cattell, 1966).

Rotation. The next decision is rotation method. The goal of rotation is to simplify and clarify the data structure. As with the extraction method, there are a variety of choices such as: Varimax, equamax, direct oblimin, quartimin and promax. Varimax rotation is by far the most common choice (Harman 1970; Krzanowski 2000).

Factor loading. Factor loading refers to the "correlation of the original variable with a factor" (Rietveld & Van Hout, 1993, p. 292). This is especially useful for determining the "substantive importance of a particular variable to a factor" (Field, 2000. p. 425). Actually, this is done by squaring this factor loading (Squaring the factor loading –the correlation of a variable will determine the amount of variance accounted for by that particular variable).

However, researchers consider various criteria for factor loading. Harman (1970) and Krzanowski (2000) suggest that items with factor loading values below the cut-off value of 0.5 on their own scales or greater than 0.4 on each of the other scales should be eliminated. This is aimed at achieving more meaningful and interpretable correlations among observable items. However some researchers consider the cut-off value to be an absolute value that is greater than 0.4 (Stevens, 1992).

Confirmatory factor analysis (CFA). CFA is a theory-testing model. The researcher begins with a hypothesis prior to the analysis. This model or hypothesis specifies which variables will be correlated with factors and which factors are correlated. The hypothesis is based on a strong theoretical and/or empirical foundation (Stevens, 2002). Thus, CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists. The researcher uses knowledge of the theory, empirical research, or both, postulates the relationship pattern a priori and then tests the hypothesis statistically.

Model fit*.* Literature of SEM has distinguished many approaches of fit indices (e.g., the absolute or stand-alone indices, incremental or comparative fit indices (Gerbing & Anderson, 1993; Hu & Bentler, 1995). An absolute fit index directly assesses how well a priori model reproduces the sample data. In contrast, an incremental fit index measures the proportionate improvement in fit by comparing a target model with a more restricted, nested baseline model. The following indices are samples of model fit used frequently in literature:

The Chi-Square value is the traditional measure for evaluating overall model fit and, "assesses the magnitude of discrepancy between the sample and fitted covariances matrices" (Hu & Bentler, 1999). However, due to the Chi-square sensitivity to sample size (Joreskog & Sorbom, 1993), researchers have sought alternative indices to assess model fit.

One of them is the relative chi-square or normal chi-square (Chi- Square/Degree of Freedom) (CMINDF: X^2 /df) (Wheaton et al., 1977). The Tucker-Lewis index (TLI) which was developed by Tucker and Lewis (1973) compares the lack of fit of a target model to the lack of fit of a baseline independence model. The TLI's value "estimates the relative improvement [in fit] per degree of freedom over a baseline model" (Hoyle & Panter, 1995, p. 166).

The Normed Fit Index (NFI) was developed by Bentler and Bonet (1980) to analyze the covariance structures, while the Incremental Fit Index (IFI) was developed by Bollen (1989) to address the issues of parsimony and sample size and has been promoted strongly by Bentler (1990). The Goodness of Fit Index (GFI) was proposed by Jöreskog and Sorbomis (1993) to measure the relative amount of variance and covariance in the sample data that is explained by the model. However, given the sensitivity of the GFI (to large and small sample sizes), it has become less popular in recent years and it has even been recommended that this index should not be reported (Sharma et al., 2005).

The Comparative Fit Index (CFI) was developed by Bentler (1990) to take sample size into account as NFI has shown a tendency to underestimate fit in small indices. The Root Mean Square Error of Approximation (RMSEA) was developed by Steiger and Lind (1980) to take into account the error of approximation in the population. For standard values of these indexes see Table 2.16.

Table 2.16

Goodness of Fit Measures Standards In SEM

Goodness of fit measure	Acceptable	Excellent
X^2/df (Wheaton, Muthen, Alwin, & Summers, 1977)	<=3.00	<2.00
TLI (Tucker & Lewis, 1973)	>.90	>.95
NFI (Hooper et al., 2008)	>.90	>.95
IFI (Carlson & Mulaik, 1993)	>.90	>.95
GFI (Jöreskog & Sorbomis, 1993; Miles & Shevlin, 1998)	>.90	>.95
CFI (Bentler, 1990; Bentler & Bonett, 1980)	>.90	>.95
RMSEA (Browne & Cudeck, 1993)	<.08	<.05

Model modification. After examination of parameter estimates, fit indices, and residuals, researchers can conduct model modifications to the original hypothesized model to have a better fitting or more parsimonious model. A modification should be considered only if it makes theoretical or common sense. Furthermore, if a model has been modified and reanalyzed, one should provide evidence that the modified model is statistically superior to the original model with a chi-square test (MacCallum, 1986; MacCallum, Roznowski, & Necowitz, 1992).

Normality in SEM

A severe deviation from normality may result in model rejection even when the model is properly specified (McIntosh, 2006). The critical ratio represents the Skewness (or kurtosis) divided by the standard error of skewness (or kurtosis). Where Skewness is a measure of symmetry (a distribution, or data set, is symmetric if it looks the same to the left and right of the center point) and kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution (kurtosis with high value tends to have a distinct peak near the mean, while kurtosis with low value tends to have a flat top near the mean rather than a sharp peak. A uniform distribution would be the extreme case). Data may be assumed to be normal if skew and kurtosis is within the range of +/- 1.0 (Hildebrand, 1986), (some say +/- 1.5 or even 2.0) (Schumacker & Lomax, 2004, p. 69), otherwise data has significant kurtosis, which means significant non-normality.

p-Value

The *p*-value is one of many other statistical tests used in literature to judge the statistical significance of the null hypothesis. The hypothesis under the test which is denoted H0 is usually stated as the model fits the data. The null hypothesis is generally rejected if the p-value < .05. However, this is not always correct according to Bentler (1990, p. 238). Bentler stated that "acceptance or rejection of the null hypothesis via a test based on *t* may be inappropriate or incomplete in model evaluation for several reasons." Barlett notes that the chosen probability level (e.g., reject the model if $p < .05$) on X^2 test is arbitrary.

A rule of thumb is that RMSEA < =.05 indicates close approximate fit, values between .05 and .08 suggest reasonable error of approximation, and RMSEA > =.10 suggest poor fit (Browne & Cudeck, 1993).

Byrne (2001, p. 85) noted that if the RMSEA point estimate <.05, the upper-bound interval of RMSEA meets the value suggested by Browne and Cudeck (1993); the probability value associated with this test of close fit is >.50 then we can conclude that the initially hypothesized model fit the data well regardless of *p*-value being less than .05.

Sample Size

Sample size have been found to be a critical concern when working with SEM. Studies have revealed that adequate sample size is partly determined by the nature of the data (Fabrigar et al., 1999; MacCallum, Widaman, Zhang, & Hong, 1999). Sample size is important because it relates to the stability of the parameter estimates.

EFA and CFA have different sample size requirements. The minimum sample observation number which has been suggested for the performance of EFA is l00 (Hair et al., 1998). For CFA, it is recommended that there be at least five observations per estimated parameter (Hair et al., 1998).

Instrument Reliability and Validity

In order for the instrument to be generalizable and used as a benchmark for further investigations, it must be reliable and valid.

Instrument reliability. An instrument is reliable to the extent that whatever variables it measures, it measures them consistently at different times and places. However, three major categories of reliability are marked in literature: test-retest, equivalent form, and internal consistency (Beckman et al., 2004):

The test-retest. The researcher is invited to administer the test twice on the same examinees (in different times). The scores should almost be the same for instrument consistency.

The equivalent form. Two different versions of the instrument are passed to the same group. The scores on the two instruments should be correlated for instrument consistency.

Internal-Consistency. Literature indicated several internal-consistency methods. However, most of them have much in common. Cronbach's alpha (Cronbach, 1951) is considered the most common test among those (Nunnally & Bernstien, 1994). Cronbach's alpha is a coefficient (a number between 0 and 1) that is used to rate the internal consistency (homogeneity) or the correlation of the items in a test. Values near 0 indicate low reliability. Values near 1 indicate high reliability. The widely-accepted social science cut-off is that alpha should be .70 or higher for a set of items to be considered a scale (Wilcox, 1992).

Instrument Validity. Validity faces many concerns (e.g., do the items measure what they claim to?) However, three types of validity have been recognised in the literature: content, criterion and construct validity (Anastasi & Urbina, 1997; DeVellis, 1991).

Content validity. Content validity is the estimate of how much a measure represents every single element of a construct. Murphy and Davidshofer (1998) revealed that "content validity is established by showing that the behaviours sampled by the test are the representative sample of the attribute being measured" (p.149). This is frequently done by asking experts in the field.

Criterion validity. Criterion validity is used to demonstrate the accuracy of a measure or instrument by comparing it with another measure or instrument which has been demonstrated to be valid. Friedenberg (1995) defined the criterion validity as the ability of a test to predict performance of another measure.

Construct validity. Construct validity refers to whether a measure or instrument measures the construct adequately. De Vellis (1991) explained that construct validity is the extent that a measure based on theory is positively related to a construct and is negatively related to another construct. Construct validity is conducted in different methods in literature. However, the factor analysis (exploratory and confirmatory) is used efficiently for such a test (Knezek, 1993; Nunnally, 1978).

Conclusion

The main purpose of the literature review was to find out the principles behind the evaluation of WBLE currently existing in the literature. Literature on constructs in the evaluation criteria for the WBLE were then examined.

This process of reviewing the literature revealed that the Usability, Pedagogical usability, Accessibility, Information quality as well as the Added value are considered main constructs in the evaluation instrument on the WBLE. The process was also extended to finding out the possible items that may measure those constructs. The evaluation methods for UPAIAv and the validation processes are also included. The following is a brief summary of the main findings of the literature review:

Case of Usability

Usability is defined by five quality attributes, the *Learnability*, *Efficiency*, *Memorability, Error recovery,* and *user Satisfaction.* These attributes are common in use to evaluate the universal usability of any learning system.

The technical usability that is part of usability is related to how a Web-based learning system is convenient, practicable, and usable for the learners. The factors that affect the technical usability of WBLE are common and more directed to the user interface design and user interaction. Such factors are *Site Structure, Site Content, Navigation tools, Screen design and layout, Media elements,* and *Interactivity.* These factors are of widespread use in the evaluation process of technical usability of system learning and unit.

Case of Pedagogical Usability

Pedagogy is the profession of teaching, while pedagogical usability is the discipline that checks whether tools, content, interface, tasks of WBLE support learners to learn in various learning contexts according to specific pedagogical objectives.

The Pedagogical dimensions refer to the capabilities of the learning system and unit to initiate powerful instructional interactions, monitor learner progress, empower effective teachers, accommodate individual differences, promote cooperative learning, design of learning activities and the learner's ability to control sequence, consider pacing, presentation medium, and level of difficulty.

With regard to the learning and instructional design theories that affect the design of pedagogy:

Literature revealed that three types of learning theories, behaviorism, cognitivism, and constructivism are relevant to WBLE. For the design of learning, many researchers advocated that a suitable combination of learning theories is a good entrance to pedagogical and usable Web-based learning. Indeed, in practice, a mixture of learning theories is being used. Practically, designers do not advocate one single learning theory, but stress the importance of finding strategies that work than taking a position on the side of a particular theory. The instructional strategy and content addressed depend on the level of the learners. Therefore, designers match learning theories with the content to be learned.

Many researchers are agreed that, in the initial stages, classical instructional design is more suitable because it is based upon predetermined outcomes, constrained and sequential instructional interactions and criterion-referenced evaluation. The constructivist approach is more applicable to the advanced phase and it is the most viable approach in the expert phase.

Furthermore, numerous models of instructional design have been developed for the purpose of analysis, strategy development and evaluation of course and lesson design. However, the Dick et al. Systems Approach Model for Designing Instruction has been a widely accepted model in literature and especially in traditional instruction and CBL. The information processing model was used commonly in the field CBL as well. Both of these two models were elaborated to fit with the WBLE, specifically in user interface design, branching and interactivity, structuring of the information, navigation tools, strategies for promoting online interaction, and distance education. Constructivists emphasized more on the design of learning environments. The construction of knowledge, provision of a meaningful and authentic context for learning, and collaboration among learners with the educator as a coach/mentor are common principles in this field of learning design.

Based on the literature, the most common criteria for pedagogical usability were *Learner control, Learner activity, Cooperative/Collaborative learning, Goal orientation, Applicability, Added value, Motivation, Valuation of previous knowledge, Flexibility, Feedback* and *Lecturer role.*

Case of Accessibility

Accessibility is the ability of learners with different characteristics and abilities to access an educational system. A general paradigm of difficulties with learners with disabilities encompassed Visual, Auditory, Motor, and Cognitive difficulties.

The World Wide Web Consortium (W3C) guidelines were considered of supreme importance for evaluating the accessibility of WBLE. They are used on a wide scale in the evaluation researches. These guidelines are *Perceivable-Content, Operable- User Interface components, Understandable- Content,* and *Robust- Content.*

Case of Informational Quality

Information quality (IQ) was recognized as an important element in the evaluation process of WBLE to measure the value provided to the user of that information. The common criteria used in literature to evaluate the IQ consist of four dimensions, namely: *Intrinsic IQ, Contextual IQ, Representational IQ,* and *Accessibility IQ*.

Case of Added Value

Added value points to those new values of learning which come alive because of using digital techniques such as computers, WWW, digital learning material, and so forth. The common criteria regarding the evaluation of added value considered the following four categories: *The flexible organization of learning, improvement of teaching quality, development of learning and communication skills by using WBLEs,* and *innovative use of information and communication technologies in education.*

CHAPTER THREE

METHODOLOGY

Introduction

As outlined in Chapter One, the ultimate objective of this enquiry is to develop an evaluation instrument for a Web-based learning environment that can be used easily by evaluators and designers and is expected to have:

1. The provision of appropriate questionnaire of universal UPAIAv for a WBLE;
2. The provision of appropriate questionnaire for instructional design principles for varying instructional and pedagogical needs;
3. The provision of appropriate questionnaire for variety of learning strategies that accommodate pedagogical needs and varying student learning styles.
4. The provision of a validated Model for UPAIAv which depicts the intercorrelations among the constructs UPAIAv.

This chapter describes the research methods employed to assist in addressing these objectives. The chapter provides the following discussions:

- Factors that influenced the selection of certain research methods.
- The literature review which informed and guided the development of the survey instruments.
- The process used to design and develop the survey instruments.
- The data sources used for this study.
- The data collection process used in this study.
- Finally, the process used to design and develop the Structural Model.

The current development research is a combination of the two types of developmental researches classified in literature (refer to Chapter One, p. 22). First, it is aimed at analyzing the current situation of the SVU regarding the UPAIAv (needs assessment), and after that is to develop an evaluation instrument. The developmental research as seen in Chapter1 has three phases: Analysis, Design, and Evaluation. So, the current methodology chapter will continue to cover these phases as well.

The following diagram illustrates the structure of this chapter.

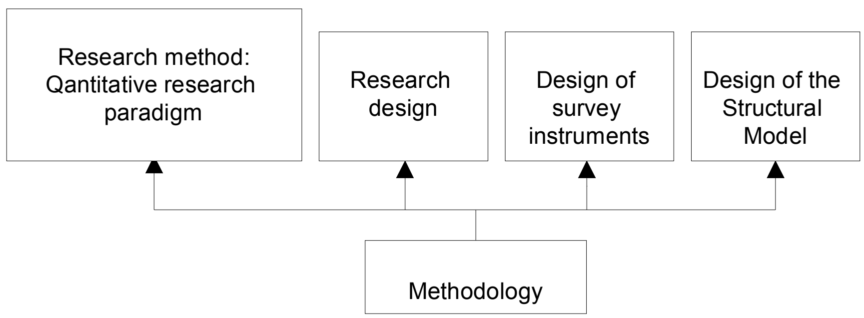


Figure 3.1. The systematic design of the Methodology chapter.

The two types of developmental research use quantitative/qualitative research methods or both (refer to Chapter Two, p. 31). However, the current research will be restricted only to quantitative methods to assist the researcher in answering the research questions presented in Chapter One as will be discussed in the next section.

Quantitative Research Paradigms

There are currently three major research paradigms in education (and in the social and behavioral sciences): *Quantitative research, Qualitative* and *Mixed research* (Johnson & Christensen, 2004). Creswell (2005) defines quantitative research as follows:

> Quantitative research is a type of educational research in which the researcher decides what to study, asks specific, narrow questions, collects numeric data from

> participants, analyzes these numbers using statistics, and conducts the inquiry in an unbiased objective manner. (p. 39).

For my thesis, I considered the quantitative method. Initially, a questionnaire was administered to students. A hard copy of the questionnaire was designed. The online questionnaire was excluded as the respondents are expected not to give enough attention to the online queries. This argument was provided by some of the university staff who attended the interview at the beginning of the need assessment process.

Rationale for the Design

Quantitative research methods are used with developmental researches as they focus on product evaluation. Creswell (2005) has indicated that *"*The quantitative data and results provide a general picture of the research problem*"* (p. 515).

The questionnaire was intended to gather as large amount of data as possible from students and generalize the results. Exploratory Factor Analysis (EFA) and Confirmatory factor analysis (CFA) differ in sample size requirements. For the performance of EFA, a l00 sample size has been suggested as a minimum sample observation number (Hair, Anderson, Tatham, & Black, 1998). For the CFA, at least five observations per estimated parameter are recommended (Hair et al., 1998).

In literature, the questionnaire is often considered to evaluate the software usability (Refer to the Usability Evaluation Methods section, Chapter Two, pp. 73-75). The questionnaire is used to assess the learner's attitudes in CBL (Overfield & Bryan-Lluka, 2003). It is used to evaluate the quality and usefulness of Learning Management System

(LMS) (Georgiakakis, Retalis, Papaspyrou, & Siassiakos, 2007). The teachers and learners (students) each have their own versions of the evaluative statements.

The questionnaire evaluation method is considered as well to evaluate the Pedagogical usability. Nokelainen (2004) used a self-evaluation questionnaire that employs a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), 6 (not applicable), 7 (don't know) (Refer to the Pedagogical usability evaluation methods section, Chapter Two, p. 97).

In addition, the questionnaire evaluation method is considered as well to evaluate the added value, accessibility and information quality (Lee, Kahn, Strong, & Wang, 2002; Nokelainen, 2006; Silius & Tervakari, 2003).

Consequently, the current research employed the quantitative research method for data collection and analysis. The quantitative method allows for the collection of data from a large group of students studying online. Collecting data on students' perceptions of the effectiveness of the WBLE regarding the UPAIAv is expected to be a practical method of inquiry. Fraser (1998) argued that the learners are in the best position to evaluate instruction that is presented to them. The lecturers were excluded from such a survey due to their small sample size currently available in the SVU. However, a further research may involve lecturers in such a survey.

Table 3.1 that provides an outline of the quantitative method employed in this research.

Table 3.1

Blueprint of the Quantitative Method Being Applied in the Research

	Quantitative method
Objectives	• To identify the students' attitudes and perceptions in respect to the UPAIAv of existing WBLE. • To identify students' understanding and use of learning techniques employed with WBLE at the SVU. • To state the levels of students' satisfaction towards these online learning environments. • To state the relationships among the latent variables: Usability, Pedagogy, Accessibility, Information quality and Added value. • To state the direct effect of each of Usability, Pedagogical usability, Accessibility, Information quality on the Added value.
Data Collection method	• Student questionnaire
Rationale	• The students are able to complete questionnaires at a time convenient to them. • The students' questionnaire is to be delivered at the start of the semester and collected at the end of semester for some selective courses. • The data collected will be analyzed using appropriate computer software: SPSS & AMOS.

Research Design

Thus, the current developmental research will employ the quantitative research method. The quantitative research method is used to collect data from a substantial group of students at the SVU (500 students). The analysis process is exploratory and confirmatory. This will lead to the validation of the instrument and the priori model of the UPAIAv as well. The validation process considered the use of the structural equation modelling (SEM) and the Analysis of Moment Structures software (AMOS). Figure 3.2 provides a representation of the research design.

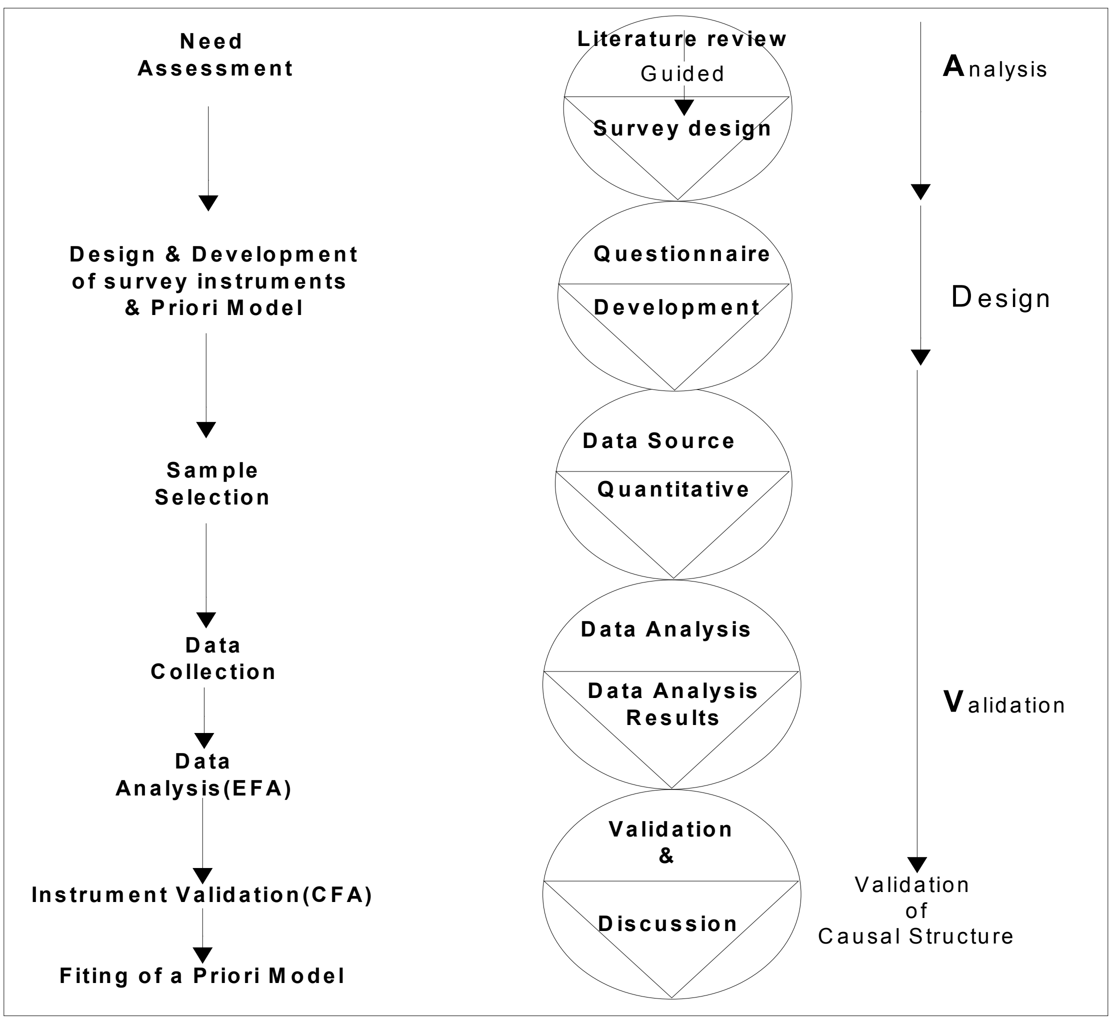


Figure 3.2. The Research Design.

Design of Survey Quantitative Instruments

The development process of the evaluation instrument is based so far on the instrument development processes suggested by Churchill (1979). Churchill's eight-step process are: Specify domain of constructs, General sample of items, Collect data, Purify measure, Collect data, Assess reliability, Assess validity and Develop norms. Specifically, using the method of structural equation model (SEM) has guided the construction process of the priori model and the evaluation instrument as can be seen in Figure 3.3.

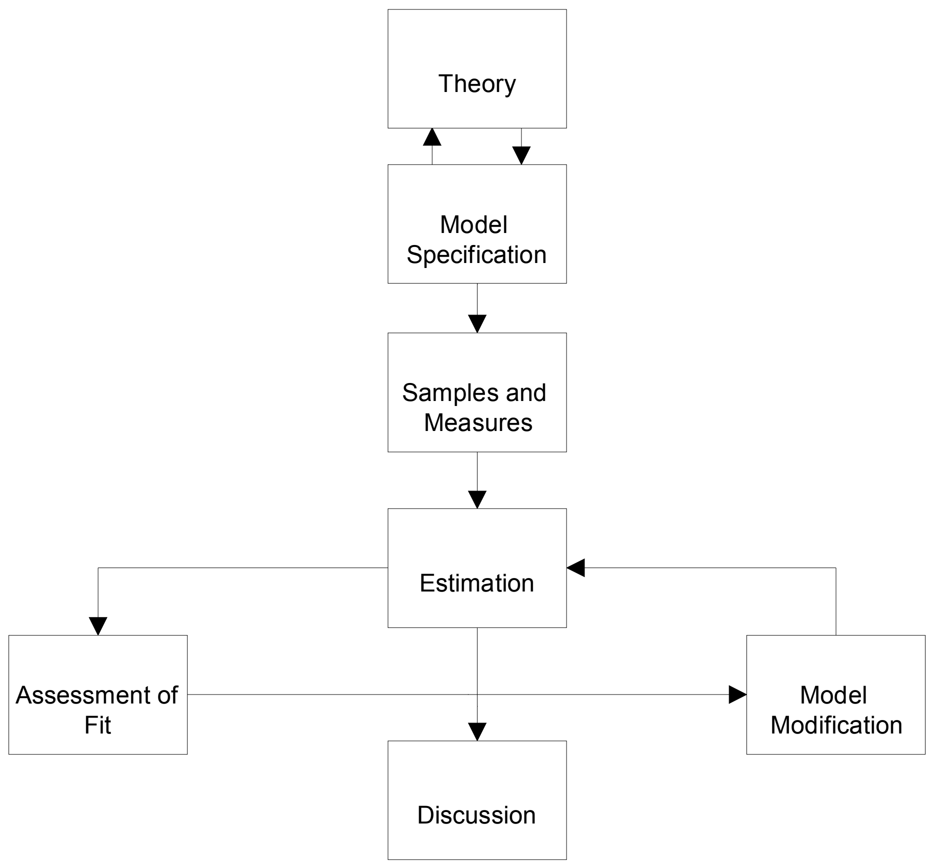


Figure 3.3. The Process Of Construct And Validation Of The Survey Instrument.

Source: From Structural Equation Modeling: *Foundations and Extensions* (p. 8), by David Kaplan, 2000, Advanced Quantitative Techniques in the Social Siences Series. Thousand Oaks, CA: Sage.

The researcher first specified a model based on theory (Model Construction); then determined how to measure constructs (Instrument Construction); collected data and then inputted the data into the SEM software package (AMOS). The package helps to test whether the data fits to the specified model (Model Testing) and produced the results, which included the overall model fit statistics and parameter estimates. In the final step, the researcher reported the interpretation process of the results.

Chapter Two examined the existing body of the design and evaluation of WBLE. The Usability, Pedagogy, Accessibility, Information quality, and Added value (UPAIAv) have been found as main constructs when evaluating the WBLE. Although the literature revealed the existence of many evaluation tools for WBLE such as those developed by Elissavet and Economides (2003) as well as Silius and Tervakari (2003) among others, those instruments revealed two main gaps. First, the current instruments lack the factor analysis study which is necessary to determine to what extent the observed items belong to the underlying constructs. Second is the absence of a Structural Model which can indicate the relationships among the constructs of Usability, Pedagogy, Accessibility, Information quality and Added value. However, the process of constructing an evaluation instrument for the WBLE requires building the current survey in a thorough fashion such that it could combine all the major areas (the UPAIAv) together in one unique tool.

The procedures toward such a task initially started by considering the students' perceptions of effective design and evaluation of online learning environments at the SVU based on the terms UPAIAv. The research emphasized questioning as many students as possible in the SVU. Meanwhile, the survey tried to involve as many online courses as possible in different disciplines at the SVU, so that it can obtain better results. But to be apparent, students are not going to assess those courses as far as those courses where chosen to enrich the evaluation process itself. In terms of, the courses will help students to reflect on some of the general questions within these courses. Figure 3.4 presents the design of the survey.

Figure 3.4 Design and development of the survey instruments.

First is to provide the major definitions of the parameters UPAIAv that informed this research, the well accepted existing evaluation criteria that will contribute in the evaluation process of the UPAIAv, and the best evaluation tools and instruments recognized in literature;

Second, is to identify the essential criteria from those accepted in the existing literature;

Third, is to design and construct the questionnaire schedules to be administered to students;

Fourth, is to pilot and revise the questionnaires schedules.

Such a survey design process is expected to enrich the design of research such as reliability and validity of the instrument. Effectively, the well-designed survey will guide participants towards embracing the given questions. In return, it will help in establishing the goodness-of-fit of the instruments. However, other important details regarding the design of the questionnaire will be revealed throughout the chapter.

Definitions of UPAIAv. Chapter two recognized the UPAIAv as crucial parameters in the evaluation of effective WBLE. The usability has been defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. The Pedagogical usability refers to the tools, content, interface and the tasks of the WBLEs that support various learners to learn in various learning contexts based on the selected pedagogical objectives. Accessibility refers to the extent to which the learning features and system functions are easily accessible and knowledgeable to the students with different abilities. The information quality refers to the quality of information presented via the Web. Finally, the added value refers to the new learning quality by using the Web as a learning environment.

Well accepted criteria in the evaluation processes of WBLE. The criteria for *generic usability, technical usability, pedagogical usability*, *accessibility* , the *information quality* and *added value* (advocated by Nielsen, 1993; Hadjerrouit, 2006; Nokelainen, 2006;

Silius & Tervakari, 2003; W3C; Lee, Kahn, Strong & Wang, 2002 respectively), are considered well accepted (based on the results of these researches) in the evaluation process of WBLE.

Evaluation tools and instruments. Among various evaluation tools for the WBLE, the tool developed by Silius and Tervakari (2003) is considered a pilot, because this tool has considered the UPAIAv adequately. Silius and Tervakari (2003) have developed a multidisciplinary evaluation framework which intended to define the critical factors in the implementation of training and learning services for a given group of learners, teachers and researchers of web-based courses. The evaluation tool was nested in the learning system at the Finnish Virtual University (FVU). Thus the (Silius and Tervakari)' evaluation tool was developed to be used over the Internet. Meanwhile, the effective instructional design model for the online instructional materials developed by Siragusa (2005) has been effective as well. Silius and Tervakari (2003) used the questionnaire as the main instrumentation to evaluate the WBLE regarding the UPAIAv. Also, Siragusa (2005) has used the questionnaire and interview to find out the appropriate online design principles and online learning strategies for varying instructional and pedagogical needs. These two researches used validated instrumentation and were very helpful in the current inquiry.

Identification of essential criteria for WBLE. The criteria described below are based so far on the accepted criteria mentioned above. An official letter has been sent to Siragusa to get permission for using some of the questions in his questionnaire. However, many improvements are done and differences have appeared. The criteria have many dimensions with groups of questions related. They aim and try to solicit only the student's perceptions of the current situation of the parameters of UPAIAv. However, as mentioned in previous section lecturers could be involved in such a survey for further research. These criteria are nests of tables which are considered so far in literature. Based on those criteria, there are major dimensions, essential to evaluate the UPAIAv of the WBLE and are expected to be super components of the prospected evaluation instrument. These dimensions will be used for the questionnaire schedule to be administered to the learners. The next paragraphs will address these two classes and, after that, questions will be developed based on these dimensions.

Statement of dimensions and development and organization of the questions. As stated in the previous section, Chapter Two has guided the current development process of dimensions for the survey which will lead at the end to the development of the proposed evaluation instrument.

Usability. With regard to the *generic usability* criteria, five attributes are applicable to most educational software. For the technical *usability criteria* there are seven dimensions that are specific to Web-based learning. See Tables 3.2, 3.3.

Pedagogy. The dimensions considered here are those related to the role of learning theories, the instructional design theories, and the instructional design models toward the design process of online learning units.

The dimensions of pedagogical usability are intended to examine whether the online learning materials do effectively activate and support student learning. See Table 3.4. Thus, the questions under these dimensions were designed in correspondence with behaviorism, cognitivism and mainly with constructivism.

As three main theories, behaviorism, cognitivism, and constructivism are being considered in literature (Jonassen, McAleese, & Duffy, 1993; Mishra, 2002; Nam & Smith-Jackson, 2007). The dimensions for Pedagogical usability are selected such that they enable examination of how well the lecturer followed the learning principles and how this is reflected effectively in the design process of the online learning unit. These included the main parts in the course design; the content, learning support, and the learning activities. The systematic design theory and the instructional design model by Dick, Carey, and Carey (2005) are both considered as evaluation criteria. (See Table 3.4).

Accessibility. The dimensions of accessibility are centered on both of the accessible system functionality and digital learning materials. See Table 3.5.

Information quality. The dimensions of the information quality are thorough in range covering the information quality through intrinsic, context, representation, and accessibility of this information. See Table 3.6.

Added value. The dimensions of added value will be centered to examine both of the specific characteristics of the digital techniques of the learning system at the SVU and the effective learning and teaching techniques being used by lecturers at the SVU as well. See Table 3.7.

It should be emphasized that some dimensions have questions which interfere and even exist with others. However, these may reflect the exact interrelationships among the UPAIAv.

This section presented each of the dimensions used for the survey with description summarizing its elements that formed the basis of the questions. The elements are presented here in draft point-form prior to the design of the questions which will appear later in the survey. With each of the dimensions and their elements identified, the questionnaires and schedules are able to be created from the layouts shown in the *Survey instruments layouts and design* section later in this chapter.

The design of questions is simple, easy to use, comprehensible, clear, and understandable without any vagueness or confusion. Such design of questions is expected to have good reliability. The questionnaire is scaled by applying a five-point Likert-scale style format as it is predominately used in the literature. In addition, the majority of questions are written as attitude statements. Such a scale is expected to facilitate the process of measuring the internal consistency using the coefficient alpha factor. Such a format will enable students to initiate an attitude continuum for each statement running from 'strongly agree' to 'agree', 'uncertain', 'disagree' to 'strongly disagree' (Oppenheim, 1992, p. 195).

Learners' survey dimensions

Dimensions of generic usability.

Table 3.2

Dimensions of Generic Usability (Basic Attributes)

Dimension	Description
Learnability	This is to examine how easy the system was for users to accomplish basic tasks the first time they encounter the design.
Efficiency	Once users have learned the design, this is to examine how quickly they can perform. What resources expended in relation to the accuracy and completeness while learners achieve goals or perform a task.
Memorability	When users return to the design after a period of not using it, this is to examine how easily they can re-establish the system proficiency.
Errors	This is to examine how many errors users make, how severe these errors are, and how easily they can recover from the errors.
Satisfaction	This is to examine how pleasant it is for learners to use the system. How far is the system comfortable and acceptable for use?

Table 3.3

Dimensions of Technical Usability

Dimension	Description
Performance	The Web-based learning system's basic performance and functionality are of supreme issue. This is to examine how well the link integrity was, the objects and multimedia components efficiency, the speed of loading, the compatibility with other browsers, and so forth.
Navigation Tools	Sound navigation tools are the mechanism of the educational system. This is to examine how well the availability and optional navigation elements were, the ease of use and accessibility, and the validity and productivity of these tools.
User Interface Layout and Design	As the user interface is the point of contact between the learners and the educational system, this is to examine how well the user interface design and layout were, in terms of appearance, ease of use and accessibility, consistency among the interface elements, and efficiency and productivity.
Information Architecture (Structure)	As the information architecture refers to the manner in which the website content is organized, this is to examine the organization of information in terms of whether it considers the learners' way of thinking and acting, the flexibility and consistency.
Content	The content is the real contact and purpose of learners, so this is to examine how well the content was organized, its readability and reliability, stability and consistency.
Media elements	As multimedia elements are to enrich the learning and pleasure to learners, this is to examine how well multimedia elements' appearance were, the ease of use and accessibility, the learner control and the validity and productivity of these elements.
Interaction	As the learner's interaction with the learning system is the ultimate attribute of good system usability, this is to examine the system's effectiveness, the efficiency, relevancy, ease of use and accessibility, the friendliness and enjoyability.

Dimensions of pedagogical usability

Table 3.4

Dimensions of Pedagogical Usability

Dimension	Description
Structure/ Organization	This is to examine how the information is displayed to learners on the Web. Also, to examine in what order the learning materials were found.
Content	This is to examine the content of the learning materials that students worked through. Content included the subject/course content, assignments, activities, case studies, lecturer/tutorial/laboratory notes, reading materials, tests, and so on. Many of the instructional design principles listed in Chapter Two are investigated in this dimension.
Interaction	This is to examine how students communicated with each other and with their instructor within the online learning environment.
Learner control	This is to examine to what extent the learning unit was designed in such a way that the learner is able to choose and move smoothly within the unit.
Cooperative/ Collaborative Learning	This is to examine to what extent the learning is taking place in groups and also to examine how the learning unit is designed such that it can be embraced cooperatively/collaboratively.
Goal Orientation	As learning is a goal-oriented activity, this is to examine whether goals and objectives were clear and presented precisely.
Applicability	This is to examine whether learners were able to transfer the skills or learned knowledge to other contexts of learning.
Motivation	This to examine how the learning materials and the online learning environment were made appealing and interesting for students. This also is to examine how their interest and motivation were maintained as they progressed throughout the learning unit.
Valuation of Previous Knowledge	This is to examine whether the learning unit considers the learner’s previous knowledge, for example, the individual differences in skills and knowledge.
Flexibility	This is to examine the smooth design of learning unit in respect to the clarity, the plentiful options of learning methods and activities, and so forth.

(table continues)

Table 3.4 (continued)

Dimension	Description
Feedback/ Help	This is to examine how students obtained feedback regarding their progress. This also examines how they obtained help while working within the online learning environment.
Lecturer Role	This is to examine what kind of role lecturers have played in designing and delivering online learning.
Learning styles and strategic	This is to examine the kinds of learning styles applied and what activities the learners were involved in throughout their online learning process.

***Dimensions of* accessibility**

Table 3.5

Dimensions of Accessibility

Dimension	Description
Perceivable Content	Information and user interface components must be perceivable by users. This is to examine how well the text alternatives fit the content flexibility, visibility and hearing ability.
Operable User interface	Interface components in the content must be operable. This is to examine how well the user interface components were functioning, generally and specifically for learners with disabilities.
Understandable Content	Information and operation of user interface must be understandable by users. This is to examine how well the main contents of the user interface were readable, understandable, and visible and feedback supported.
Robust Content	Content should be robust enough and accessible. This is to examine how well the content considers current and future compatibility with assistive technology agents.

Dimensions of information quality

Table 3.6

Dimensions of Informational Quality

Dimension		Description
Intrinsic IQ	Accuracy	This is to examine the extent to which information is legitimate or valid according to some stable reference.
	Objectivity	This is to examine the degree to which information is unbiased and impartial.
	Believability	This is to examine the degree to which the information is accepted as correct by the learners.
	Reputation	This is to examine the degree to which the information or its source is in high standing.
Contextual IQ	Relevancy	This is to examine the extent to which information is applicable and helpful/applicable in a given activity
	Timeliness	This is to examine the time elapsed from the last update to a source.
	Completeness	This is to examine the extent to which an information object matches the precision and completeness needed in the context of a given activity
	Amount of information	This is to examine the size of the query result.
Representational IQ	Interpretability	This is to examine the degree to which the information conforms to technical ability of the learner. Technical abilities include languages spoken, units understood, etc.
	Understandability	This is to examine the degree to which the information can be easily comprehended by the user.
	Concise representation	This is to examine the degree to which the structure of the information matches the information itself.
	Consistent representation	This is to examine the extent of consistency in using the same values and elements to convey the same concepts and meanings in an information object

(table continues)

Table 3.6 (continued)

Dimension		Description
Accessibility IQ	Accessibility	This is to examine the probability that a feasible query is correctly answered in a given time range.
	Ease of operations	This is to examine how easy the system operations are to manipulate.
	Access security	This is to examine the degree to which information is passed privately from learners to the information source and back.

Dimensions of added value

Table 3.7

Dimensions of Added Value

Dimension		Description
The flexible organisation of education	Understanding time and space	This is to examine to what extent teachers have flexibly planned the interactive activities and the course structure.
	Interdisciplinary and vertical study opportunities	This is to examine to what extent learners were given the opportunity to choose learning modes.
	Access to digital materials	This is to examine to what extent learners were informed and provided access to electronic resources.
The improvement of teaching quality	The design of learning environments and course structures	This is to examine to what extent lecturers were skilled in using the tools and characteristics of the learning environments to design pedagogically appropriate learning environment.
	The quality of teaching materials	This aimed to elicit the learners' opinions toward the role of web-based environments in producing and updating the teaching materials besides the quality of these materials being produced.

(table continues)

Table 3.7 (continued)

Dimension				Description
The development of learning	The innovative use of communication skills using	and	information web-based learning	
			Collaborative web-based learning	This aimed to elicit the learners' opinions toward the interactive ways offered by the Web-based learning tools.
			Individualized self-directive web-based learning	This is to examine to what extent learners were given control over learning. It examined too, whether collaborative and individualized teaching was used adequately and consistently within the context of learning.
			Technological expertise	This is to examine the lecturers' technological expertise needed to capture the environment tools.

Survey instrument layout and design. The layout of the questionnaires schedules are developed from the bank of questions which are supplied in Appendix A. Table 3.12 presents a brief sample of the students' questionnaire layout.

Student questionnaire Layout

Table 3.8

Student Questionnaire Layout

Instructions

Examples

Section 1. Demographic information

1. Name (optional)					
2.Age	3.Sex(M/F)	4.Faculty	5.Year of study	6.Name of the Course	7. Course ID

Students' Web access

Access from home	
Getting started guide/Training	
Level of experience	

(table continues)

Table 3.8 (continued)

Section 2 – Usability Evaluation

Students' perception of the Web site's usability basic attributes (learnability, Efficiency, Memorability, Errors recovery and User's Satisfaction).

Students' perception of the Web site's technical usability (Performance, Navigation Tools, User Interface Layout and Design, Information Architecture, Content, Media elements and user's Interaction).

Section 3– Pedagogical usability Evaluation

Students' perception, interaction and satisfaction of the learning and teaching methods (Course's Structure, Content, Interaction, Learner control, Cooperative/Collaborative Learning, Goal Orientation, Applicability, Motivation, Valuation of Previous Knowledge, Flexibility, Feedback, Lecturer Role, and Learning styles and strategies).

Section 5- Accessibility Evaluation

Students' perception of the Web site's accessibility and functionality and the digital learning materials as well (The Web site's Perceivable Content, The Operable User interface, The Understandable Content, and Robust Content).

Section 6- Information quality Evaluation

Students' perception of the System and Courses information quality (the intrinsic information, the contextual, the representational, and the accessibility of this information).

Section 7– Added Value Evaluation

Students' perception of the specific characteristics of the digital techniques (the learning system at the SVU) and the effective learning and teaching techniques being used by lecturers at the SVU as well (The flexible organization of learning, The improvement of teaching quality, The development of learning and communication skills using the WBLE, and The innovative use of information and communication technologies in teaching).

Questionnaire format and design. The student questionnaires are designed to be administered by hand. The online questionnaire was put aside as experiences with online questionnaire in the SVU were not encouraging. Many of the questions are in a Likert-type five point format that asked if the respondents "Strongly disagree" (1), "Disagree" (2), "Uncertain" (3), "Agree" (4) or "Strongly agree" (5) with the given statements. Multiple choice type questions are provided on the form. The student questionnaires are presented in Appendix A.

Data Source

The survey is designed to include students studying at the SVU. Letters were forwarded to lecturers who are teaching classes online to invite them to participate in the survey. The management support was helpful to get a big number of students to participate in the questionnaire. See Figure 3.5 which clarifies the survey procedure.

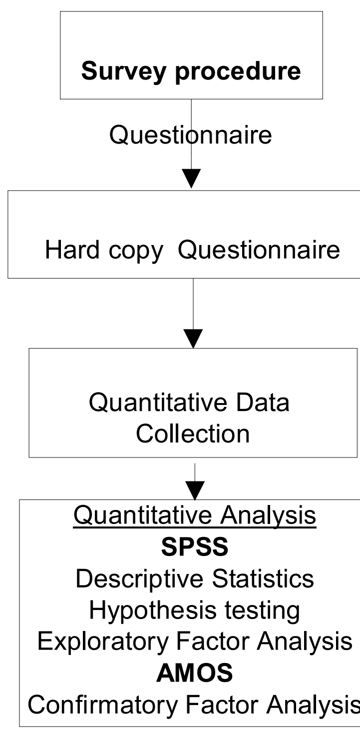


Figure 3.5. Survey procedure.

Data Sample. The idea is to choose a sample which best resembles the majority of the population as far as possible. Therefore, the sample size was 500. The rationale for diversities is, first, to reflect the variety in the population of units and secondly to allow more related issues on the topic to emerge to provide a better insight into the situation. The assumptions underlying the data sample selection are:

- postgraduate students are more prepared for online learning than undergraduate students;
- students who are studying a computing unit are more equipped to use the Web;

Based on the above assumptions and constraints, four units of learners were selected initially consisting of

- An undergraduate unit
- A postgraduate unit
- A computing unit
- A non-computing unit

Data Collection. The following describes the processes used to collect the quantitative survey data from the students using the survey instruments. The process of data collection was conducted through two stages. These two data sets were subjected to two-stage factor analysis. The first data set (247) was subjected to an exploratory factor analysis, and the second data set (253) was subjected to a confirmatory factor analysis.

In order to obtain valid responses, students are given sufficient time before they are in the position to comment on and submit the survey. That is, the questionnaire was administered to the SVU management at the beginning of the semester, and students were asked to give it back after almost two months (or at the end of semester for some selective courses). Students' questionnaire was delivered by hand too but with cooperation of the Internet Lab managers.

Quantitative Data. Upon completing the questionnaires by students, questionnaires will be collected and the results will then be transferred to a Microsoft Excel worksheet ready for analysis by the relevant computer software.

Pilot Test. This process sought to ensure whether the instrument possessed acceptable validity. Thus, the instrument is subjected to many experts from different fields. A questionnaire of 400 questions was forwarded to experts and academics ranging from statistics, design and development, to the online learning specifications. Some of them are chosen from Malaysia; University of Malaya (UM), Open University Malaysia (OUM), and the others are from Syria (Syrian Virtual University). Besides, a random sample group of students (5 students studying in SVU) was chosen. See Appendix B.

The comments from all above experts, academics and students can be summarized as follows:

- The questionnaire is too long. This will require too much time from respondents. This could result in invalid and unreliable answers.
- There are too many repeated questions which can result in boredom among respondents.
- There are some questions needing reformatting (e.g., there are some biased formatting in some questions, etc.)

- The questionnaire is preferred to be translated into Arabic. This comment is reported by all students in the sample. Students reported that the English format of the instrument is difficult to understand.

Based on the above suggestions, the instrument was reformatted and forwarded again to a few of those experts. The final version of the instrument resulted in 169 questions. The instrument was translated into Arabic too. The questionnaire was translated into Arabic based on Brisling's (1970) recommendations. Factors that affect translation quality and how equivalence between source and target versions can be evaluated were considered. These translation steps were useful in preserving the validity and reliability of the measure because they helped ascertain whether unexpected findings are due to errors in translation or other confounding variables in the data (McDermott & Palchanes, 1994). A professional translator from English to Arabic re-edited the translated version and his comments have been considered.

Data Analysis. The following describes the process used to analyze the quantitative data. This process was conducted in two stages; exploratory and confirmatory. Quantitative data were analyzed using two software programmes; Statistical Package for the Social Sciences (SPSS) version 16 and the Analysis of Moment Structures (AMOS) version 7.

Factor Analysis. Factor analysis is a statistical technique used frequently in the process of constructing a model or an instrument (refer to Chapter Two, p. 88). Basically, the two types of factor analysis; exploratory (EFA) and confirmatory factor analysis (CFA) are used in the data analysis process.

The first data set (247) was analyzed to explore and determine how and to what extent the observed variables in the evaluation instrument were linked to their underlying constructs (factors) using EFA. The EFA determined the items for each specific factor as well as factorial structure of the instrument. The second data set (253) was analyzed to confirm the previous factorial structure derived from the EFA procedure using CFA. The CFA using a structural equation modeling approach was employed to measure the goodness-of-fit indices and construct the instrument reliability. Thus, this process led to validation of the instrument and a priori model as well.

Some descriptive analyses applying frequency distribution were conducted to measure the reliability and association between some variables.

Reliability and Validity

As the researcher wishes to develop an evaluation instrument that is simultaneously valid, reliable, and generalisable to as large and inclusive web-based learning environments as possible; the instrument must be reliable and valid. The consistency of scores and its meaningfulness are kept throughout using the following steps:

Reliability. The idea behind reliability is that any significant results must be inherently repeatable. The following steps were taken to enhance the instrument reliability:

- Formulation of the questionnaire. Questions are formulated in a simple and meaningful manner, in such a way they can be embraced by participants.
- Time. Participants were given the necessary time to complete the instrument at a sufficient time interval.

- Appropriate techniques of analysis were used to the level of measurement (e.g., Cronbach's alpha).
- The coefficient alpha. The Cronbach's alpha was considered to test the internal consistency as it corresponds to the type of the questions in the questionnaire (most items are scored as continuous variables, e.g., strongly agree to strongly disagree).
- Sampling a variety of units to improve the ability to measure variation in student perceptions;
- Pilot testing of the instrument.

Validity. Do the items measure what they claim to? The following steps are figured to help answer this question:

- Questions of the questionnaires were forwarded to experts in the related fields.
- Finally, using the EFA and CFA contributed to the instrument reliability and validity.

Conclusion

The current chapter depicted the methodology and planning process undertaken to develop the survey instruments for use in this enquiry. Throughout the chapter, a discussion regarding the factors influencing the selection of research methods for this study was provided. A general instrument for guiding the questionnaire was put forward. The next chapter will describe the quantitative data analysis process.

CHAPTER FOUR

QUANTITATIVE SURVEY ANALYSIS

Introduction

The focus of this chapter is to provide a description of the analytical process used to examine the quantitative data collected from the survey. This is aimed at providing answers to the following research questions:

5. What constructs of Web-based learning Environment are relevant to Syrian Virtual University's Web-based learning Environment? (EFA)
6. What is the reliability and validity of the SVU-I in measuring the Web-based Learning Environment? (CFA)
7. To what extent, if any, does the hypothesized priori model fit sample data? (What is the causal structure of the SVU's Web-based learning environment?)
8. To what extent, if any, does the usability, pedagogical usability, accessibility, and information quality measure have significant direct and indirect influence on the added value of the Web based learning environment?

Research Question One

What constructs of Web-based learning Environment are relevant to Syrian Virtual University's Web-based learning environment?

Participants

Some 247 students returned the questionnaires out of 300 (96 females and 151 males) --a response rate of 82.3%- with ages ranging from 19 to 38 years, with a mean age of 25 years

(*SD* = 4). Table 4.1 summarizes the descriptive statistics of the respondents' demographic profile.

Table 4.1

Demographic Profile and Descriptive Statists of Surveyed Students (First data set)

Item	Frequency	Percentage
Gender		
Female	96	38.9
Male	151	61.1
Age		
19-24	128	51.82
25-30	99	40.08
>30	20	8.10
Students over Faculties		
BIT: Bachelor in Information Technology	81	32.8
BISE: Bachelor in Information Systems Engineering	57	23.1
BSE: Bachelor in Science Economics	67	27.1
HND: Higher National Diploma	42	17
Net form home		
Yes	92	37.2
No	155	62.8
Computer skills		
Beginner	12	4.9
Qualified	67	27.1
Professional	110	44.5
Expert	58	23.5

Participants came from four departments: 81 from Bachelor in Information Technology (BIT), 57 from Bachelor in Information Systems Engineering (BISE), 67 from Bachelor in Science Economics (BSE), and 42 from the Higher National Diploma (HND). Four courses are chosen form those departments respectively as follows: ITA: Web Application Design and Development, MIS: Management Information System, AAC: Computer Applications in Management, and MPI: Market Planning and Intelligence for e-Commerce. Students indicated quite different percentage to the possibility of accessing the Net from home (92 indicated Yes, while 155 indicated No). Finally, the students indicated good experiences in using the Internet (23.5% indicated Experts, 44.5% indicated Professionals, 27.1% indicated Qualifiers, while only 4.9% of students indicated Beginners).

Factor Analysis

The two types of factor analysis are used here (refer to chapter 3, p. 124) for exploratory and confirmatory factor analysis.

Exploratory factor analysis. Essentially, the EFA is used in the research to define the underlying constructs for items in the evaluation instrument. The analysis thus proceeds in an exploratory mode to determine how and to what extent the observed variables in the evaluation instrument are linked to their underlying constructs (factors). The decision behind such a process follows common standard criteria. That is, measures that are highly correlated (either positively or negatively) are likely influenced by the same factors, while those relatively uncorrelated are likely influenced by different factors (Thompson, 2004).

Assumptions underlying EFA. The research considered the standard assumptions underlying using EFA. A basic assumption of EFA is that within a collection of observed variables, there exists a set of underlying factors, smaller in number than the observed variables (Kim & Mueller, 1978). Two statistics on the SPSS output allowed the researcher to investigate this basic assumption, which are the Kaiser-Meyer-Olkin Measure of Sampling Adequacy, and Bartlett's Test of Sphericity. The Kaiser-Meyer-Olkin (KMO)

Measure of Sampling Adequacy generally indicates whether or not the variables are able to be grouped into a smaller set of underlying factors where high values (close to 1.0) generally indicate that a factor analysis may be useful with the data, while a value less than .50 suggests that the results of the factor analysis probably will not be very useful, *Ibid*. Table 4.2 indicates how clearly our data support the use of factor analysis (as the KMO values for the constructs: Usability, Pedagogical usability, Accessibility and Added Value are .873, .936, .716, .833, and .811 respectively. And this suggests subsequently that the data may be grouped into a smaller set of underlying factors.

Table 4.2

KMO and Bartlett's Test

		Usability (U)	Pedagogical usability (P)	Accessibility (A)	Information quality (IQ)	Added Value (AV)
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.87[a]	.94[a]	.72[a]	.83[a]	.81[a]
Bartlett's Test of Sphericity	Approx. Chi-Square	7312.12	10938.04	880.85	1314.18	1152.74
	Df	1081.00	2016.00	55.00	105.00	105.00
	Sig.	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]

a:.00 to .40 (Don't Factor); 0.50 to o.59 (Miserable); .60 to .69 (Middling); .80 to .89 (Meritorious); and .9 to 1.00 (Marvelious) (Kaiser, Meyer, and Olkin), b: $p < 0.001$

And the Bartlett's Test of Sphericity was significant over these constructs ($p < .05$). Finally, the communalities were all above .4. See Tables 4.3, 4.4, 4.5, 4.6, and 4.7.

The sample size is one more basic assumption for EFA. The minimum sample observation number which has been suggested for the performance of EFA is l00 (Hair et al., 1998). The normal distribution of the data is one more assumption for EFA. See Table 4.8 which indicates how the Skewness and Kurtosis met the condition for the symmetry of the sample distribution and the spread of the data (both Skewness and Kurtosis were within the range [-2, +2]).

Extraction Methods. A Principal Components Extraction (PCE) method and Varimax rotation were conducted on this subset sample of 247 participants. Hair et al. (1998) recommend rotation because it simplifies the factor structure and usually results in more meaningful factors (p. 380). And using PCE will reduce data dimensionality by performing a covariance analysis between factors (refer to chapter 2, p. 89). Its focus will be on the interrelationships among the observed variables (158 items) in the instrument. PCE is simple and until more recently was considered the appropriate method for exploratory factor analysis (Arrindell & van der Ende, 1985; Guadagnoli & Velicer, 1988; Schonemann, 1990; Steiger, 1990; Velicer & Jackson, 1990). PCE is conducted several times on each construct in the instrument (Usability, Pedagogical usability, Accessibility, Information quality, and Added value) respectively. Using Rotation will help clean up the factors. Kaiser (1958) indicated that each factor, high loadings (correlations) will result in a few variables; the rest will be near zero. As with the current research, items with factor loading values below the cut-off value of 0.5 on their own scales or greater than 0.4 on each of the other scales were eliminated. This is purposed to achieve more meaningful and interpretable correlations among observable items (Harman, 1970; Krzanowski, 2000). Tabachnick and Fidell (2001) define a "crossloading" item as an item that loads at .32 or higher on two or more factors. The researcher can decide to drop out that element from the analysis if there are several adequate to strong loaders (.50 or better) on each factor. Factor analyses were repeated until a solution in which all the items included in the analysis met these criteria was attained. The individual items retained in the model and factor loadings are presented in Tables 4.3, 4.4, 4.5, 4.6 and Table 4.7.

Exploratory factor analysis of Usability. Table 4.3 presents the Usability Rotated Component Matrix where ten-factor solutions have been emerged from rotation of the construct Usability (see Table 4.2). The principal components analysis showed a variance accounted for 68.15 %. However, only seven factors will be retained. Three factors were deleted. This is because 12 items were eliminated because they did not contribute to a simple factor structure and failed to meet a minimum criteria of having a primary factor loading of .5 or above, and no cross-loading of .3 or above. The principal components analysis showed a variance accounting for 68.15%. The seven factors already named were: Information architecture (U_IA) (6 items), Multimedia (U_M) (6 items), User interface (U_UI) (5 items), Navigation tools (U_N) (5 items), Basic attributes (U_BA) (5 items), Content (U_C) (4 items), and Performance (U_P) (3 items), while 12 items were deleted (see Table 4.3).

The first factor named ‘Information Architecture’ accounted for 9.81% of the variance. The second factor is named ‘Multimedia’, and accounts for 9.55% of the variance. The third factor is named ‘Basic Attributes’, and it accounts for 8.84% of the variance. The fourth factor is ‘User Interface’, accounting for 8.60 % of the variance. The fifth factor is “Navigation”, accounting for 8.20% of the variance. The sixth factor is ‘Content’, accounting for 7.95% of the variance. The seventh factor is ‘Performance’, accounting for 5.20% of the variance.

Table 4.3

Usability Rotated Component Matrix

	Component										CM
	1	2	3	4	5	6	7	8	9	10	
U_IA1. Headings were created effectively.	.80										.69
U_IA9. I am satisfied with the design of the site's information architecture.	.80										.76
U_IA3. Links were kept separated from narrative text blocks.	.79										.69
U_IA2. The site's information was positioned according to priority	.79										.73
U_IA8. Site's content and subject matter are consistent with the keywords and key phrases used in search engines.	.78										.64
U_IA7. Site structure is organised to minimise the number of levels below the homepage (pages are not structured far from the main user interface).	.66										.60
U_IA5. Title tags describe page content appropriately.	.42										.56
U_M8 Using multimedia elements was satisfactory.		.79									.77
U_M4 The visual and auditory media were provided with equivalent text.		.76									.65
U_M6 The system informs learners of the media's size and time download.		.75									.67
U_M1 Media elements were of high visual and aural quality.		.74									.65
U_M7 Using media was not gratuitously.		.74									.71
U_M5 Names of media elements reflect its real content and effect.		.71									.61
U_M2 Animations were used deliberately.		.48				.47					.51
U_BA1 The system was easy for me to accomplish basic tasks the first time I encounter it.			.91								.91

(table continues)

Table 4.3 *(continued)*

Usability Rotated Component Matrix

	Component										CM
	1	2	3	4	5	6	7	8	9	10	
U_BA3 I can easily re-establish proficiency after a period of not using the system.			.87								.82
U_BA5 The system is pleasant, comfortable and acceptable of use?			.85								.84
U_BA4 I can recover from errors easily.			.83								.77
U_BA2 Once I have learned to use the system, I can quickly perform tasks.			.79								.73
U_UI9 I am satisfied with the user interface layout and design.				.84							.76
U_UI7 Background and foreground colors are relevant with each other (no interference).				.81							.70
U_UI8 Text formatting techniques (e.g., Bold, Italic, and Underline) were used consistently.				.79							.72
U_UI1 The main User Interface is not busy.				.69							.67
U_UI6 The interface design used similar control icons for all types of media and over all web pages.				.55				55	.		.67
U_UI5 The user interface design uses standard colours for links (blue for links and red or purple for visited links).				.50							.54
U_UI2 Horizontal webpage scrolling is avoided at all times.				.48				42	.		.55
U_N2 The site map was helpful.					.85						.77
U_N4 External links were loaded in a separate window.					.82						.81
U_N1 The navigation design connected all related information in a sequence that made sense to me.					.78						.71

(table continues)

Table 4.3 *(continued)*

Usability Rotated Component Matrix

	Component										CM
	1	2	3	4	5	6	7	8	9	10	
U_N7 I am satisfied with my browsing over the class web site					.73						.71
U_N3 Links showed clearly the relationship between all pages of the site and the currently viewed page.					.66						.62
U_C4 Every essay contained the author name and her/is contact information, main titles of homepages, date of publishing, etc.						.79					.69
U_C2 Longer pages exist only when content should be printed as one document.						.78					.71
U_C1 Web pages were thoroughly free from all misspelling and grammatical errors.						.75					.67
U_C5 The site's content design is satisfactory.						.72					.68
U_M3 Videos were short.		.44				.56					.58
U_C3 Every page contained the University name, some contact info and logo.						.49					.42
U_P3 Most pages on the website work with all browsers and various versions of each, and still have the same characteristics.							.81				.74
U_P1 No links in the user interface were missing or broken. All links work.							.78				.77
U_P4 I am satisfied with the site's performance.							.76				.78
U_UI4 Height and width dimensions were included in all "image" tags.				.42				.71			.75
U_UI3 Blinking or Ticker-Tape text was avoided				.48				.51			.59
U_IA6 Graphs and diagrams were used adequately and clarifying concepts.	.44								.61		.62
U_IA4 Links labels were matching the titles of the pages to which they refer.	.51								.55		.63

(table continues)

Table 4.3 *(continued)*

Usability Rotated Component Matrix

	Component										CM
	1	2	3	4	5	6	7	8	9	10	
U_P2 Most web pages took less time to load.							46	.	.47		.60
U_N5 The “skip to main content” link was included at the top of each page. There are no dead-end pages.					.41					.61	.64
U_N6 Local search engines are productive.					.42					.58	.60

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 15 iterations.
CM: Communality

Deleted items. Some items are deleted: The item “U_P2 Most web pages took less time to load” had cross Factor loadings .46 and .47 on both Structure and Factor 9 (not named). The item “U_UI2 Horizontal webpage scrolling is avoided at all times” has cross Factor loadings .48 and .42 on both User interface and Factor 8 (not named). The item “U_UI3 Blinking or Ticker-Tape text was avoided” has cross factor loadings .48 and .51 on both User interface and Factor 8 (not named). The item “U_UI4 Height and width dimensions were included in all “image tags” ” has cross factor loadings .42 and .71 on both User interface and Factor 8 (not named). The item “U_UI6 The interface design used similar control icons for all types of media and over all web pages” has cross factor loadings .55 and .55 on both User interface and Factor 8 (not named). The item “U_N5 The “skip to main content” link was included at the top of each page. There are no dead-end pages” has cross factor loadings .41 and .61 on both Navigation and Factor 10 (not named). The item “U_N6 Local search engines are productive” has cross factor loadings .42 and .58 on both Navigation and Factor 10 (not named).

The item “U_IA4 Links labels were matching the titles of the pages to which they refer” has cross factor loadings .51 and .55 on both Information Architecture and Factor 9 (not named). The item “U_IA5 Title tags describe page content appropriately” has factor loadings .43 (<.5). The item “U_IA6 Graphs and diagrams were used adequately and clarifying concepts” The item “U_C3 Every page contained the University name, some contact info and logo” has cross factor loadings .446 and .606 on both Information Architecture and Factor 9 (not named). The item U_M2 Animations were used deliberately” has cross factor loadings .48 and .47 on both Multimedia elements and Content. The item U_M3 Videos were kept short” has cross factor loadings .44 and .56 on both Multimedia elements and Content.

All remained items loaded significantly onto their respective factors as can be seen in Table 4.3.

Exploratory factor analysis of Pedagogical Usability. Table 4.4 presents the Pedagogical usability Rotated Component Matrix. Thirteen-factor solutions emerged from rotation of the construct Pedagogical usability. The principal components analysis showed a variance accounted for 70.31%. The thirteen-factors are already named as follows, Content(P_C) (7 items); Structure (P_S) (6 items); Lecturer role (P_LR) (6 items); Motivation (P_M) (6 items); Collaborative/Cooperation learning (P_CCL) (5 items) Learner control (P_LC) (5 items); Learning styles and strategies (P_LSS) (6 items); Goals (P_G) (5 items); Applicability (P_A) (5 items); Previous knowledge (P_PK) (4 items); Interaction (P_I) (3 items); Feedback (P_FB) (3 items); Flexibility (P_F) (3 items). None of the items were eliminated.

Table 4.4

Pedagogical Usability Rotated Component Matrix

	Component													CM
	1	2	3	4	5	6	7	8	9	10	11	12	13	
P_C7 I am satisfied with the course content.	.84													.83
P_C2 A complete syllabus of the course was available ahead of learning.	.82													.75
P_C1 Objectives of each lesson (topic, assignment, etc.) were stated clearly.	.80													.73
P_C5 The content encompassed all stated objectives (both theory and practice).	.80													.73
P_C4 Content was built upon learners' prior knowledge.	.77													.74
P_C3 The syllabus was helpful.	.76													.73
P_C6 The content is rich with multimedia components.	.75													.70
P_S3 The organization of the learning material facilitated my exploration of the course.		.81												.76
P_S1 Topics were presented in a logical and ordered manner.		.81												.81
P_S6 I am satisfied with the course structure.		.78												.76
P_S5 The help is structured productively.		.78												.75
P_S2 Hierarchies of content are designed of breadth rather than depth (no more than three levels in each paragraph).		.77												.70
P_S4 No gaps in structuring the information.		.73												.73
P_LR4 Lecturers manage the discussions and forums helpfully.			.71											.69
P_LR6 I am satisfied with the lecturer's role in this course.			.70											.75
P_LR5 Lecturers reply to our emails periodically.			.68											.68

(table continues)

Table 4.4 *(continued)*

Pedagogical Usability Rotated Component Matrix

	Component													CM
	1	2	3	4	5	6	7	8	9	10	11	12	13	
P_LR2 Lecturers provide me with one-on-one instruction during the class time.			.65											.67
P_LR1 Lecturers perform tasks in a straightforward manner			.60											.64
P_LR3 Lecturers use the technology well and reliably.			.57											.59
P_M1 The course topics are interesting.				.71										.70
P_M5 The activities throughout the course motivate me to learn.				.71										.68
P_M6 The course encourages active participation and knowledge construction.				.67										.69
P_M3 The course topics meet my needs and expectations.				.62										.63
P_M4 The course topics focus on real-world problems.				.61										.69
P_M2 The presented topics in the course were completely new to me.				.56										.62
P_CCL4 The class Web site authorized me to know what other learners have been doing in the learning material, e.g., which topics have been read the most or assignments that have been the most popular, etc.					.76									.74
P_CCL5 I feel satisfied with the cooperative/collaborative learning techniques being conducted in this course.					.75									.83
P_CCL3 I frequently communicate with my classmates (via email, bulletin boards, and chat).					.69									.66
P_CCL1 Much of learning sessions took place in groups.					.69									.66
P_CCL2 I frequently participate in online discussion with other team members.					.69									.67

(table continues)

Table 4.4 *(continued)*

Pedagogical Usability Rotated Component Matrix

	Component													CM
	1	2	3	4	5	6	7	8	9	10	11	12	13	
P_LC5 I feel satisfied with my control over learning.						.78								.80
P_LC2 I have the opportunity to control the media elements.						.73								.70
P_LC4 I have access to online lecturer's notes						.71								.73
P_LC3 I have always the feeling that I am responsible for my own learning.						.68								.69
P_LC1 I have the opportunity to spend as much time as I want or need learning the material.						.62								.68
P_LSS7 Lecturers' support (feedback) is presented in a scaffolding way.							.68							.71
P_LSS3 I am required in this course to find out my own solution (not the teacher's or the program's model solutions).							.66							.67
P_LSS5 I am usually rewarded for good answers (e.g., expressions of approval or admiration, of respect and gratitude),							.64							.69
P_LSS6 Lecturers used to consider my remarks and suggestions.							.61							.57
P_LSS8 Lecturers often encourage us to work collaboratively with other class members on assignments.							.61							.67
P_LSS4 The course often provides learning problems with a pre-defined model for the solution.							.51							.58
P_G4 The objectives show clearly what kind of the assessment I am going to have at the end of semester.								.76						.75
P_G5 Special behavioral objectives are identified adequately (I know about behaviors for success, failure and dishonesty in the class).								.73						.64
P_G2 The objectives state clearly what skills are required in order to reach each goal.								.64						.62

(table continues)

Table 4.4 *(continued)*

Pedagogical Usability Rotated Component Matrix

	Component													CM
	1	2	3	4	5	6	7	8	9	10	11	12	13	
P_G1 The objectives are built using simple language.								.64						.61
P_G3 The objectives show clearly what I'm going to know (or learn) after having the course.								.60						.65
P_A3 The available examples in the course are helpful when performing assignments.									.72					.70
P_A2 This course teaches me indeed the skills that I will need.									.67					.69
P_A5 I feel that this course has been designed for me.									.66					.66
P_A4 Learning was accomplished through the base "learning by doing" using methods that involved practical tasks.									.59					.65
P_A1 The course topics accommodated different learning styles.									.53					.62
P_PK2 The course is structured to go over earlier material before starting to teach a new topic.										.72				.74
P_PK1 I am assessed ahead relating to some required skills and techniques for this course.										.72				.73
P_PK3 The course topics are designed in such away to meet different learning levels.										.65				.69
P_PK4 The course is not over simplifying learning instead it was designed in new ways to provide appropriate scaffolding and support.										.62				.65
P_I5 Progress reports, assignments feedback, etc. are frequently communicated to me.											.75			.78
P_I6 I feel satisfied with the reaction I got in this class web site.											.71			.78

(table continues)

Table 4.4 *(continued)*

Pedagogical Usability Rotated Component Matrix

	Component													CM
	1	2	3	4	5	6	7	8	9	10	11	12	13	
P_I4 Lecturers frequently schedule specific chat times and conversational spaces to discuss course topics, and to reflect on ideas and learning experiences.											.69			.72
P_FB2 My lecturer's expectations are clearly communicated to me.												.73		.81
P_FB3 Generally, I am satisfied with the help provided in the class web site.												.73		.79
P_FB1 There is an adequate technical online support from the support department.												.63		.70
P_F3 The class web site gives me the opportunity to add some comments and suggestions.													.73	.76
P_F2 The course contains diverse assignments.													.68	.77
P_F1 The course offers optional routes for my progress													.59	.70

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 8 iterations
CM: Communality

Exploratory factor analysis of accessibility. Table 4.5 presents the Accessibility Rotated Component Matrix. None of items were deleted and four-factor solutions emerged from rotation of the construct Accessibility. The principal components analysis showed variance accounted for 72.137%. The four-factors are already named as follows: Perceivable content (A_P) (4 items); Operable content (A_O) (3 items); Understandable content (A_U) (2 items); and Robust content (A_R) (2 items).

Table 4.5

Accessibility Rotated Component Matrix

	Component				CM
	1	2	3	4	
A_P5 Content was presented in a way that is visible and hearable.	.81				.67
A_P2 Text alternatives were provided for any non-text content.	.76				.63
A_P4 Content was flexibly presented in different ways without losing information or structure (e.g., spoken aloud, simpler layout, etc.).	.75				.64
A_P3 Synchronized alternatives were provided for multimedia (such as captions, audio descriptions, sign language, etc.)	.73				.55
A_O3 I am provided with flexible ways to help me navigate, find content, and determine where I am in the site.		.88			.80
A_O2 The presented content was very concise, quiet, and understandable which has avoided causing seizures (e.g., flashes).		.84			.74
A_O1 Most user interface functionalities were available from the keyboard.		.74			.63
A_U1 Text content was readable and understandable.			.89		.82
A_U2 I can predict the appearance and operation of the web pages.			.87		.80
A_R1 Content can be interpreted reliably by a wide variety of user agents, including assistive technologies.				.91	.83
A_R2 Content is accessible (or accessible alternative is provided).				.90	.82

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations
CM: Communality

Exploratory factor analysis of Information quality. Table 4.6 presents the Information quality Rotated Component Matrix. None of items were deleted and four-factor solutions emerged from rotation of the construct Information quality. The principal components analysis showed a variance accounted for 63.669%. The four factors are already named as follows: Intrinsic information (IQ_I) (4 items); Contextual information (IQ_C) (4 items); Representational information (IQ_R) (4 items); and Accessible information (IQ_A) (3 items).

Table 4.6

Information Quality Rotated Component Matrix

	Component				CM
	1	2	3	4	
IQ_R2 The information was easily comprehended.	.84				.73
IQ_R3 The structure of the information was matching with the information itself.	.80				.71
IQ_R1 The information was conforming to our technical abilities.	.77				.65
IQ_R4 The information was consistent.	.69				.52
IQ_C3 The information presented was completely covering the context of a given activity.		.84			.76
IQ_C2 The information was up to date.		.78			.67
IQ_C1 The information was applicable and helpful.		.71			.59
IQ_C4 The size of information corresponded with the context.		.64			.46
IQ_I2 The information was unbiased.			.80		.67
IQ_I3 The information was correct.			.78		.63
IQ_I4 The source of information was in high standing.			.71		.62
IQ_I1 The information was valid according to some stable reference.			.67		.52
IQ_A2 The system operations were easy to manipulate.				.82	.70

(table continues)

Table 4.6 *(continued)*

Information Quality Rotated Component Matrix

	Component				CM
	1	2	3	4	
IQ_A1 The system is giving correct answer to a feasible query in a given time range.				.78	.64
IQ_A3 We were secured that information is passing privately through the system.				.76	.68

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 5 iterations.
CM: Communality

Exploratory factor analysis of Added value. Table 4.7 presents the Added value Rotated Component Matrix. None of items were deleted and four-factor solutions emerged from rotation of the construct Added value. The principal components analysis showed a variance accounted for 61.92%. The four-factors are already named as follows: Teaching quality (AV_TQ) (6 items); Flexible learning (AV_F) (4 items); Learning and communication skills (AV_S) (3 items); and Innovative use of information and communication technologies (AV_I) (2 items).

Table 4.7

Added Value Rotated Component Matrix

	Component				CM
	1	2	3	4	
AV_TQ5 Flexible feedback and support are promptly provided throughout the course time.	.76				.61
AV_TQ2 Lecturers knew how to connect teaching, e.g., to situations in working life.	.74				.56
AV_TQ3 Lecturers knew how to conduct individualized teaching.	.72				.55

(table continues)

Table 4.7 *(continued)*

Added Value Rotated Component Matrix

	Component 1	2	3	4	CM
AV_TQ4 Course materials are produced by specialists.	.70				.57
AV_TQ1 Lecturers are using the web-based learning environments tools adequately.	.64				.50
AV_TQ6 Support to personal contacts is available in time.	.64				.44
AV_F2 The class web site opens up the opportunities for you to cross over different education levels, fields and organizations to increase sharing of information, expertise and knowledge (via Internet-based resources or together with hard resources).		.79			.66
AV_F3 I have been informed about appropriate materials available electronically.		.79			.67
AV_F1 Lecturers have flexibly planned the interactive activities and the learning and the course structure (e.g. timetable for the course) carefully beforehand.		.74			.61
AV_F4 I have been supported with efficient and effective systems to access to electronic material (e.g., flexible borrowing systems)		.73			.60
AV_S1 The class web site offers many collaborative web-based learning tools (e.g., tools for student collaborative inquiry, problem-based learning, articulation and dialogue, debate and personal reflection, etc.)			.81		.72
AV_S3 Learning methods of collaborative and individualized teaching are used effectively in every context and situation.			.78		.63
AV_S2 I have been given the control over learning (e.g., I am able to actively choose the program components in whatever desired order).			.78		.66
AV_I2 The technological tools provided in the class web site have improved the teaching methods in comparison to previous learning environments.				.87	.80
AV_I1 The planning of course structure is closely connected to the course objectives and the teaching methods on the course.				.76	.72

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.
CM: Communality

Summary. Table 4.8. offers the eigenvalues, percentage of variance and the Total variance explained for these factors and their related constructs.

Table 4.8

Reliability, Eigenvalues and Variance Explained

	Scale	Eigenvalues	% of variance	Total variance explained
USABILITY	Information Architecture	12.54	26.68	68.15
	Multimedia	3.79	8.06	
	Basic Attributes	3.54	7.54	
	User Interface	2.71	5.77	
	Navigation	2.41	5.12	
	Content	2.12	4.52	
	Performance	1.70	3.62	
PEDAGOGY	Content	23.13	36.14	70.31
	Structure	3.88	6.06	
	Lecturer role	2.62	4.10	
	Motivation	2.11	3.29	
	Cooperative/Collaborative learning	1.96	3.05	
	Learner control	1.80	2.81	
	Learning styles and strategies	1.64	2.56	
	Goal orientation	1.57	2.46	
	Applicability	1.48	2.30	
	Evaluation of previous knowledge	1.36	2.13	
	Interaction	1.30	2.03	
	Feedback/ Help	1.12	1.75	70.31
	Flexibility	1.04	1.63	
ACCESSIBILIY	Perceivable Content	3.35	30.44	72.14
	Operable Interface	2.06	18.75	
	Understandable Content	1.39	12.63	
	Robust-Content	1.14	10.32	
INOFORMATION QUALITY	Representational	4.90	32.69	63.67
	Contextual	1.82	12.15	
	Intrinsic	1.47	9.80	
	Accessibility	1.36	9.03	
ADDED VALUE	Teaching quality	4.40	29.36	61.92
	Flexible learning	2.11	14.04	
	Communication skills	1.62	10.80	
	Innovative use of information	1.16	7.73	

Reliability of the Obtained Factors

The following will provide a scale analysis of the dimensions of the universal Usability and Accessibility, Pedagogical usability, Information quality and Added value used in the student questionnaire (see Appendix A, p. 271). With each of the dimensions, Likert-scale (1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree) question items were selected for the scale analysis.

Internal consistencies for each of the scales were determined by calculating the value of coefficient alpha (Cronbach's alpha). These ranged from .702 to .939, as shown in Table 4.9. The skewness and kurtosis were in the standard range [-2, +2]. This assumes a normal distribution of the data. Some median scores are somewhat higher than the associated mean scores because the scores are negatively skewed. The mode scores indicate how the "4" (Agree) option occurs most frequently (about 60%) throughout the reported scores. However, the second most frequent choice is the "3" (Uncertain). This indicates that students were unable to decide. This probably indicates a possible need for specific areas needing attention to improve. Some selected option "5" (Strongly Agree), the rest of the responses drop-off towards option "2" (Disagree), and very few selected option "1" (Strongly Disagree).

Table 4.9

Scale Reliability and Frequencies from Initial Student Questionnaire Analysis (UPAIA)

	Scale	Reliability (coefficient alpha)	No. of scale items	Range of items means: Lowest item mean	Range of items means: Highest item mean	Students N=247: Mean	Median	Mode	Std. Deviation	Skewness	Kurtosis
USABILITY	Basic Attributes	.94	5	3.29	3.72	3.43	3.60	4	.92	-.93	.16
	Performance	.85	3	2.56	3.23	2.92	3.00	3	.91	-.03	-.51
	User Interface	.84	5	3.29	3.45	3.36	3.40	3	.66	-.64	.21
	Navigation	.89	5	3.21	3.37	3.26	3.40	3	.81	-.47	-.17
	Information Architecture	.89	6	3.15	3.40	3.31	3.33	4	.72	-.58	.38
	Content	.85	4	3.16	3.62	3.30	3.25	3	.73	-.38	-.12
	Multimedia	.89	6	3.11	3.28	3.17	3.33	3	.76	-.78	.71
PEDAGOGICAL USABILITY	Structure	.92	6	3.02	3.42	3.22	3.33	2	.91	-.45	-.68
	Content	.93	7	3.17	3.32	3.24	3.43	4	.84	-.52	-.47
	Interaction	.85	3	3.06	3.35	3.17	3.33	4	.87	-.012	-.79
	Learner control	.88	5	3.17	3.38	3.25	3.40	4	.88	-.48	-.39
	Cooperative/Collaborative learning	.88	5	2.79	3.19	3.01	3.00	4	.86	-.06	-.77
	Goal orientation	.85	5	3.19	3.26	3.24	3.40	4	.81	-.52	-.45
	Applicability	.85	5	2.93	3.30	3.08	3.40	3	.87	-.48	-.26
	Motivation	.87	6	2.97	3.20	3.10	3.20	4	.86	-.32	-.78
	Evaluation of previous knowledge	.85	4	2.93	3.32	3.18	3.50	2	.86	-.29	-.93

(table continues)

Table 4.9 *(continued)*

Scale Reliability and Frequencies from Initial Student Questionnaire Analysis (UPAIA)

		Scale	Reliability (coefficient alpha)	No. of scale items	Range of items means: Lowest item mean	Range of items means: Highest item mean	Students N=247: Mean	Median	Mode	Std. Deviation	Skewness	Kurtosis
PEDAGOGICAL	USABILITY	Flexibility	.83	3	2.98	3.04	3.01	3.33	4	.94	-.21	-.91
		Feedback/ Help	.86	3	3.25	3.38	3.31	3.67	4	.87	-.53	-.57
		Lecturer role	.89	6	3.15	3.28	3.20	3.33	4	.84	-.33	-.51
		Learning styles and strategies	.88	6	3.10	3.23	3.15	3.33	3	.94	-.34	-.77
ACCESSIBILIY		Perceivable Content	.79	4	2.79	3.41	3.17	3.25	4	.83	-.35	-.17
		Operable Interface	.80	3	2.98	3.31	3.14	3.33	3	.87	-.30	-.46
		Understandable Content	.78	2	3.18	3.46	3.32	3.50	4	1.01	-.38	-.49
		Robust-Content	.79	2	3.20	3.52	3.36	3.50	4	1.01	-.43	-.19
INOFORMATION	QUALITY	Intrinsic	.78	4	3.09	3.36	3.23	3.50	4	.88	-.38	-.55
		Contextual	.78	4	3.12	3.32	3.23	3.50	4	.88	-.46	-.40
		Representational	.82	4	3.13	3.32	3.27	3.50	4	.88	-.39	-.60
		Accessibility	.75	3	2.96	3.22	3.05	3.00	3	.95	-.20	-.57
ADDED	VALUES	Flexible learning	.81	4	3.14	3.27	3.21	3.25	3	.81	-.44	-.34
		Teaching quality	.81	6	3.04	3.32	3.10	3.33	3	.79	-.13	-.47
		Communication skills	.75	3	3.09	3.30	3.21	3.33	4	.89	-.24	-.43
		Innovative use of information	.70	2	3.07	3.37	3.22	3.50	4	1.01	-.36	-.32

Confirmatory factor analysis. CFA is one of structural equation modeling techniques used to determine the goodness of fit between a hypothesized model and the sample data. The used technique will verify the factor structure of a set of observed variables and their underlying latent constructs (refer to chapter one, p. 4).

Using Analysis of Moment Structures (AMOS), Version 16.0, a CFA is conducted on the second data set.

Participants

Some 350 questionnaires were passed to students studying in the same departments with the cooperation of the computer lab managers. A total of 253 students returned the questionnaires out of 350 (109 females and 144 males). This reflected a response rate of 72.3 %- with ages ranging from 19 to 37 years, with a mean age of 25 years (*SD*=4).Table 4.10 summarizes the descriptive statistics of the second data set respondents' demographic profile.

Table 4.10

The descriptive statistics of the second data set respondents' demographic profile

Item	Frequency	Percentage
Gender		
Female	109	43.1
Male	144	56.9
Age		
19-24	140	55.34
25-30	99	39.13
>30	14	5.53

(table continues)

Table 4.10 *(continued)*

The descriptive statistics of the second data set respondents' demographic profile.

Item	Frequency	Percentage
Students over Faculties		
BIT: Bachelor in Information Technology	100	39.5
BISE: Bachelor in Information Systems Engineering	65	25.7
BSE: Bachelor in Science Economics	50	19.8
HND: Higher National Diploma	38	15.0
Net access from home		
Yes	110	43.5
No	143	56.5
Computer skills		
Beginner	12	4.7
Qualified	60	23.7
Professional	122	48.2
Expert	59	23.3

N=253

Participants came from the same four departments as in the first data set (the EFA stage): 100 from Bachelor in Information Technology (BIT), 65 from Bachelor in Information Systems Engineering (BISE), 50 from Bachelor in Science Economics (BSE), and 38 from the Higher National Diploma (HND). The same four courses are re-chosen from those departments respectively as follows: ITA: Web Application Design and Development, MIS: Management Information System, AAC: Computer Applications in Management, and MPI: Market Planning and Intelligence for e-Commerce. Students indicated again rather different percentage to the possibility of accessing the Net from home (110 indicated Yes, while 143 indicated No). Finally, the students indicated good experiences in using the Internet (23.3% indicated Experts, 48.2% indicated Professionals, 23.7% indicated Qualifiers, while only 4.7% of students indicated Beginners).

Conducting EFA on the first data set came out with seven factors (Usability); thirteen factors (Pedagogical usability); four factors (Accessibility); four factors (Information quality); and four factors (Added value). Thus, the confirmatory factor analysis was conducted to validate these outcomes from using EFA. CFA is used to validate those underlying critical indicators in each of those mentioned factors of the instrument constructs (Usability, Pedagogical usability, Accessibility, information quality and added value).

CFA will describe how well the observed indicators serve as critical measurement of latent variable. This will confirm in turn the hypothesized factor structure and determine whether the factor structure required modification.

Specifically, the CFA is intended to answer the following three research questions:

1. What is the reliability and validity of the SVU-Evaluation Instrument in measuring the Web-based Learning Environment?
2. To what extent, if any, does the hypothesized priori model fit sample data? (What is the causal structure of the SVU's Web-based learning environment?)
3. To what extent, if any, does usability, pedagogical usability, accessibility, and information quality measures has significant direct and indirect influence on the added value of the Web based learning environment?

Research Question Two

What is the reliability and validity of the SVU- Instrument in measuring the Web-based Learning Environment?

Model Fit Indexes

Many fit indexes are used in literature. However, the researcher will consider the following common goodness- of-fit indicators: the chi- square/degree of freedom (X^2 /df), the Non-Normed Fit Index (NNFI/ TLI), the Incremental Fit Index (IFI), the Comparative Fit Index (CFI), and finally, the Root Mean Square Error of Approximation (RMSEA) (refer to chapter 2, p. 90).

First of all, the following will provide a scale analysis of the validated dimensions of the universal Usability and Accessibility, Pedagogical usability, Information quality and Added value used in the student questionnaire (see Appendix B, p. 283). With each of the dimensions, Likert-scale (1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree) question items were selected for the scale analysis.

Internal consistencies for each of the scales were determined by calculating the value of coefficient alpha (Cronbach's alpha). These ranged from .70 to .897, as shown in Table 4.11. The skewness and kurtosis were in the standard range [-2, +2]. This assumes a normal distribution of the data. Very few median scores are a little bit higher than the associated mean scores because the scores are negatively skewed. The mode scores indicate how the "3" (Uncertain) option occurs most frequently (about 59.36%) throughout the reported scores. This indicates that students were unable to decide. This probably indicates a possible need for specific areas needing attention to improve. The second most frequent choice is the

"4" (Agree). However, some selected option "5" (Strongly Agree), the rest of the responses drop-off towards option "2" (Disagree), and very few selected option "1" (Strongly Disagree).

Table 4.11

Scale Reliability and Frequencies from Second Student Questionnaire Analysis (UPAIA)

	Scale	Reliability (coefficient alpha)	No. of scale items	Range of items means		Students N=253					
				Lowest item mean	Highest item mean	Mean	Median	Mode	Std. Deviation	Skewness	Kurtosis
USABILITY	Basic Attributes	.90	5	3.41	3.93	3.61	4.0	4	.69	-.34	-.01
	Performance	.83	3	2.87	3.53	3.25	3.0	3	.81	.18	-.47
	User Interface	.81	5	3.34	3.45	3.41	3.0	3	.60	-.12	-.44
	Navigation	.87	5	3.37	3.47	3.44	3.0	3	.69	.10	-.18
	Information Architecture	.84	6	3.35	3.57	3.55	4.0	4	.66	-.04	-.20
	Content	.79	4	3.26	3.57	3.49	3.0	3	.65	.38	-.19
	Multimedia	.78	5	3.29	3.45	3.40	3.0	3	.60	.21	-.22
PEDAGOGICAL USABILITY	Structure	.89	6	3.24	3.47	3.46	3.0	3	.78	.04	-.40
	Content	.85	7	3.15	3.46	3.36	3.0	3	.69	.25	-.05
	Interaction	.81	3	3.37	3.58	3.45	3.0	4	.76	-.09	-.38
	Learner control	.758	4	3.26	36	3.61	4.0	4	.60	.21	-.49
	Cooperative/Colla-borative learning	.83	4	3.13	3.38	3.41	3.00	3	.74	.19	-.21
	Goal orientation	.73	3	3.22	3.60	3.41	3.00	3	.72	.20	-.16

(table continues)

Table 4.11 *(continued)*

Scale Reliability and Frequencies from Initial Student Questionnaire Analysis (UPAIA)

	Scale	Reliability (coefficient alpha)	No. of scale items	Range of items means: Lowest item mean	Range of items means: Highest item mean	Students N=253: Mean	Median	Mode	Std. Deviation	Skewness	Kurtosis
PEDAGOGICAL USABILITY	Applicability	.87	4	3.11	3.52	3.53	3.00	3	.71	.244	-.27
	Motivation	.82	3	3.33	3.43	3.40	3.00	3	.83	-.03	-.60
	Evaluation of previous knowledge	.70	3	3.41	3.44	3.46	3.00	3	.61	.09	-.32
	Flexibility	.86	3	3.28	3.41	3.33	3.00	3	.75	.06	-.34
	Feedback/ Help	.75	3	3.35	3.50	3.46	4.00	4	.66	-.33	-.29
	Lecturer role	.86	5	3.31	3.54	3.44	3.00	3	.71	.01	-.24
	Learning styles and strategies	.79	5	3.30	3.40	3.31	3.00	3	.66	.52	.39
ACCESSIBILIY	Perceivable Content	.71	4	3.17	3.67	3.63	4.00	4	.73	.08	-.36
	Operable Interface	.70	3	3.07	3.71	3.34	3.00	3	.73	.03	-.31
	Understandable Content	.71	2	3.56	3.67	3.78	4.00	4	.74	.01	-.53
	Robust-Content	.71	2	3.37	3.38	3.54	4.00	4	.81	-.16	.01
INOFORMATION QUALITY	Intrinsic	.74	4	3.23	3.45	3.45	4.00	4	.90	-.56	.14
	Contextual	.75	4	3.13	3.34	3.34	3.00	3	.87	-.06	-.27
	Representational	.76	4	3.12	3.34	3.38	4.00	4	.87	-.28	-.71
	Accessibility	.75	3	3.08	3.44	3.27	3.00	4	.91	-.31	-.47

(table continues)

Table 4.11 *(continued)*

Scale Reliability and Frequencies from Initial Student Questionnaire Analysis (UPAIA)

	Scale	Reliability (coefficient alpha)	No. of scale items	Range of items means		Students N=253					
				Lowest item mean	Highest item mean	Mean	Median	Mode	Std. Deviation	Skewness	Kurtosis
ADDED VALUE	Flexible learning	.80	4	3.17	3.41	3.36	3.00	4	.86	-.23	-.50
	Teaching quality	.79	6	2.96	3.30	3.21	3.00	3	.82	-.01	-.59
	Communication skills	.72	3	3.14	3.28	3.26	3.00	3	.92	-.35	-.17
	Innovative use of information	.70	2	3.17	3.58	3.58	4.00	4	.93	-.07	-.83

Measurement Models

Figure 4.1, 4.3, 4.5, 4.7, and 4.9 represent the five first-order measurement models for the constructs, Usability, pedagogical usability, Accessibility, Information quality and Added value respectively while the Figure 4.2, 4.4, 4.6, 4.8, and 4.10 represent the second-order factor models for those constructs. A second-order factor model is one with one or more latents whose indicators are themselves latents too. The second-order factor models aim to provide a clear framework for organizing the underlying dimensions in the first-order. The structural model in the second-order will be examined in term of how the underlying dimensions in the first-order contribute to the overall second-order factor model. Circles represent latent variables and rectangles represent measured variables (observed variables). The straight line pointing from a latent variable to the observed variables indicates the causal effect of the latent variable on the observed variables while the curved arrow between latent variables indicates that they are correlated.

As could be seen in these Figures, all indicated indices fit with the standard goodness-of-fit values those recommended in literature (Bentler, 1990; Bentler & Bonett, 1980; Browne & Cudeck, 1993; Hu & Bentler, 1999; Tucker & Lewis, 1973). The following is purposed to present a brief discussion of these measurements.

Usability first-order factor model. The construct Usability revealed on seven factors (User Interface, Information Architecture, Navigation, Content, Performance, Media Elements, and Basic Attributes). The initial run of the usability measurement model had indicated a good model fit to the data (Figure 4.1) with one item exception. The item "U_M4: The system informs learners of the media's size and time download." indicated a low factor loading (.462). Therefore, this item was excluded. Then, the Usability measurement model appeared to have a good fit to the data.

Indices. CMIN=519.78, CMINDF = 1.10, TLI = .99, CFI = .99 and the RMSEA = .020 (Refer to Figure 4.1). No post-hoc modifications were conducted as there were good fit of the data to the model.

Standardized Regression Weights (Factor loading). All remained items loaded significantly onto their respective factors. All the factors has a positive effect on their predictors (>.5). See Table 4.12.

Table 4.12

Standardized Regression Weights- Usability First-Order

			Estimate				Estimate
U_UI1	<---	U_UI	0.7	U_C2	<---	U_C	0.60
U_UI2	<---	U_UI	0.68	U_C3	<---	U_C	0.64
U_UI3	<---	U_UI	0.68	U_C4	<---	U_C	0.85
U_UI4	<---	U_UI	0.68	U_P1	<---	U_P	0.94
U_UI5	<---	U_UI	0.65	U_P2	<---	U_P	0.73
U_IA1	<---	U_IA	0.7	U_P3	<---	U_P	0.72
U_IA2	<---	U_IA	0.66	U_M1	<---	U_M	0.7
U_IA3	<---	U_IA	0.64	U_M2	<---	U_M	0.7
U_IA4	<---	U_IA	0.62	U_M3	<---	U_M	0.67
U_IA5	<---	U_IA	0.63	U_M4	<---	U_M	0.52
U_IA6	<---	U_IA	0.85	U_M5	<---	U_M	0.61
U_N1	<---	U_N	0.92	U_BA1	<---	U_BA	0.83
U_N2	<---	U_N	0.71	U_BA2	<---	U_BA	0.78
U_N3	<---	U_N	0.74	U_BA3	<---	U_BA	0.72
U_N4	<---	U_N	0.7	U_BA4	<---	U_BA	0.79
U_N5	<---	U_N	0.73	U_BA5	<---	U_BA	0.88
U_C1	<---	U_C	0.73				

Referring to Table 4.12, the highest and lowest predicting item for each factor is summarized in Table 4.13.

Table 4.13

The Highest And Lowest Predicting Items For The Usability Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
User Interface (UI)	U_UI1: The main User Interface is not busy	U_UI5: I am satisfied with the user interface layout and design	.07/.65
Information Architecture (IA)	U_IA6: I am satisfied with the design of the site's information architecture	U_IA4: Site structure is organized to minimize the number of levels below the homepage	.85/.62
Navigation (N)	U_N1: The navigation design connected all related information in a sequence that made sense to me	U_N4: External links were loaded in a separate window	.92/.70
Content (C)	U_C4: The site's content design is satisfactory	U_C2: Longer pages exist only when content should be printed as one document	.85/.60
Performance (P)	UP1: No links in the user interface were missing or broken. All links work	U_P3: I am satisfied with the site's performance	.94/.72
Media Elements(M)	U_M1: Media elements were of high visual and aural quality.	U_M4: Media was not used gratuitously.	.71/.52
Basic Attributes(BA)	U_BA5: The system is pleasant, comfortable and acceptable of use	U_BA3: I can easily re-establish proficiency after a period of not using the system	.88/.72

Regression Weights. Table 4.14 supports the results from the EFA (refer to Table 4.3 Usability Rotated Component Matrix). That is, Usability is significantly indicated by the seven factors of Basic attributes, Performance, User Interface, Navigation, Information architecture, Content and Media Elements. According to Garson (2005), all the regression weights are significant. When the Critical Ratio (CR) is > 1.96 for a regression weight, that path is significant at the .05 level (that is, its estimated path parameter is significant). See Table 4.14

Table 4.14

The Regression Weights - Usability First-Order

			Estimate	S.E.	C.R.	P	Label				Estimate	S.E.	C.R.	*p*	Label
U_UI3	<---	U_UI	1.17	.13	8.75	***	par_1	U_M5	<---	U_M	1.00				
U_UI2	<---	U_UI	1.10	.13	8.55	***	par_2	U_M4	<---	U_M	.74	.11	6.70	***	par_15
U_UI1	<---	U_UI	1.07	.12	8.57	***	par_3	U_M3	<---	U_M	1.03	.13	8.23	***	par_16
U_IA6	<---	U_IA	1.00					U_M2	<---	U_M	.90	.11	8.12	***	par_17
U_IA5	<---	U_IA	.76	.08	10.08	***	par_4	U_M1	<---	U_M	.97	.12	8.06	***	par_18
U_IA4	<---	U_IA	.64	.06	10.05	***	par_5	U_BA5	<---	U_BA	1.00				
U_IA3	<---	U_IA	.72	.07	10.56	***	par_6	U_BA4	<---	U_BA	.93	.06	15.64	***	par_19
U_IA2	<---	U_IA	.74	.07	11.12	***	par_7	U_BA3	<---	U_BA	.77	.06	13.34	***	par_20
U_IA1	<---	U_IA	.76	.06	11.74	***	par_8	U_BA2	<---	U_BA	.78	.05	15.01	***	par_21
U_N4	<---	U_N	.96	.09	10.77	***	par_9	U_BA1	<---	U_BA	.90	.05	16.44	***	par_22
U_N3	<---	U_N	.99	.09	11.56	***	par_10	U_P3	<---	U_P	1.02	.09	11.13	***	par_23
U_N2	<---	U_N	1.04	.10	10.99	***	par_11	U_UI4	<---	U_UI	1.03	.12	8.29	***	par_24
U_N1	<---	U_N	1.27	.09	13.86	***	par_12	U_C3	<---	U_C	1.04	.13	7.79	***	par_25
U_C2	<---	U_C	1.00					U_C4	<---	U_C	1.35	.15	9.18	***	par_26
U_C1	<---	U_C	1.19	.14	8.43	***	par_13	U_N5	<---	U_N	1.00				
U_P2	<---	U_P	1.00					U_UI5	<---	U_UI	1.00				
U_P1	<---	U_P	1.33	.10	13.03	***	par_14								

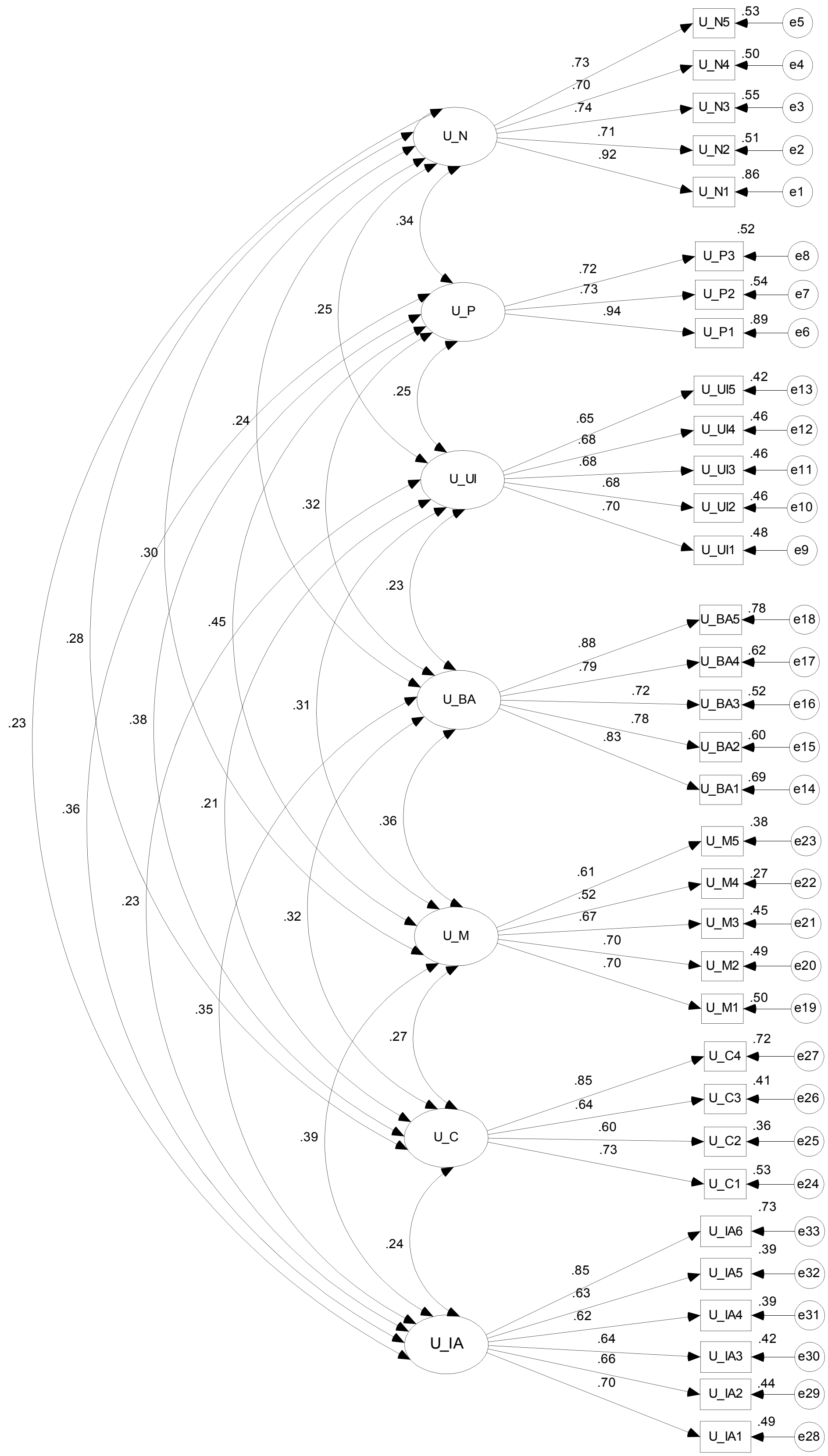
*** significant at the .001 level.

Correlations. Table 4.15 shows how the User Interface, Information Architecture, Navigation, Content, Performance, Media Elements and Basic attributes indicated a positive correlation.

Table 4.15

Correlation – Usability First-Order

			Estimate				Estimate
U_N	<-->	U_P	.34	U_UI	<-->	U_C	.21
U_UI	<-->	U_P	.25	U_IA	<-->	U_N	.23
U_UI	<-->	U_BA	.23	U_N	<-->	U_M	.30
U_M	<-->	U_BA	.36	U_N	<-->	U_C	.28
U_C	<-->	U_M	.27	U_IA	<-->	U_P	.36
U_IA	<-->	U_C	.24	U_C	<-->	U_P	.38
U_C	<-->	U_BA	.32	U_P	<-->	U_M	.45
U_IA	<-->	U_M	.39	U_P	<-->	U_BA	.32
U_IA	<-->	U_BA	.35	U_N	<-->	U_BA	.24
U_UI	<-->	U_M	.31	U_UI	<-->	U_IA	.23
				U_UI	<-->	U_N	.25



CMIN=519.78, CMINDF=1.10, TLI=.99, CFI=.99, RMSEA=.02, p=.07

Figure 4.1. The Usability Measurement Model/ First-order.

Usability second-order factor model. The Usability second-order factor model indicates a good model fit to the data (Figure 4.2). (CMIN=527.17, CMINDF=1.08, TLI=.99, CFI=.99, RMSEA=.02, *p*=.11).

Standardized Regression Weights (Factor loading). Table 4.16 shows how the seven factors (User Interface (UI), Information Architecture (IA), Navigation (N), Content (C), Performance (P), Media Elements (M) and Basic attributes (BA)) load significantly on the Usability.

Table 4.16

Standardized Regression Weights- Usability Second-Order

			Estimate
TU_M	<---	U	.66
TU_C	<---	U	.51
TU_IA	<---	U	.55
TU_BA	<---	U	.54
TU_UI	<---	U	.43
TU_P	<---	U	.66
TU_N	<---	U	.49

Regression Weights. Table 4.17 shows how the regression weight for usability (U) in the prediction of the seven related factors are significantly different from zero at the 0.001 level.

Table 4.17

Regression Weights- Usability Second-Order

	Estimate	S.E.	C.R.	P	Label
TU_M <---U	.73	.16	4.64	***	par_27
TU_C <---U	.67	.15	4.40	***	par_28
TU_IA <---U	1.16	.23	5.01	***	par_29
TU_BA <---U	1.10	.22	5.05	***	par_30
TU_UI <---U	.70	.17	4.08	***	par_31
TU_P <---U	1.19	.23	5.22	***	par_32
TU_N <---U	1.00				

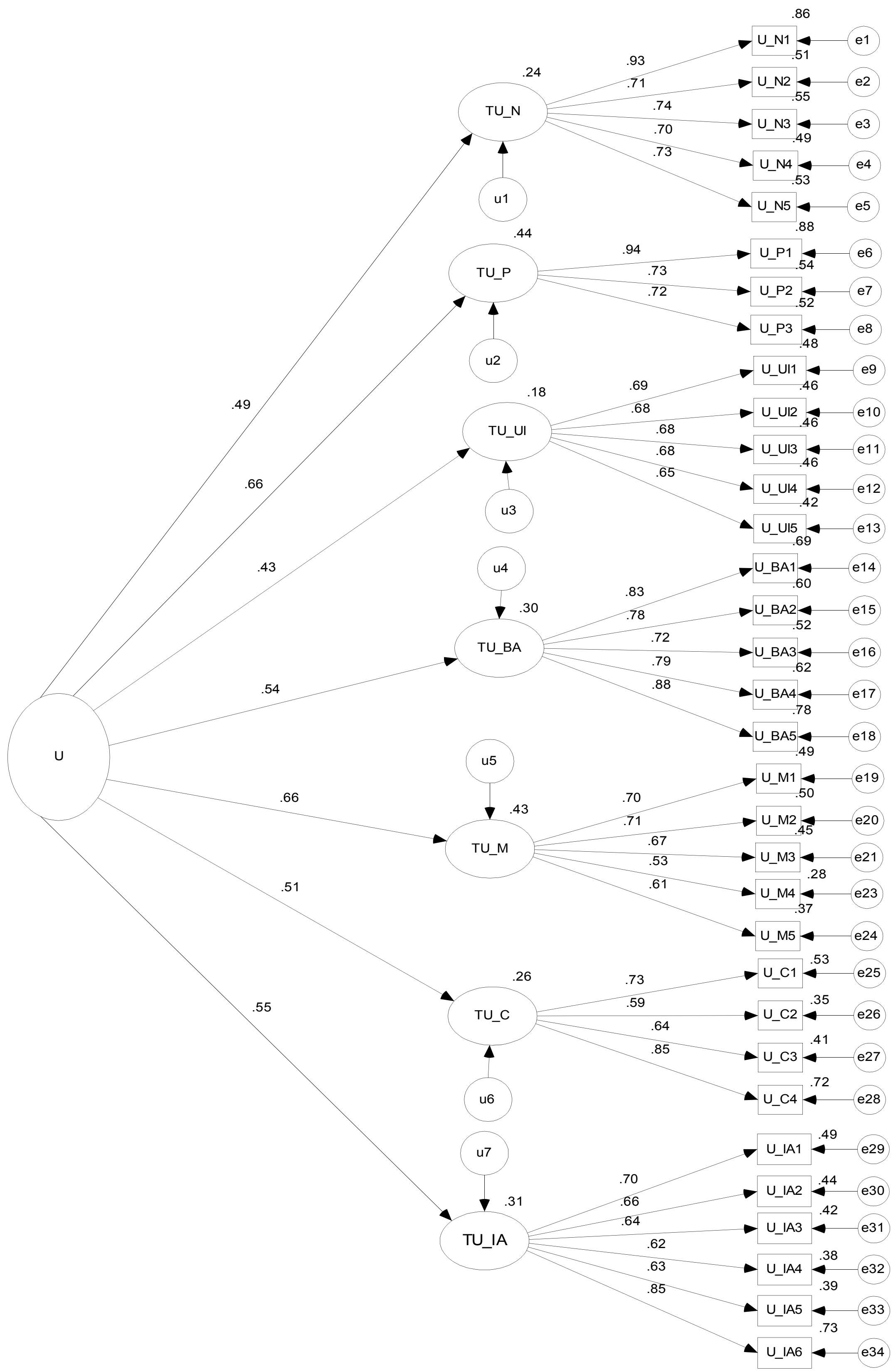
*** significant at the .001 level.

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2), indicates the amount of variance the common factor accounts for in the observed variables. These ranged from 18% to 44%. See Table 4.18.

Table 4.18

Squared Multiple Correlations - Usability second-order

	Estimate		Estimate
TU_BA	.30	TU_N	.24
TU_M	.43	TU_IA	.31
TU_P	.44	TU_UI	.18
TU_C	.26		



CMIN=527.17, CMINDF=1.08, TLI=.99, CFI=.99, RMSEA=.02, p=.11

Figure 4.2. The Usability Measurement Model/ Second-order.

Pedagogical usability first-order factor model. The Pedagogical usability construct revealed on thirteen factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility). The initial run of the Pedagogical usability model had indicated a good model fit to the data after excluding the following items which indicated a low factor loading: the item "P_LC2 I have the opportunity to control over the media elements" indicated a low factor loading (.469). All other excluded items have indicated a low factor loading <.4:"P_CCL3 I frequently communicate with my classmates (via email, bulletin boards, chat line)"; "P_G1 The objectives are built using simple language"; " P_G3 The objectives show clearly what I'm going to know (or learn) after having the course"; "P_A4 Learning was accomplished through the base" learning by doing" using methods that involved practical tasks"; "P_M1 The course topics are interesting"; "P_M2 The presented topics in course were completely new to me"; "P_M5 The activities throughout the course motivate me to learn"; "P_PK2 The course is structured to go over earlier material before starting to teach a new topic"; "P_LR2 Lecturers provide me with one-on-one instruction during the class time"; and finally the item "P_LSS3 I am required in this course to find out my own solution (not the teacher's or the program's model solutions)" .The item "U_M4 The system informs learners of the media's size and time download." indicated a low factor loading (.462). Therefore, this item was excluded. Then, the Pedagogical usability measurement model appeared to be has a good fit to the data. See Figure 4.2

Indices. CMIN=1489.53, CMINDF=1.19, TLI = .96, CFI = .96 and the RMSEA = .028 (Figure 4.3).

No post-hoc modifications were conducted as the model indicated a good fit to the data.

Standardized Regression Weights (Factor loading). All remained items loaded significantly onto their respective factors as can be seen in Table 4.19.

Table 4.19

Standardized Regression Weights- Pedagogical Usability First-Order

			Estimate				Estimate
P_S1	<---	P_S	0.82	P_LR2	<---	P_LR	0.69
P_S2	<---	P_S	0.73	P_LR3	<---	P_LR	0.71
P_S3	<---	P_S	0.74	P_LR4	<---	P_LR	0.76
P_S4	<---	P_S	0.79	P_LR5	<---	P_LR	0.66
P_S5	<---	P_S	0.75	P_A1	<---	P_A	0.86
P_S6	<---	P_S	0.73	P_A2	<---	P_A	0.67
P_C1	<---	P_C	0.72	P_A3	<---	P_A	0.83
P_C2	<---	P_C	0.76	P_A4	<---	P_A	0.81
P_C3	<---	P_C	0.62	P_G1	<---	P_G	0.69
P_C4	<---	P_C	0.62	P_G2	<---	P_G	0.77
P_C5	<---	P_C	0.66	P_G3	<---	P_G	0.61
P_C6	<---	P_C	0.72	P_LC1	<---	P_LC	0.62
P_C7	<---	P_C	0.6	P_LC2	<---	P_LC	0.8
P_CCL1	<---	P_CCL	0.91	P_LC3	<---	P_LC	0.7
P_CCL2	<---	P_CCL	0.71	P_LC4	<---	P_LC	0.6
P_CCL3	<---	P_CCL	0.72	P_PK1	<---	P_PK	0.72
P_CCL4	<---	P_CCL	0.65	P_PK2	<---	P_PK	0.82
P_M1	<---	P_M	0.76	P_PK3	<---	P_PK	0.53

(table continues)

Table 4.19 *(continued)*

Standardized Regression Weights- Pedagogical Usability First-Order

			Estimate				Estimate
P_M2	<---	P_M	0.79	P_I4	<---	P_I	0.84
P_M3	<---	P_M	0.77	P_I5	<---	P_I	0.75
P_LSS3	<---	P_LSS	0.73	P_I6	<---	P_I	0.72
P_LSS4	<---	P_LSS	0.6	P_FB1	<---	P_FB	0.75
P_LSS5	<---	P_LSS	0.69	P_FB2	<---	P_FB	0.72
P_LSS6	<---	P_LSS	0.62	P_FB3	<---	P_FB	0.67
P_LSS7	<---	P_LSS	0.65	P_F1	<---	P_F	0.89
P_LR1	<---	P_LR	0.9	P_F2	<---	P_F	0.82
				P_F3	<---	P_F	0.76

Refer to Table 4.19, the highest and lowest predicting item for each factor is summarized in Table 4.20.

Table 4.20

The Highest and Lowest Predicting Items for the Pedagogical Usability Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
Structure (P_S)	P_S1: Topics were presented in a logical and ordered manner.	P_S2: Hierarchies of content are designed of breadth rather than depth (no more than three levels in each paragraph).	.82/.73
Course Content (P_C)	P_C2: A complete syllabus of the course was available ahead of learning.	P_C7: I am satisfied with the course' content.	.76/.60
Cooperative/Collaborative Learning (P_CCL)	P_CCL1: Much of learning sessions took place in groups.	P_CCL4: I feel satisfied with the cooperative/collaborative learning techniques being conducted in this course.	.91/.65

(table continues)

Table 4.20 *(continued)*

The Highest and Lowest Predicting Items for the Pedagogical Usability Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
Motivation (P_M)	P:M2: The course topics focus on real-world problems.	P_M1: The course topics meet my needs and expectations.	.79/.76
Learning Styles and Strategies P_LSS)	P_LSS3: The course often provides learning problems with a pre-defined model for the solution.	P_LSS4: I am usually rewarded for good answers (e.g., expressions of approval or admiration, of respect and gratitude),	.73/.60
Lecturer Role (P_LR)	P_LR1: Lecturers perform tasks in a straightforward manner	P_LR5: I am satisfied with the lecturer's role in this course.	.90/.66
Applicability (P_A)	P_A1: The course topics accommodated with different learning styles.	P_A2: I feel that this course has been designed for me.	.86/.67
Goals and Objectives (P_G)	P_G2: The objectives show clearly what kind of the assessment I am going to have at the end of semester.	P_G3: Special behavioural objectives are identified adequately (I got known about behavioural for success, failure and dishonesty in the class).	.77/.61
Learner Control (P_LC)	P_LC2: I have always the feeling that I am responsible for my own learning.	P_LC4: I feel satisfied with my control over learning.	.80/.60
Evaluation of Previous Knowledge (P_PK)	P_PK2: The course topics are designed in such away to meet different learning levels.	P_PK3: The course is not over simplifying learning instead it was designed in new ways to provide appropriate scaffolding and support.	.82/.53
Interaction (P_I)	P_I4: Lecturers, frequently schedule specific chat times and conversational	P_I6: I feel satisfied with the reaction I got in this class web site.	.84/.72
Feedback (P_FB)	P_FB1: There was an adequate help provided within the class.	P_FB3: Generally, I am satisfied with the help provided in the class web site.	.75/.67
Flexibility (P_F)	P_F1: The course offers optional routes for my progress	P_F3: The class web site gives me the opportunity to add some comments and suggestions.	.89/.76

Regression Weight. Referring to the Table 4.21, all the regression weights for factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) in the prediction of their observed items are significant at the 0.001 level.

Table 4.21

The Regression Weights- Pedagogical Usability First-Order

			Estimate	S.E.	C.R.	P	Label				Estimate	S.E.	C.R.	P	Label
P_PK1	←-	P_PK	1					P_G3	←-	P_G	1				
P_S1	←-	P_S	1.12	0.09	12.99	***	par_1	P_M1	←-	P_M	1				
P_S2	←-	P_S	0.99	0.09	11.47	***	par_2	P_M3	←-	P_M	1.07	0.1	11.06	***	par_13
P_S3	←-	P_S	1.14	0.1	11.74	***	par_3	P_M2	←-	P_M	1.11	0.09	11.77	***	par_14
P_S4	←-	P_S	1.15	0.09	12.67	***	par_4	P_LSS3	←-	P_LSS	1				
P_S5	←-	P_S	1					P_LSS6	←-	P_LSS	0.81	0.09	8.82	***	par_15
P_LC4	←-	P_LC	1					P_LSS5	←-	P_LSS	0.95	0.1	9.87	***	par_16
P_C1	←-	P_C	0.99	0.1	10.22	***	par_5	P_LSS4	←-	P_LSS	0.84	0.09	8.83	***	par_17
P_C2	←-	P_C	1.08	0.1	11.09	***	par_6	P_LR1	←-	P_LR	1				
P_C3	←-	P_C	0.86	0.1	8.89	***	par_7	P_LR4	←-	P_LR	0.91	0.06	14.88	***	par_18
P_C4	←-	P_C	0.87	0.1	9.01	***	par_8	P_LR2	←-	P_LR	0.86	0.07	12.36	***	par_19
P_C5	←-	P_C	0.88	0.09	9.46	***	par_9	P_LR3	←-	P_LR	0.85	0.06	13.13	***	par_20
P_C6	←-	P_C	1					P_LR5	←-	P_LR	0.81	0.07	11.69	***	par_21
P_CCL4	←-	P_CCL	0.72	0.06	11.15	***	par_10	P_A1	←-	P_A	1				
P_CCL3	←-	P_CCL	0.78	0.06	13.52	***	par_11	P_A4	←-	P_A	1.03	0.07	15.16	***	par_22

(table continues)

Table 4.21 *(continued)*

The Regression Weights- Pedagogical Usability First-Order

			Estimate	S.E.	C.R.	P	Label				Estimate	S.E.	C.R.	P	Label
P_CCL2	<---	P_CCL	0.87	0.07	12.95	***	par_12	P_A3	<---	P_A	1.13	0.07	15.59	***	par_23
P_CCL1	<---	P_CCL	1					P_A2	<---	P_A	0.86	0.08	11.4	***	par_24
P_G1	<---	P_G	1.15	0.15	7.94	***	par_25	P_FB1	<---	P_FB	1	0.11	9.27	***	par_33
P_G2	<---	P_G	1.26	0.15	8.58	***	par_26	P_FB3	<---	P_FB	0.78	0.09	8.39	***	par_34
P_LC1	<---	P_LC	1	0.13	7.51	***	par_27	P_FB2	<---	P_FB	1				
P_LC2	<---	P_LC	1.13	0.13	9.03	***	par_28	P_F1	<---	P_F	1.09	0.07	15.3	***	par_35
P_LC3	<---	P_LC	0.97	0.12	8.15	***	par_29	P_F3	<---	P_F	1	0.08	12.79	***	par_36
P_PK3	<---	P_PK	0.94	0.14	6.9	***	par_30	P_F2	<---	P_F	1				
P_PK2	<---	P_PK	1.2	0.13	9.19	***	par_31	P_I6	<---	P_I	0.95	0.09	10.34	***	par_37
P_I5	<---	P_I	1					P_C7	<---	P_C	0.79	0.09	8.73	***	par_38
P_I4	<---	P_I	1.16	0.09	12.37	***	par_32	P_LSS7	<---	P_LSS	0.89	0.09	9.51	***	par_39
								P_S6	<---	P_S	1.01	0.09	11.34	***	par_40

*** at the .001 level.

Correlations. Table 4.22 shows how the factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) indicated a positive correlation.

Table 4.22

Correlation- Pedagogical Usability First-Order

			Estimate				Estimate
P_FB	←>	P_F	0.29	P_G	←>	P_LR	0.58
P_PK	←>	P_FB	0.5	P_PK	←>	P_A	0.5
P_PK	←>	P_LC	0.46	P_PK	←>	P_LR	0.49
P_CCL	<-->	P_G	0.54	P_LC	<-->	P_A	0.46
P_G	<-->	P_A	0.45	P_LC	<-->	P_M	0.51
P_M	<-->	P_A	0.51	P_LC	<-->	P_LR	0.46
P_M	<-->	P_LSS	0.44	P_S	<-->	P_CCL	0.37
P_LSS	<-->	P_LR	0.74	P_C	<-->	P_G	0.45
P_S	<-->	P_LR	0.33	P_A	<-->	P_I	0.51
P_S	<-->	P_C	0.22	P_S	<-->	P_F	0.32
P_C	<-->	P_I	0.47	P_C	<-->	P_F	0.43
P_PK	<-->	P_CCL	0.44	P_I	<-->	P_F	0.39
P_S	<-->	P_LSS	0.41	P_I	<-->	P_FB	0.39
P_LC	<-->	P_FB	0.39	P_C	<-->	P_FB	0.25
P_PK	<-->	P_G	0.41	P_S	<-->	P_FB	0.36
P_CCL	<-->	P_FB	0.38	P_PK	<-->	P_I	0.35
P_LC	<-->	P_CCL	0.66	P_PK	<-->	P_C	0.31
P_LC	<-->	P_G	0.6	P_LC	<-->	P_C	0.38
P_CCL	<-->	P_A	0.46	P_C	<-->	P_CCL	0.42
P_CCL	<-->	P_M	0.54	P_C	<-->	P_A	0.44
P_G	<-->	P_M	0.51	P_S	<-->	P_LC	0.27
P_G	<-->	P_LSS	0.51	P_LC	<-->	P_I	0.39
P_LSS	<-->	P_A	0.53	P_LC	<-->	P_LSS	0.41

(table continues)

Table 4.22 *(continued)*

Correlation- Pedagogical Usability First-Order

			Estimate				Estimate
P_LR	<-->	P_A	0.4	P_PK	<-->	P_S	0.33
P_M	<-->	P_LR	0.39	P_S	<-->	P_G	0.44
P_S	<-->	P_M	0.34	P_PK	<-->	P_M	0.48
P_C	<-->	P_LSS	0.46	P_PK	<-->	P_LSS	0.49
P_S	<-->	P_I	0.32	P_G	<-->	P_I	0.45
P_C	<-->	P_LR	0.31	P_CCL	<-->	P_I	0.44
P_LR	<-->	P_I	0.35	P_M	<-->	P_I	0.51
P_PK	<-->	P_F	0.46	P_CCL	<-->	P_LR	0.54
P_LC	<-->	P_F	0.45	P_A	<-->	P_FB	0.29
P_G	<-->	P_FB	0.46	P_M	<-->	P_FB	0.31
P_CCL	<-->	P_LSS	0.53	P_LSS	<-->	P_F	0.54
P_S	<-->	P_A	0.37	P_LR	<-->	P_FB	0.39
P_C	<-->	P_M	0.4	P_LR	<-->	P_F	0.44
P_LSS	<-->	P_I	0.43	P_G	<-->	P_F	0.47
P_LSS	<-->	P_FB	0.31	P_CCL	<-->	P_F	0.48
P_A	<-->	P_F	0.46	P_M	<-->	P_F	0.52

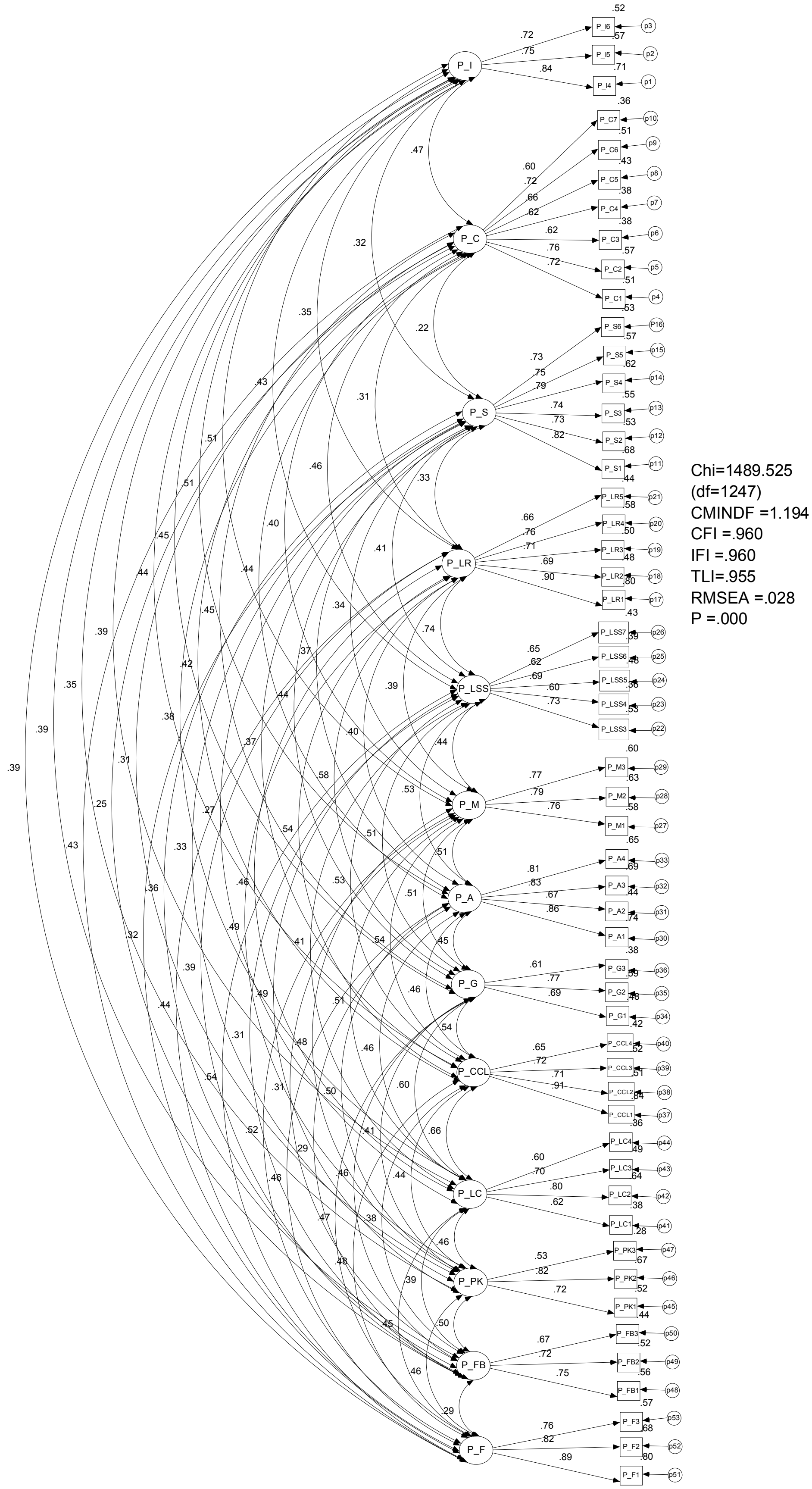


Figure 4.3. The Pedagogical Usability Measurement Model/First order

Pedagogical usability second-order factor model. The Pedagogical usability second-order factor model indicates a good model fit to the data (Figure 4.4). CMIN=1619.65, CMINDF=1.23, TLI=.95, CFI=.95, RMSEA=.03, *p*=.001)

Standardized Regression Weights (Factor loading). Table 4.23 shows how the thirteen factors (Structure (S), Course Content (C), Cooperative/Collaborative Learning (CCL), Motivation (M), Learning Styles and Strategies (LSS), Lecturer Role (LR), Applicability (A), Goals and Objectives (G), Learner Control (LC), Evaluation of Previous Knowledge (PK), Interaction (I), Feedback (FB), and Flexibility (F)) load significantly on the Pedagogical usability.

Table 4.23

Standardized Regression Weights- Pedagogical usability Second-Order

			Estimate				Estimate
P_F	<---	P	.67	P_M	<---	P	.69
P_FB	<---	P	.52	P_LSS	<---	P	.75
P_PK	<---	P	.65	P_LR	<---	P	.70
P_LC	<---	P	.69	P_S	<---	P	.51
P_CCL	<---	P	.74	P_C	<---	P	.57
P_G	<---	P	.74	P_I	<---	P	.62
P_A	<---	P	.68				

Regression Weights. Table 4.24 shows how the regression weight for pedagogical usability (P) in the prediction of the thirteen related factors are significantly different from zero at the 0.001 level.

Table 4.24

Regression Weights- Pedagogical Usability Second-Order

		Estimate	S.E.	C.R.	P	Label
P_F	<---P	1.51	.23	6.48	***	par_41
P_FB	<---P	1.01	.19	5.26	***	par_42
P_PK	<---P	1.00				
P_LC	<---P	1.17	.20	5.76	***	par_43
P_CCL	<---P	1.35	.22	6.22	***	par_44
P_G	<---P	1.25	.21	5.83	***	par_45
P_A	<---P	1.45	.22	6.64	***	par_46
P_M	<---P	1.53	.24	6.36	***	par_47
P_LSS	<---P	1.24	.21	6.05	***	par_48
P_LR	<---P	1.41	.22	6.53	***	par_49
P_S	<---P	1.04	.19	5.51	***	par_50
P_C	<---P	1.22	.21	5.77	***	par_51
P_I	<---P	1.14	.19	5.88	***	par_52

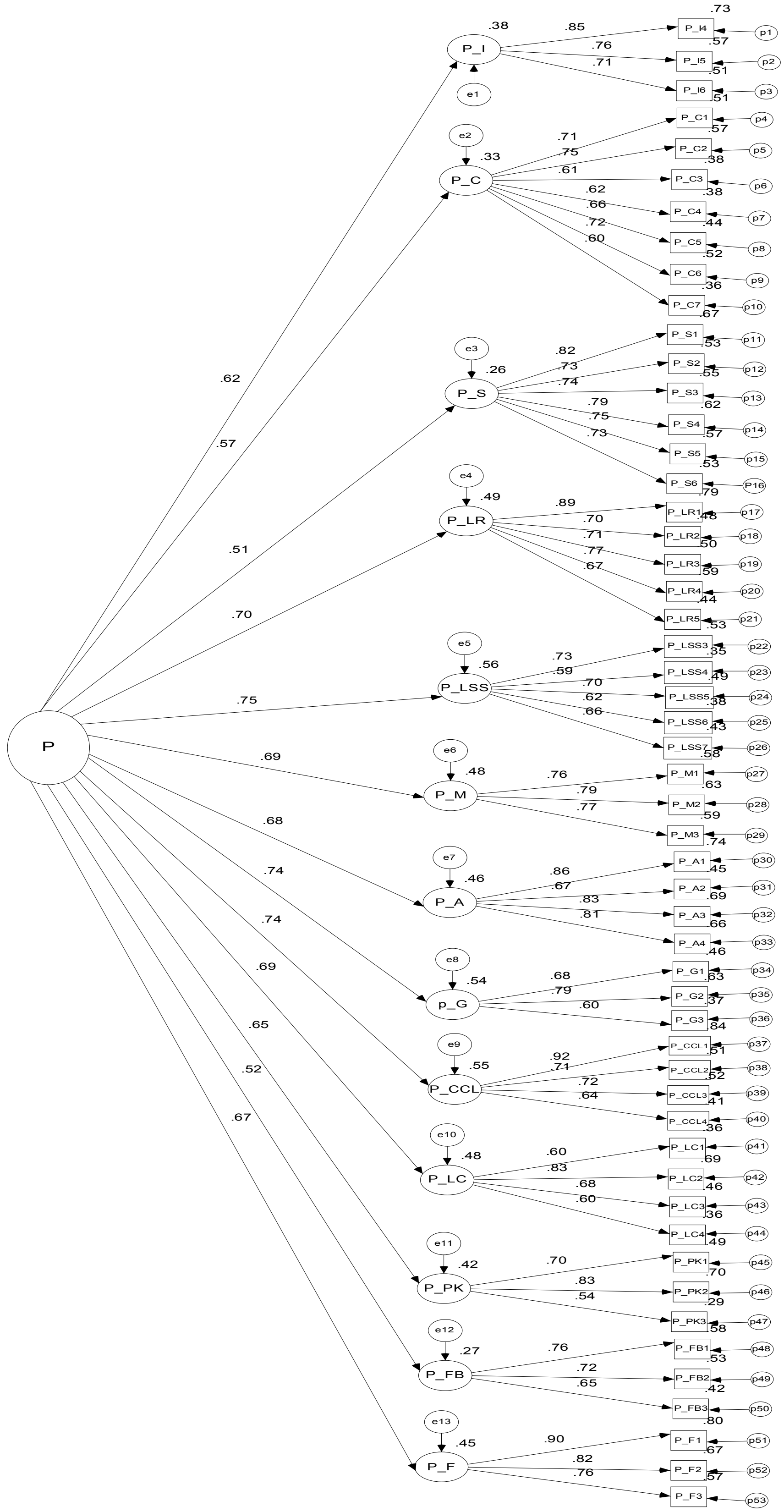
*** at the .001 level.

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) can be seen in Table 4.25. They indicated amount of variance ranged from 25.6 % to 56 %.

Table 4.25

Squared Multiple Correlations - Pedagogical Usability Second-Order

	Estimate		Estimate
P_F	.45	P_G	.54
P_FB	.28	P_CCL	.55
P_I	.38	P_C	.33
P_A	.46	P_LC	.479
P_LR	.49	P_S	.256
P_LSS	.56	P_PK	.422
P_M	.48		



CMIN=1619.65, CMINDF=1.23, TLI=.95, CFI=.95, RMSEA=.03, p=.001

*Figure 4.*4. The Pedagogical Usability Measurement Model/Second order

Accessibility first-order factor model. The Accessibility construct revealed on four factors (Perceivable Content, Operable Content, Understandable Content, and Robust Content). The measurement model was well fitted with the data. No items indicated a low factor loading. Therefore, no items were deleted. See Figure 4.5.

Indices. CMIN=73.57, CMINDF=1.94, TLI = .92, CFI = .95, and the RMSEA = .062. No post-hoc modifications were conducted as there was a good model fit to the data.

Standardized Regression Weights (Factor loading). All items loaded significantly onto their respective factors. All the factors has a positive effect on their predictors (>=.5) as can be seen in Table 4.26.

Table 4.26

Standardized Regression Weights-Accessibility First-Order

			Estimate				Estimate
A_O1	<---	A_O	0.59	A_P5	<---	A_P	0.7
A_O2	<---	A_O	0.69	A_U2	<---	A_U	0.71
A_O3	<---	A_O	0.73	A_U1	<---	A_U	0.77
A_P2	<---	A_P	0.61	A_R1	<---	A_R	0.69
A_P3	<---	A_P	0.64	A_R2	<---	A_R	0.8
A_P4	<---	A_P	0.5				

Refer to Table 4.26, the highest and lowest predicting item for each factor is summarized in Table 4.27.

Table 4.27

The Highest and Lowest Predicting Items for the Accessibility Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
Perceivable Content (A_P)	A_P5: Content was presented in a way that is visible and hearable.	A_P4: Content was flexibly presented in different ways without losing information or structure (e.g., spoken aloud, simpler layout, etc.).	.70/.50
Operable Content (A_O)	A_O3: I am provided with flexible ways to help me navigate, find content, and determine where I am in the site.	A_O1: Most user interface functionalities were available from the key board.	.73/.59
Understandable Content (A_U)	A_U1: Text content was readable and understandable.	A_U2: I can predict the Web pages appearance and operation.	.77/.71
Robust Content (A_R)	A_R2: Content is accessible (or accessible alternative is provided).	A_R1: Content can be interpreted reliably by a wide variety of user agents, including assistive technologies.	.80/.69

Regression Weight. Referring to the Table 4.28, all the regression weights for factors (Perceivable Content, Operable Content, Understandable Content, and Robust Content) in the prediction of their items are significant at level 0.001.

Table 4.28

The Regression Weights - *Accessibility First-Order*

			Estimate	S.E.	C.R.	P	Label				Estimate	S.E.	C.R.	P	Label
A_O1	<---	A_O	1.00					A_P3	<---	A_P	1.13	.16	7.25	***	par_3
A_O2	<---	A_O	1.16	.16	7.26	***	par_1	A_P4	<---	A_P	.76	.13	6.05	***	par_4
A_O3	<---	A_O	1.16	.16	7.34	***	par_2	A_P5	<---	A_P	1.33	.18	7.54	***	par_6
A_U1	<---	A_U	1.00					A_U2	<---	A_U	.84	.12	7.05	***	par_7
A_P2	<---	A_P	1.00					A_R1	<---	A_R	1.00				
								A_R2	<---	A_R	1.22	.18	6.91	***	par_8

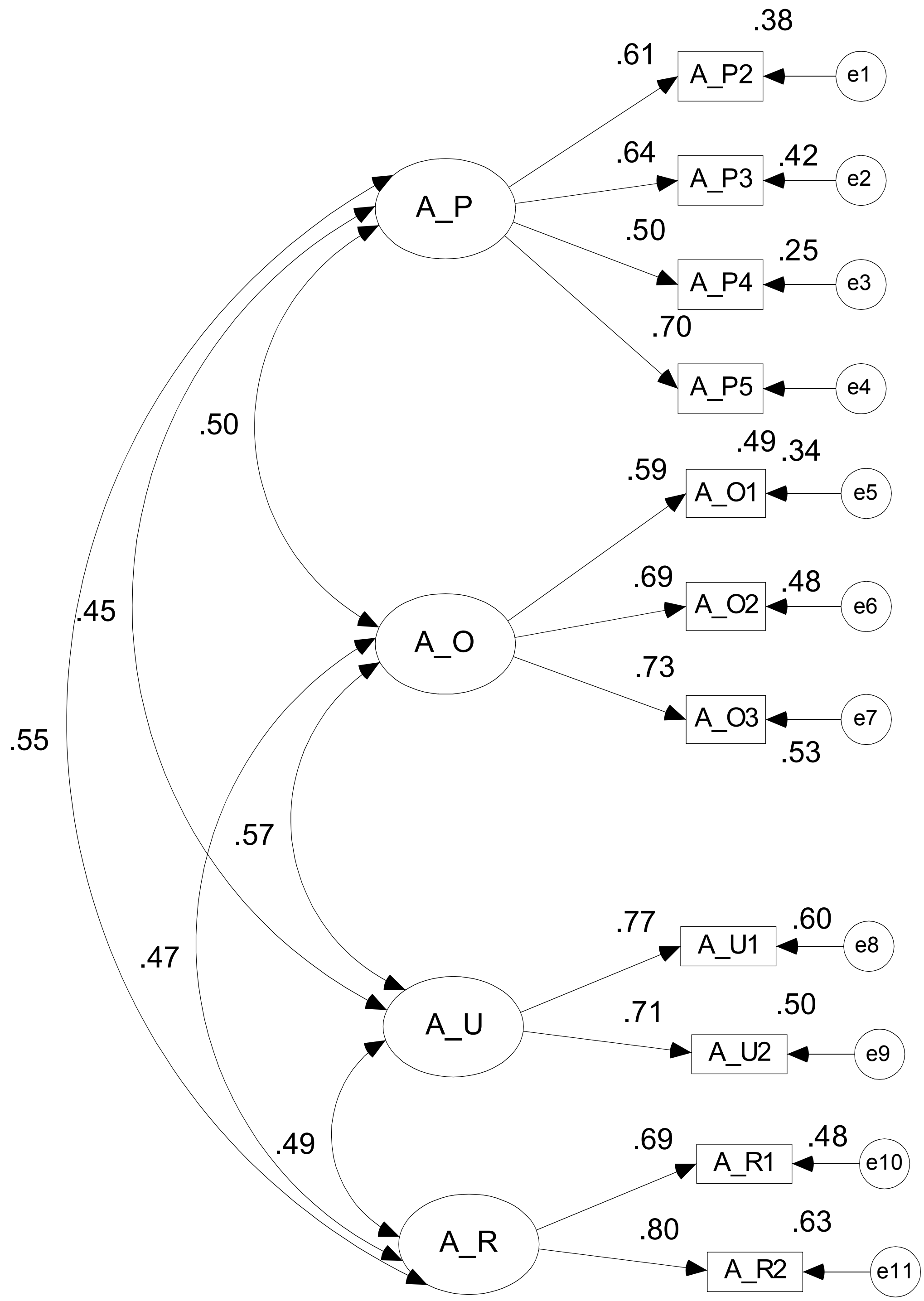
*** at the .001 level.

Correlations. The four factors (Perceivable Content, Operable Content, Understandable Content, and Robust Content) indicated a positive correlation as can be seen in Table 4.29

Table 4.29

Correlation- Accessibility First-Order

			Estimate				Estimate
A_O	<-->	A_P	0.5	A_P	<-->	A_R	0.55
A_U	<-->	A_R	0.49	A_U	<-->	A_P	0.45
A_O	<-->	A_R	0.47	A_O	<-->	A_U	0.57



CMIN=73.57, CMINDF= 1.94, TLI= .92, CFI= .95, RMSEA=.06, p=.001

Figure 4.5. Accessibility measurement model/First order

Accessibility second-order factor model. The Accessibility second-order factor model indicates a good model fit to the data (Figure 4.6). CMIN=76.57, CMINDF= 1.91, TLI= .93, CFI= .95, RMSEA=.06, *p*=.001

Standardized Regression Weights (Factor loading). Table 4.30 shows how the four factors (Perceivable Content (P), Operable Content (C), Understandable Content (U), and Robust Content (R)) load significantly on the Accessibility.

Table 4.30

Standardized Regression Weights-Accessibility Second-Order

			Estimate
A_P	<---	A	.70
A_O	<---	A	.72
A_U	<---	A	.71
A_R	<---	A	.70

Regression Weights. Table 4.31 shows how the regression weight for Accessibility (A) in the prediction of the four related factors are significantly different from zero at the 0.001 level.

Table 4.31

Regression Weights- Accessibility Second-Order

			Estimate	S.E.	C.R.	P	Label				Estimate	S.E.	C.R.	P	Label
A_P	<---	A	.84	.17	4.96	***	Par_8	A_U	<---	A	1.00				
A_O	<---	A	.88	.18	4.89	***	Par_9	A_R	<---	A	1.32	.25	5.32	***	par_10

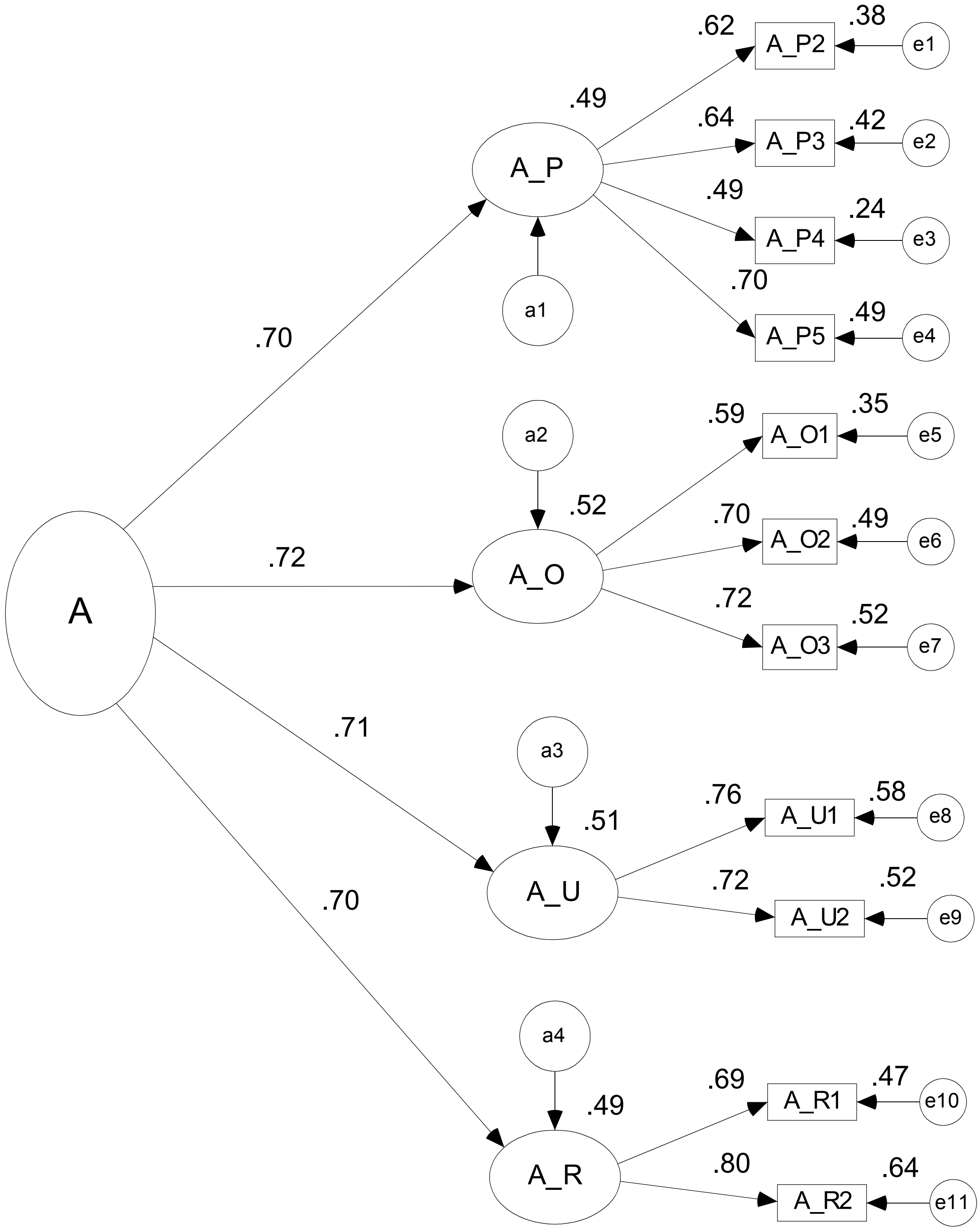
*** at the .001 level.

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) can be seen in Table 4.32. They indicated amount of variance ranged from 49 % to 52 %. See Table 4.32.

Table 4.32

Squared Multiple Correlations- Accessibility Second-Order

	Estimate
A_R	.49
A_P	.49
A_U	.51
A_O	.52



CMIN=76.57, CMINDF= 1.91, TLI= .93, CFI= .95, RMSEA=.06, p=.001

Figure 4.6. Accessibility measurement model/Second order

Information Quality first-order factor model. The Information Quality construct revealed on four factors (Intrinsic, Contextual, Representational, and Accessible information quality). The measurement model was well fitted with the data. No items indicated a low factor loading. See Figure 4.7.

Indices. CMIN=137.64, CMINDF=1.64, CFI = .95; TLI = .94; and the RMSEA = .05 (Figure 4.7). No post-hoc modifications were conducted as there were a good fit of the data to the model.

Standardized Regression Weights (Factor loading). All items loaded significantly onto their respective factors as can be seen in Table 4.33.

Table 4.33

Standardized Regression Weights- Information Quality First-Order

			Estimate				Estimate
IQ_R4	<---	IQ_R	0.66	IQ_I4	<---	IQ_I	0.62
IQ_R3	<---	IQ_R	0.51	IQ_I3	<---	IQ_I	0.69
IQ_R2	<---	IQ_R	0.74	IQ_I2	<---	IQ_I	0.68
IQ_R1	<---	IQ_R	0.76	IQ_I1	<---	IQ_I	0.58
IQ_C4	<---	IQ_C	0.53	IQ_A3	<---	IQ_A	0.76
IQ_C3	<---	IQ_C	0.63	IQ_A2	<---	IQ_A	0.66
IQ_C2	<---	IQ_C	0.73	IQ_A1	<---	IQ_A	0.61
IQ_C1	<---	IQ_C	0.77				

Referring to Table 4.33, the highest and lowest predicting item for each factor is summarised in Table 4.34.

Table 4.34

The Highest and Lowest Predicting items for the Information Quality Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
Intrinsic (IQ_I)	IQ_I3: The information was correct.	IQ_I1: The information was valid according to some stable reference.	.69/.58
Contextual (IQ_C)	IQ_C1: The information was applicable and helpful.	IQ_C4: The size of information was corresponding to the context.	.77/.53
Representational (IQ_R)	IQ_R1: The information was conforming to our technical abilities.	IQ_R1: The structure of the information was matching with the information itself.	.76/.51
Accessible (IQ_A)	IQ_A2: The system operations were easy to manipulate.	IQ_A1: The system is giving correct answer to a feasible query in a given time range.	.76/.61

Regression Weight. Referring to the Table 4.35, all the regression weights for factors (Intrinsic, Contextual, Representational, and Accessible information quality) in the prediction of their items are significant at the .001 level.

Table 4.35

The Regression Weights - Information Quality First-Order

			Estimate	S.E.	C.R.	*p*	Label				Estimate	S.E.	C.R.	*p*	Label
IQ_R4	<---	IQ_R	1.00					IQ_C2	<---	IQ_C	1.32	.18	7.44	***	par_5
IQ_R3	<---	IQ_R	.90	.14	6.69	***	par_1	IQ_C1	<---	IQ_C	1.21	.16	7.57	***	par_6
IQ_R2	<---	IQ_R	1.26	.14	8.89	***	par_2	IQ_I4	<---	IQ_I	1.00				
IQ_R1	<---	IQ_R	1.25	.14	8.95	***	par_3	IQ_I3	<---	IQ_I	1.15	.15	7.63	***	par_7

*** significant at the .001 level.

(table continues)

Table 4.35 *(continued)*

The Regression Weights - Information Quality First-Order

			Estimate	S.E.	C.R.	*p*	Label				Estimate	S.E.	C.R.	*p*	Label
IQ_C4	<---	IQ_C	1.00					IQ_I2	<---	IQ_I	1.09	.14	7.57	***	par_8
IQ_C3	<---	IQ_C	1.13	.16	6.90	***	Par_4	IQ_I1	<---	IQ_I	.89	.13	6.90	***	par_9
IQ_A3	<---	IQ_A	1.00					IQ_A1	<---	IQ_A	.71	.09	8.20	***	par_11
IQ_A2	<---	IQ_A	1.01	.11	9.19	***	Par_10								

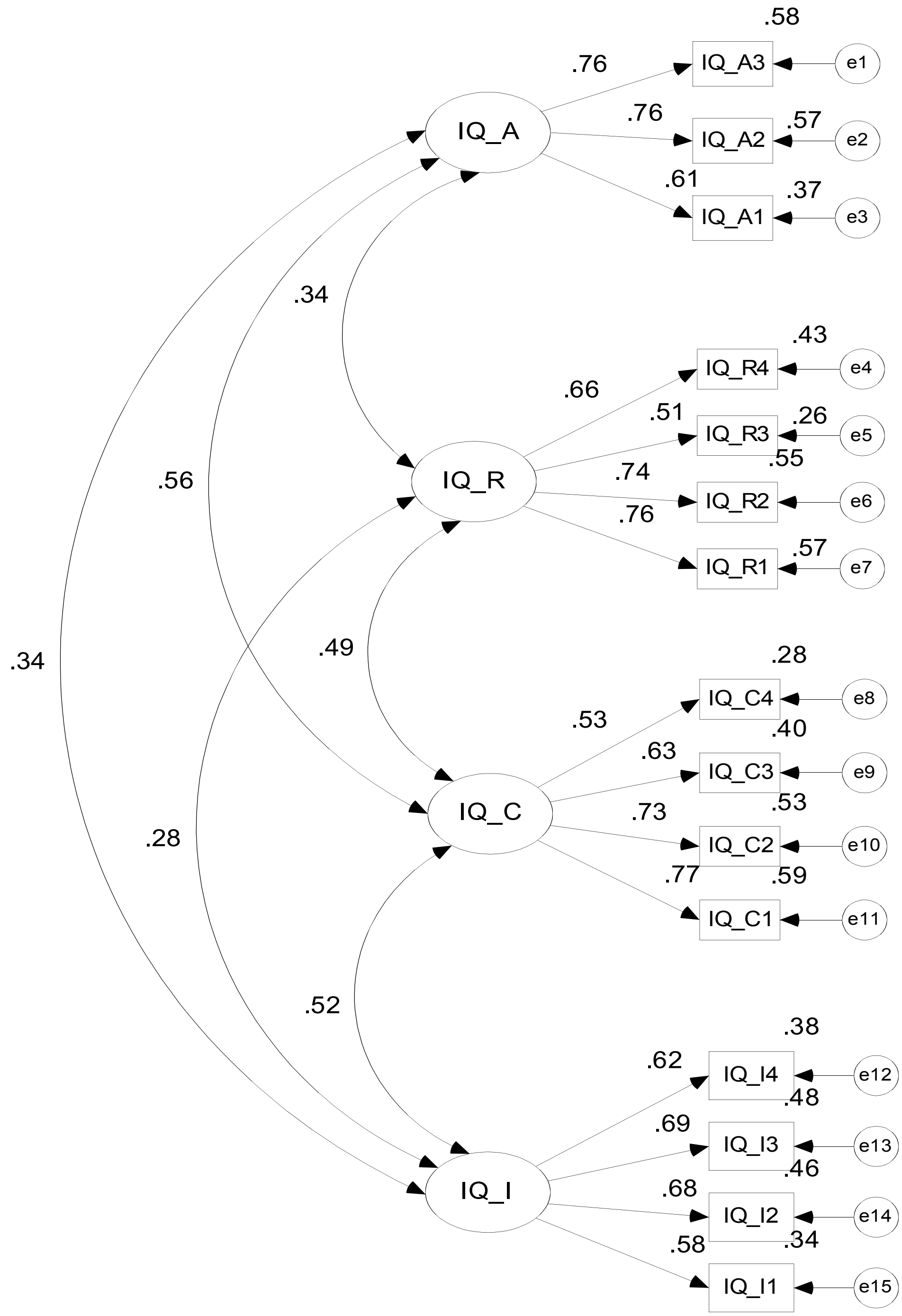
*** significant at the .001 level.

Correlations. The four factors (Intrinsic, Contextual, Representational, and Accessible information quality) indicated a positive correlation. See Table 4.36.

Table 4.36

Correlations - Information Quality First-Order

			Estimate
IQ_R	<-->	IQ_A	.34
IQ_I	<-->	IQ_A	.34
IQ_R	<-->	IQ_C	.49
IQ_C	<-->	IQ_A	.56
IQ_C	<-->	IQ_I	.52
IQ_R	<-->	IQ_I	.28



CMIN=137.63, CMINDF= 1.64, TLI= .94, CFI= .95, RMSEA=.05, *p*=.001

Figure 4.7. Information quality measurement model/First order

Information Quality second-order factor model. The Information quality second-order factor model indicates a good model fit to the data (Figure 4.8). CMIN=137.77, CMINDF= 1.60, TLI= .94, CFI= .95, RMSEA=.049, p=.001

Standardized Regression Weights (Factor loading). Table 4.37 shows how the four factors (Intrinsic (I), Contextual (C), Representational (R), and Accessible information quality(A)) load significantly (>.5)on the Information quality.

Table 4.37

Standardized Regression Weights-information Quality Second-Order

			Estimate
IQ_A	<---	IQ	.61
IQ_C	<---	IQ	.92
IQ_R	<---	IQ	.54
IQ_I	<---	IQ	.57

Regression Weights. Table 4.38 shows how the regression weight for Information quality (IQ) in the prediction of the four related factors are significantly different from zero at the 0.001 level.

Table 4.38

Regression Weights -Information Quality Second-Order

	Estimate	S.E.	C.R.	*p*	Label
IQ_A <--- IQ	1.35	.29	4.75	***	par_12
IQ_C <--- IQ	1.50	.35	4.36	***	par_13
IQ_R <--- IQ	.90	.21	4.39	***	par_14
IQ_I <--- IQ	1.00				

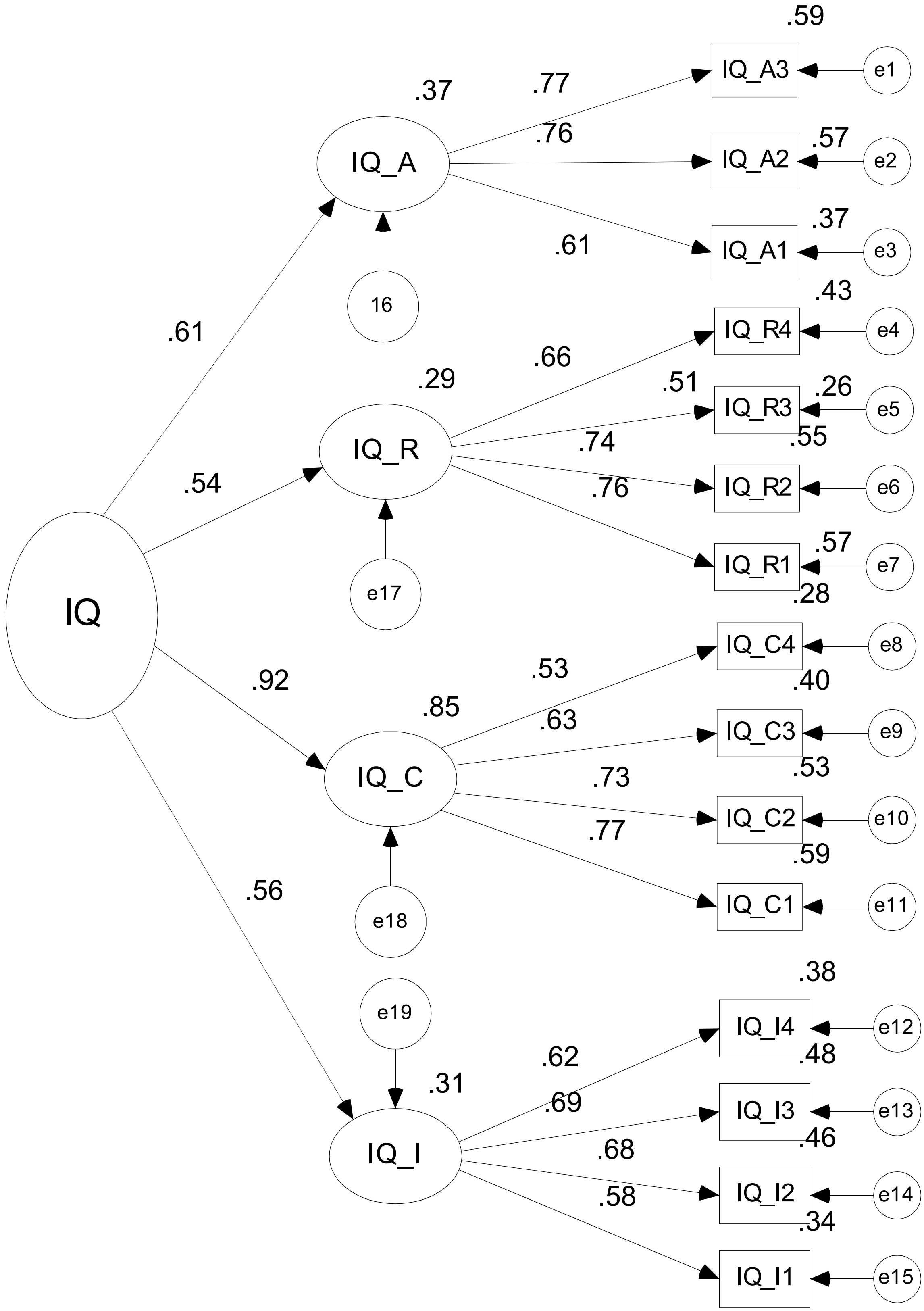
*** significant at the .001 level.

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2), indicates the amount of variance the common factor accounts for in the observed variables. These ranged from 29 % to 85 % see Table 4.39.

Table 4.39

Squared Multiple Correlations: Information quality Second-Order

	Estimate
IQ_A	.37
IQ_I	.31
IQ_C	.85
IQ_R	.29



CMIN=137.77, CMINDF= 1.60, TLI= .94, CFI= .95, RMSEA=.049, p=.001

Figure 4.8. Information quality measurement model/Second order

Added Value first-order factor model. The Added Value construct revealed on four factors (Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies). The measurement model was well fitted with the data. No items indicated a low factor loading. See Figure 4.9

Indices. CMIN=140.04, *C*MINDF=1.68, TLI = .94, CFI = .95 and the RMSEA = .051 (Figure 4.9). No post-hoc modifications were conducted as there were a good fit of the data to the model.

Standardized Regression Weights (Factor loading). All items loaded significantly (>=.5) onto their respective factors as can be seen in Table 4.40.

Table 4.40

Standardized Regression Weights- Added Value First-Order

			Estimate				Estimate
AV_TQ1	<---	AV_TQ	0.59	AV_F1	<---	AV_F	0.65
AV_TQ2	<---	AV_TQ	0.72	AV_F2	<---	AV_F	0.73
AV_TQ3	<---	AV_TQ	0.65	AV_F3	<---	AV_F	0.58
AV_S1	<---	AV_S	0.58	AV_TQ4	<---	AV_TQ	0.64
AV_S2	<---	AV_S	0.75	AV_TQ5	<---	AV_TQ	0.5
AV_S3	<---	AV_S	0.72	AV_F4	<---	AV_F	0.84
AV_I1	<---	AV_I	0.81	AV_TQ6	<---	AV_TQ	0.62
AV_I2	<---	AV_I	0.67				

Referring to Table 4.40, the highest and lowest predicting item for each factor is summarized in Table 4.41.

Table 4.41

The Highest and Lowest Predicting Items for the Added Value Construct

	The Highest predicting item	The lowest predicting item	Highest /lowest predicting item
Flexible Learning (AV_F)	AV_F4: I have been supported with efficient and effective systems to access to electronic material (e.g., flexible borrowing systems)	AV_F3: I have been informed about appropriate materials available electronically.	.84/.58
Improvement of Teaching Quality (AV_TQ)	AV_TQ2: Lecturers knew how could connect teaching e.g. to situations in working life.	AV_TQ5: Flexible feedback and support are promptly provided throughout the course time.	.72/.50
Learning & Communication Skills (AV_S)	AV_S2: I have been given control over learning (e.g., I am able to actively choose the program components in whatever desired order).	AV_S1: The class web site offers many collaborative web-based learning tools	.75/.58
Innovative use of Information and Communication Technologies (AV_I)	AV_I1: The planning of course structure is closely connected to the course objectives and the teaching methods on the course.	AV_I2: The technological tools provided in the class web site have improved the teaching methods in comparison to previous learning environments.	.81/.67

Regression Weight. Referring to the Table 4.42, all the regression weights for factors (Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies) in the prediction of their items are significant at the 0.001 level.

Table 4.42

The Regression Weights - Added Value First-Order

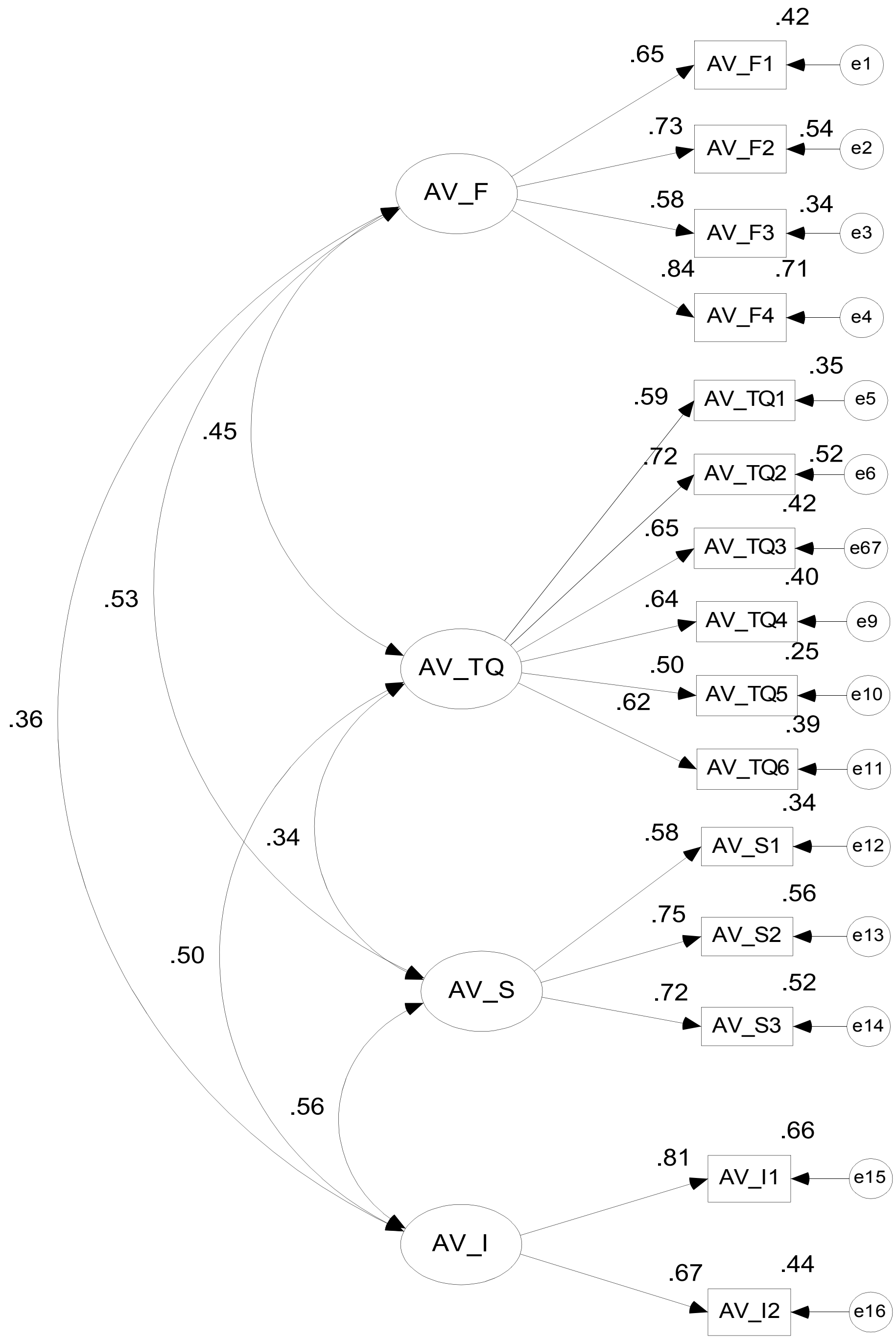
			Estimate	S.E.	C.R.	P	Label				Estimate	S.E	C.R.	P	Label
AV_TQ1	<---	AV_TQ	1.00					AV_F1	<---	AV_F	1.00				
AV_TQ2	<---	AV_TQ	1.26	.16	8.14	***	par_1	AV_F2	<---	AV_F	1.22	.13	9.35	***	par_6
AV_TQ3	<---	AV_TQ	1.14	.15	7.62	***	par_2	AV_F3	<---	AV_F	.94	.12	7.77	***	par_7
AV_S1	<---	AV_S	1.00					AV_TQ4	<---	AV_TQ	1.08	.14	7.55	***	par_14
AV_S2	<---	AV_S	1.26	.17	7.61	***	par_3	AV_TQ5	<---	AV_TQ	.92	.15	6.29	***	par_15
AV_S3	<---	AV_S	1.31	.17	7.56	***	par_4	AV_F4	<---	AV_F	1.34	.13	9.97	***	par_16
AV_I1	<---	AV_I	1.00					AV_TQ6	<---	AV_TQ	1.16	.16	7.46	***	par_17
AV_I2	<---	AV_I	.91	.13	7.00	***	par_5								

Correlations. The four factors (Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies) indicated a positive correlation. See Table 4.43.

Table 4.43

Correlation - Added Value First-Order

			Estimate				Estimate
AV_TQ	<-->	AV_F	.45	AV_TQ	<-->	AV_I	.50
AV_TQ	<-->	AV_S	.34	AV_S	<-->	AV_F	.53
AV_S	<-->	AV_I	.56	AV_I	<-->	AV_F	.36



CMIN=140.04, CMINDF= 1.67, TLI= .94, CFI= .95, RMSEA=.051, p=.001

Figure 4.9. Added value measurement model/ First order

Added Value second-order factor model. The Added value second-order factor model indicates a good model fit to the data (Figure 4.10). (CMIN=130.50, CMINDF= 1.79, TLI= .93, CFI= .94, RMSEA=.056, p=.001)

Standardized Regression Weights (Factor loading). Table 4.44 shows how the four factors (Flexible Learning (F), Teaching Quality (TQ), Learning & Communication Skills(S), and Innovative use of Information and Communication Technologies (I)) load significantly on the Added value.

Table 4.44

Standardized Regression Weights- Added Value Second-Order

			Estimate
AV_F	<---	AV	.66
AV_TQ	<---	AV	.66
AV_S	<---	AV	.73
AV_I	<---	AV	.71

Regression Weights. Table 4.45 shows how the regression weight for accessibility (U) in the prediction of four related factors are significantly different from zero at the .001 level.

Table 4.45

Regression Weights- Added Value Second-Order

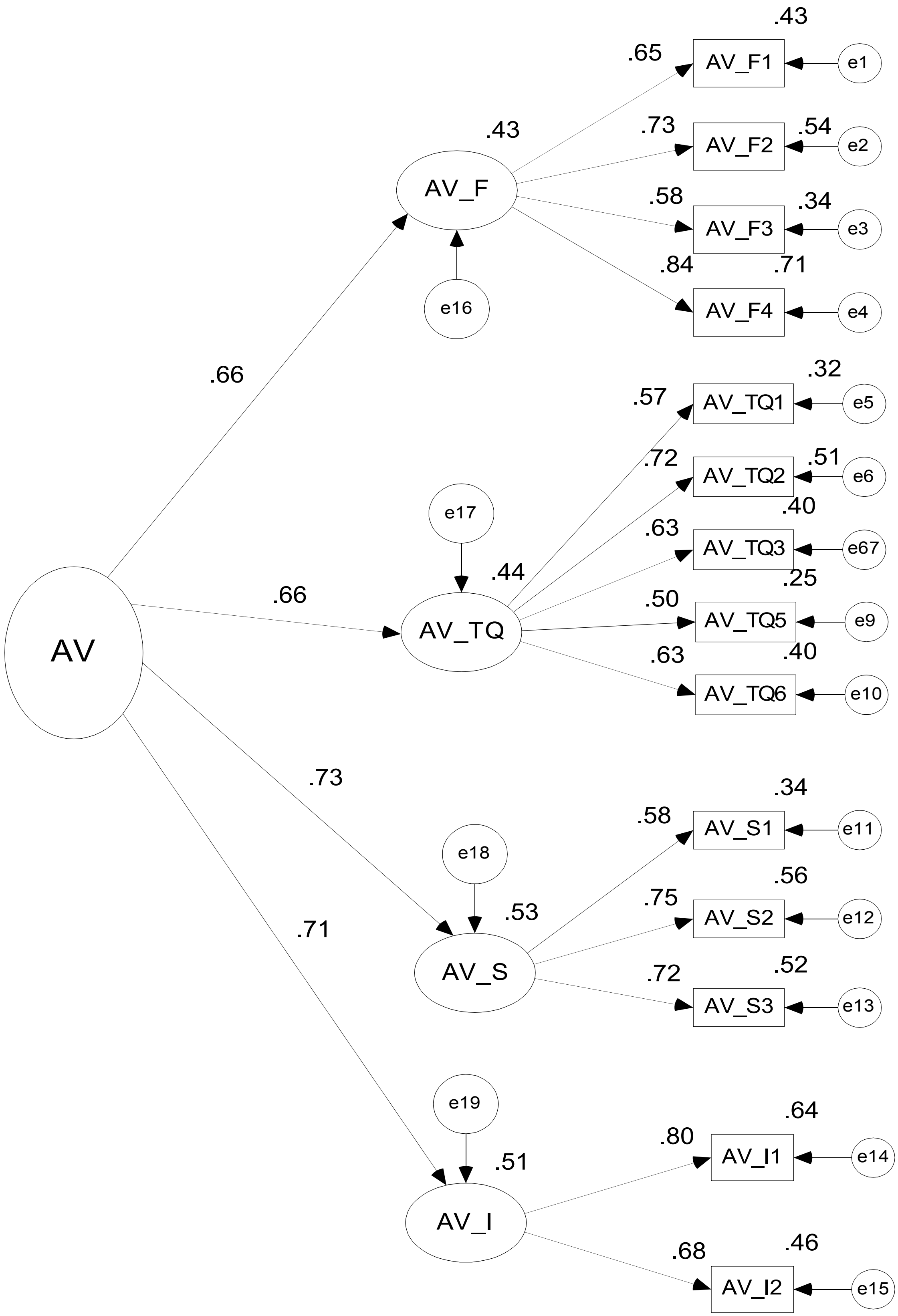
			Estimate	S.E.	C.R.	*p*	Label
AV_F	<---	AV	1.09	.23	4.82	***	par_11
AV_TQ	<---	AV	1.00				
AV_S	<---	AV	1.14	.24	4.68	***	par_12
AV_I	<---	AV	1.39	.27	5.07	***	par_13

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2), indicates the amount of variance the common factor accounts for in the observed variables. These ranged from 43% to 53%. See Table 4.46.

Table 4.46

Squared Multiple Correlations- Added Value Second-Order

	Estimate
AV_F	.43
AV_I	.51
AV_S	.53
AV_TQ	.44



CMIN=130.50, CMINDF= 1.79, TLI= .93, CFI= .94, RMSEA=.056, *p*=.001

Figure 4.10. Added value measurement model/ Second order.

The Measurement Model for the Constructs UPAIAv (Usability, Pedagogical usability, Accessibility, Information quality and the Added value). Figure 4.11 represents the CFA model of the UPAIAv. The initial run of the model indicated a good fit to the data. The indices fit with the standard goodness-of-fit values. No post-hoc modifications were conducted as there were a good fit of the model to the data. See Figure 4.11

Indices. CMIN=566.49, CMINDF =1.23, TLI = .93, CFI = .93 and the RMSEA = .03.

Standardized Regression Weights (Factor loading). All factors loaded significantly onto their respective constructs as can be seen in Table 4.47.

Table 4.47

Standardized Regression Weights for the UPAIAv Model

			Estimate				Estimate
U_BA	←-	U	0.52	P_F	←-	P	0.57
U_P	←-	U	0.62	P_FB	←-	P	0.5
U_UI	←-	U	0.5	P_LR	←-	P	0.57
U_N	←-	U	0.52	P_LSS	←-	P	0.55
U_IA	←-	U	0.5	IQ_I	←-	IQ	0.57
U_C	←-	U	0.5	IQ_C	←-	IQ	0.75
U_M	←-	U	0.55	IQ_R	←-	IQ	0.57
P_S	←-	P	0.55	IQ_A	←-	IQ	0.53
P_C	←-	P	0.54	A_P	←-	A	0.58
P_I	←-	P	0.62	A_U	←-	A	0.51

(table continues)

Table 4.47 *(continued)*

Standardized Regression Weights for the UPAIAv Model

			Estimate				Estimate
P_LC	<---	P	0.62	A_R	<---	A	0.61
P_CCL	<---	P	0.68	A_O	<---	A	0.54
P_G	<---	P	0.58	AV_F	<---	AV	0.65
P_A	<---	P	0.64	AV_TQ	<---	AV	0.53
P_M	<---	P	0.56	AV_S	<---	AV	0.6
P_PK	<---	P	0.52	AV_I	<---	AV	0.51

Referring to Table 4.47, the highest and lowest predicting item for each construct is summarized in Table 4.48.

Table 4.48

The Highest and Lowest Predicting Factor for the UPAIAv

	The Highest predicting factor	The lowest predicting factor	Highest /lowest predicting item
Usability (U)	U_P: System Performance	U_UI: System User Interface	.62/.50
Pedagogical usability (P)	P_CCL: Cooperative/Cooperation Learning	P_FB: Feed Back	.68/.50
Accessibility (A)	A_R: Robust Content	A_U: Understandable Content	.75/.53
Information quality (IQ)	IQ_C: Contextual Information Quality	IQ_A: Accessible Information Quality	.61/.51
Added value (AV)	AV_F: Flexible learning	AV_I: Innovative use of Information and Communication Technologies	.65/.51

Regression Weight. Referring to Table 4.49, all the regression weights for constructs (Usability, Pedagogical usability, Accessibility, Information quality and the Added value) in the prediction of their factors are significantly different from zero at the .001 level.

Table 4.49

The Regression Weights for the UPAIAv Model

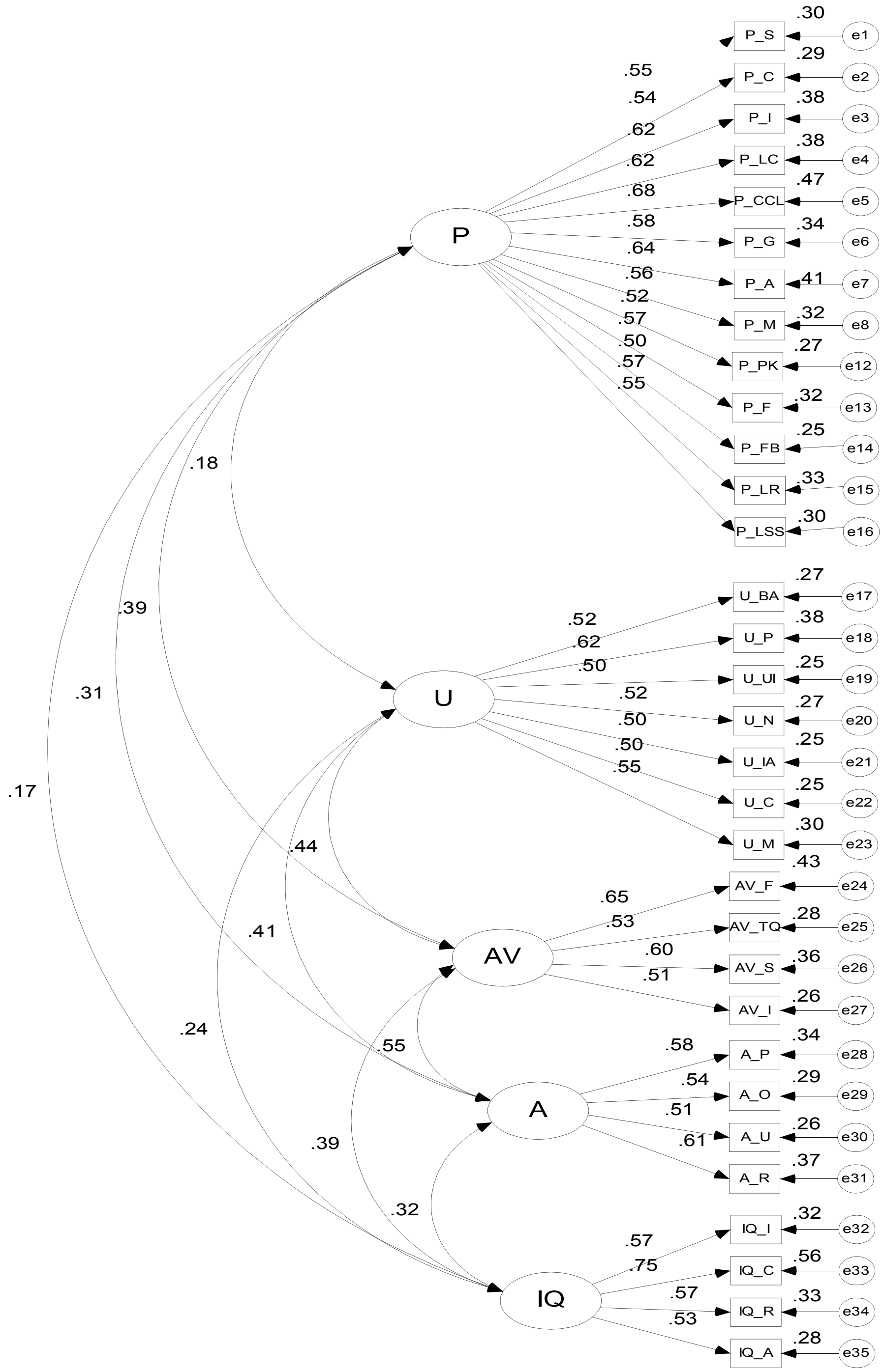
			Estimate	S.E.	C.R.	*p*	Label				Estimate	S.E.	C.R.	*p*	Label
IQ_I	<---	IQ	1.00					AV_I	<---	AV	.84	.14	6.10	***	par_12
IQ_C	<---	IQ	1.27	.19	6.81	***	par_1	U_IA	<---	U	.91	.17	5.51	***	par_13
IQ_R	<---	IQ	.98	.16	6.28	***	par_2	U_C	<---	U	.91	.16	5.53	***	par_14
IQ_A	<---	IQ	.95	.16	5.99	***	par_3	P_CCL	<---	P	1.17	.15	7.90	***	par_15
A_P	<---	A	1.00					P_G	<---	P	.97	.14	7.13	***	par_16
U_BA	<---	U	1.00					P_A	<---	P	1.06	.14	7.61	***	par_17
U_P	<---	U	1.40	.22	6.24	***	par_4	P_M	<---	P	1.09	.16	6.98	***	par_18
U_UI	<---	U	.85	.15	5.52	***	par_5	P_PK	<---	P	.74	.11	6.61	***	par_19
U_N	<---	U	1.00	.18	5.67	***	par_6	P_F	<---	P	.99	.14	7.02	***	par_20
P_S	<---	P	1.00					U_M	<---	U	.92	.16	5.84	***	par_30
P_C	<---	P	.87	.13	6.78	***	par_7	A_O	<---	A	.93	.16	5.74	***	par_31
P_I	<---	P	1.09	.15	7.41	***	par_8	P_FB	<---	P	.76	.12	6.41	***	par_32
P_LC	<---	P	.87	.12	7.42	***	par_9	P_LR	<---	P	.94	.13	7.03	***	par_33
AV_F	<---	AV	1.00					P_LSS	<---	P	.83	.12	6.84	***	par_34
AV_TQ	<---	AV	.78	.12	6.26	***	par_10	A_U	<---	A	.88	.16	5.53	***	par_35
AV_S	<---	AV	.98	.14	6.77	***	par_11	A_R	<---	A	1.19	.19	6.10	***	par_36

Correlations. The seven constructs (Usability, Pedagogical usability, Accessibility, Information quality and the Added value) indicated a positive correlation. See Table 4.50

Table 4.50

Correlation among Constructs UPAIAv

			Estimate				Estimate
IQ	<-->	P	0.17	IQ	<-->	AV	0.39
U	<-->	P	0.18	P	<-->	AV	0.39
IQ	<-->	U	0.24	A	<-->	U	0.41
A	<-->	P	0.31	U	<-->	AV	0.44
IQ	<-->	A	0.32	A	<-->	AV	0.55



CMIN=566.49 , CMINDF=1.23 , TLI=.93 , CFI=.83 , RSMEA=.031 , p=.001

Figure 4.11. The Measurement Model Usability, Pedagogical usability, Accessibility, Information quality & Added value CFA.

Research Question Three

To what extent, if any, does the hypothesized priori model fit the sample data? (What is the causal structure of the SVU's Web-based learning environment?)

The Causal Structural Model for UPAIAv for a WBLE

Figure 4.12 represents the structural model for the UPAIAv for a WBLE. The initial run of the hypothesized priori causal structural model indicated a good fit to the data. However, Table 4.51 indicated that the regression weight for Pedagogical usability (P) in the prediction of Information quality (IQ) is not significantly different from zero at the .05 level (two-tailed). Therefore, the path from P to IQ is deleted. The modified model can be seen in Figure 4.12. The modified model indicated a good fit to the data.

Table 4.51

Causal Structural: Regression Weights: (Group number 1 - Default Model)

			Estimate	S.E.	C.R.	*p*	Label
P	<---	U	0.24	0.11	2.18	.03	par_31
IQ	<---	U	0.33	0.15	2.28	.02	par_32
IQ	<---	P	0.15	0.10	1.57	.12	par_33
A	<---	IQ	0.17	0.08	2.17	.03	par_26
A	<---	P	0.21	0.09	2.49	.01	par_30
A	<---	U	0.42	0.14	3.14	.00	par_37
AV	<---	U	0.32	0.15	2.19	.03	par_29
AV	<---	P	0.24	0.09	2.53	.01	par_34
AV	<---	IQ	0.18	0.09	2.12	.03	par_35
AV	<---	A	0.36	0.13	2.73	.01	par_36

Indices. CMIN= 569.04, CMINDF =1.25; CFI = .93; TLI = .93; and the RMSEA = .03, *p*=.001 (See Figure 4.12)

Standardized regression weight. All the standardized regression coefficients indicated significant causal positive effect between the constructs (U→P, U→IQ, IQ→P, P→A, U→A, U→AV, P→AV, IQ→AV, and A→AV). See Table 4.52.

Table 4.52

Causal Structural: Standardized Regression Weights: (Group number 1 – Modified model)

			Estimate				Estimate
P	<---	U	0.19	AV	<---	U	0.22
IQ	<---	U	0.24	AV	<---	P	0.22
A	<---	IQ	0.21	AV	<---	IQ	0.20
A	<---	P	0.22	AV	<---	A	0.33
A	<---	U	0.33				

Regression weight. Referring to Table 4.53, all the regression weights for constructs (Usability, Pedagogical usability, Accessibility, Information quality and the Added value) in the prediction of the related constructs are significantly different from zero at the .001 level.

Table 4.53

Causal Structural: Regression Weights: (Group number 1 – Modified Model

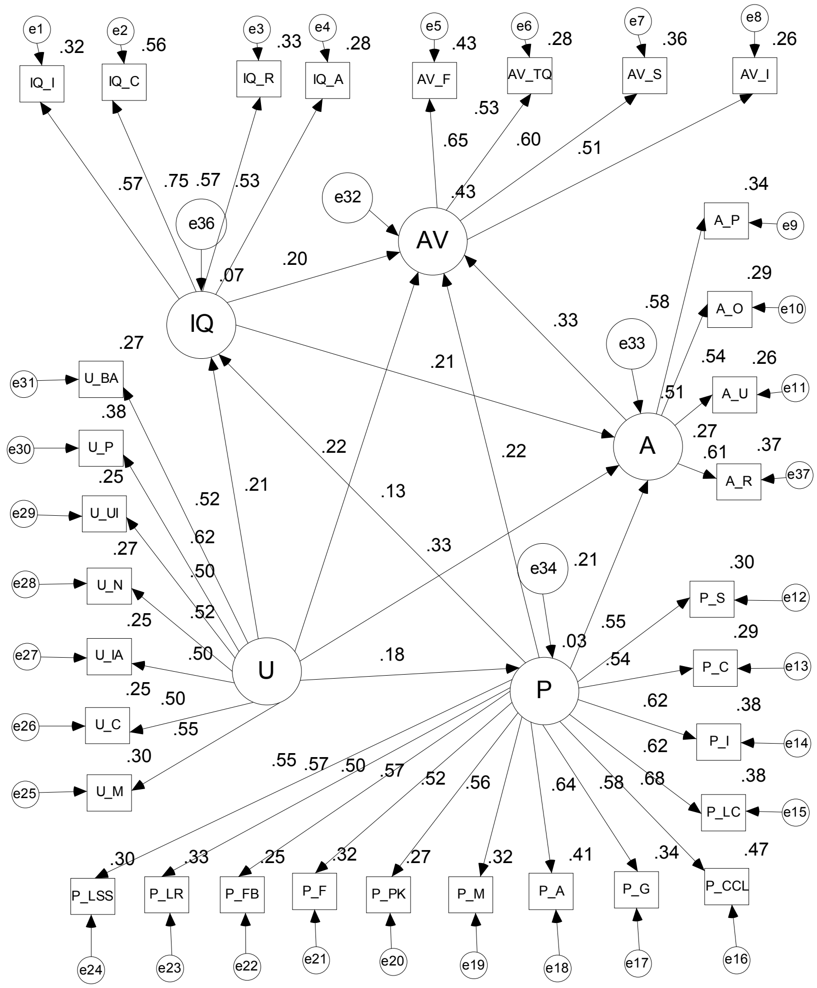
			Estimate	S.E.	C.R.	*p*	Label
P	<-	U	0.25	0.11	2.27	.02	par_31
IQ	<-	U	0.38	0.15	2.59	.01	par_32
A	<-	IQ	0.17	0.08	2.18	.03	par_26
A	<-	P	0.22	0.08	2.56	.01	par_30
A	<-	U	0.42	0.14	3.10	.01	par_36
AV	<-	U	0.32	0.15	2.15	.03	par_29
AV	<-	P	0.24	0.09	2.59	.01	par_33
AV	<-	IQ	0.18	0.09	2.13	.03	par_34
AV	<-	A	0.37	0.13	2.73	.01	par_35

Squared multiple correlations. The predictors of the Pedagogical usability explain only 3.6% of its variance. The predictors of the Information quality explain only 5.9% of its variance. The predictors of the accessibility explain only 26.2% of its variance; and the predictors of Added value explain only 57.3% of its variance (Table 4.54).

Table 4.54

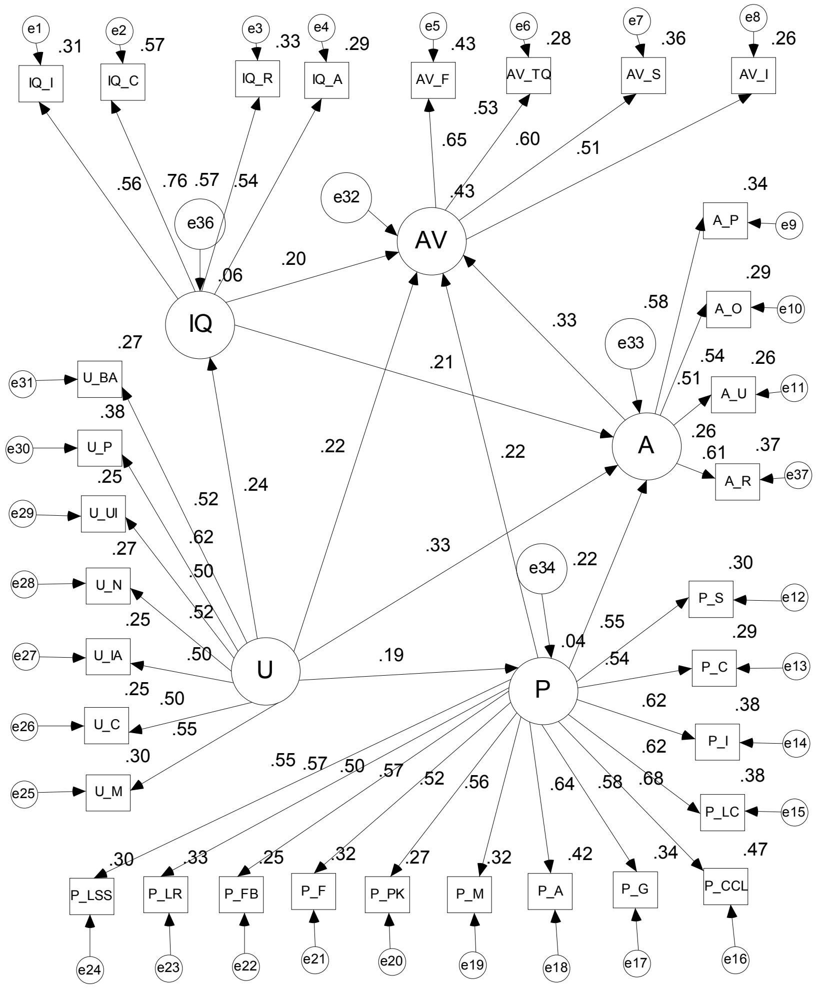
Causal Structural: Squared Multiple Correlations: (Group number 1 - Modified Model)

	Estimate
P	.04
IQ	.06
A	.26
AV	.43



Chi Square=566.489, CMINDF=1.248, TLI=.928, CFI=.934, RMSEA=.031, p=.000

*Figure 4.12***.** The just identified priori structural model for UPAIAv for a WBLE.



Chi Square=569.054, CMINDF=1.251, TLI=.927, CFI=.933, RMSEA=.032, p=.000

*Figure 4.13***.** The just reduced priori structural model for UPAIAv for a WBLE.

Research Question Four

To what extent, if any, do usability, Pedagogical usability, accessibility, and information quality measures have significant direct and indirect influence on the added value of the Web based learning environment?

The Direct and Indirect Effects

The Path coefficients can be used to break down the correlations in the model into direct and indirect effects.

The direct effects are those straight forward arrows from one factor to another (e.g., from independent factor to dependent factor.). In social science research, an indirect effect occurs when the influence of an independent variable (factor) on the dependent variable (factor) is mediated by an intervening variable (factor).

The Direct Effects. Figure 4.54 indicates direct effects (straight arrows) from the constructs: Usability, Pedagogical usability, Accessibility, and Information quality to the Added value. Table 4.55 shows these direct effects values. These values ranged from 0.09 to 0.18. Among these direct effects.

Table 4.55

The Direct Effects - Standard Errors (Group number 1 - PrioriMmodel)

	U	P	A	IQ	AV
P	.14	.00	.00	.00	.00
IQ	.16	.00	.00	.00	.00
A	.15	.09	.00	.08	.00
AV	.18	.11	.17	.09	.00

The Indirect Effects. Figure 4.55 indicates indirect effects (non-straight arrows) of the constructs: Usability, Pedagogical usability, Accessibility, and Information quality on the Added value. Table 4.56 shows these indirect effects values. These values ranged from 0.04 to 0.12.

Table 4.56

The Indirect Effects - Standard Errors (Group number 1 - Priori Model)

	U	P	A	IQ	AV
P	.00	.00	.00	.00	.00
IQ	.00	.00	.00	.00	.00
A	.06	.00	.00	.00	.00
AV	.12	.05	.00	.04	.00

The Total Effects. The sum of direct and indirect effects of the constructs: Usability, Pedagogical usability, Accessibility, and Information quality on the Added value will give the total effect.

The total effects of the UPAI on the Av ranged form .09 to 0.19 (Table 4.57).

Table 4.57

The Total Effects - Standard Errors (Group number 1 – Priori Model)

	U	P	A	IQ	AV
P	.14	.00	.00	.00	.00
IQ	.16	.00	.00	.00	.00
A	.16	.09	.00	.08	.00
AV	.19	.11	.17	.09	.00

The Total Effects- Lower Bounds- Upper Bounds. The boundaries of total effects of Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are: [.39-1.00], [.16-.53], [.12-.42], [.15-.70] respectively (Table 4.58 & Table 4.59).

Table 4.58

The Total Effects - Lower Bounds (BC) (Group number 1 – Priori Model)

	U	P	A	IQ	AV
P	.08	.00	.00	.00	.00
IQ	.15	.00	.00	.00	.00
A	.32	.07	.00	.04	.00
AV	.39	.16	.15	.12	.00

Table 4.59

The Total Effects - Upper Bounds (BC) (Group number 1 - Priori Model)

	U	P	A	IQ	AV
P	.52	.00	.00	.00	.00
IQ	.68	.00	.00	.00	.00
A	.81	.37	.00	.30	.00
AV	1.00	.53	.70	.42	.00

The Total Effects – Two Tailed Significance. The two- tailed significances of the total effects of the Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are declared in Table 4.60. All these total effects were significantly different from zero at the .01 level (two-tailed). All of these are bootstrap approximations obtained by constructing two-sided bias- corrected confidence intervals. The *p*-value of these total effects – two tailed significances of the Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are .001, .001, .003, and .005 respectively.

Table 4.60

The Total Effects – Two Tailed Significance (BC) (Group number 1 - Priori Model)

	U	P	A	IQ	AV
P	.021	...	...	...	...
IQ	.003	...	...	...	...
A	.001	.012	...	.029	...
AV	.001	.001	.005	.003	...

CHAPTER FIVE

RESULTS, DISCUSSIONS & RECOMMMENDATIONS

Introduction

The research aims to construct an evaluation instrument (EI) for a Web Based Learning Environment (WBLE) and furthermore to validate its causal structure. Based on the literature review (Chapter two), the researcher assumes that there are five principal factors to evaluate a WBLE, namely: the Usability, Pedagogy, Accessibility, Information quality, and Added value (UPAIAv). Furthermore, the researcher assumes that the factors Usability, Pedagogy, Accessibility, Information quality are correlated to each other. A priori model was developed to depict the possible causal effect of Usability, Pedagogy, Accessibility and Information quality on Added value. A questionnaire involving five Likert-type scales has been developed for such a purpose. The quantitative research method was used to collect data from 500 students at the Syrian Virtual University (SVU).

A Structural Equation Modelling (SEM) method was undertaken using the AMOS (Analysis of Moment Structures) statistical program, Version 16.0. The use of SEM in the developmental research of an evaluation instrument for a WBLE has increased and grown dramatically during recent years (Grigorovici, Constantin, Jayakar, Taylor, & Schement, 2004). Thus, SEM was selected as a powerful statistical methodology that combines measurement model or confirmatory factor analysis (CFA) and structural model (SM) into a simultaneous statistical procedure. Among several advantages over using SEM are, it estimates relationships between latent variables; allows for explicit tests of competing models; explores direct, indirect and total effects; and explores multivariate relationships in an integrated manner (Hair, Black, Babin, Anderson, & Tatham, 2006) (refer to Chapter two, p. 88).

Basically, the research cycle for developing the evaluation instrument involves two steps: (1) an exploratory step that puts forward hypothesized measurement model(s) via the analysis of empirical data from a referent population (the SVU's students); and (2) a confirmatory step that tests the hypothesized measurement model(s) against new data gathered from the same referent population. Thus, the first data set (247) was subjected to an exploratory factor analysis (EFA), and the second data set (253) was subjected to a confirmatory factor analysis (CFA).

Using the Statistical Package for the Social Sciences (SPSS) Version 16, data were analyzed using descriptive statistics, factor analysis, and correlative analyses between factor score estimates. The descriptive statistics estimated the item means and deviations. The EFA was conducted to determine the items for each specific factor as well as factorial structure of the instrument. Factors were then assessed for their levels of internal reliability.

EFA on the first data set resulted in seven factors for Usability; thirteen factors for Pedagogy; four factors for Accessibility; four factors for Information quality; and four factors for Added value.

Using the structural equation modeling (SEM) approach and the Analysis of Moment Structures (AMOS) Version 16.0, the confirmatory factor analysis was employed to measure the goodness-of- fit indices and to construct reliability of the instrument. The priori model was confirmed. The findings indicated that the priori model fits with data. Furthermore, the findings indicated that the constructs Usability, Pedagogy, Accessibility, and Information quality affect the Added value. Finally, correlations among factor scores were measured and reported.

Theoretical Background and Hypothesis

A variety of evaluation instruments have been proposed to identify the learning environment that directly influences Web-based learning. Those instruments have encompassed versatile constructs such as usability issues, course content, learner, technical, pedagogical, accessibility, information quality, and added value (Albion 1999; Chin, Diehl, & Norman, 1988; Forsblom & Silius, 2002a, 2002b; Horila et al., 2002; Lee et al., 2002; Lin et al., 1997; Nielsen, 1993, 1994; Preece et al., 2002; Chalmers, 2003; Tognazzini, 2003; Hadjerrouit, 2006; Labbate, 1996; Quinn, 1996; Squires 1997; Reeves, 1994; Schneiderman, 1998; Silius & Tervakari, 2003; Squires & Preece, 1996, 1999).

However, for this research, the Usability, Pedagogy, Accessibility, Information quality as well as Added value (UPAIAv) are chosen as critical constructs in the planning of an evaluation instrument for a WBLE (Hadjerrouit, 2006; Nielsen, 1993; Nokelainen, 2002-2006; Silius & Tervakari, 2003-2005). The researcher assumes that usability, pedagogy, accessibility and information quality are correlated to each other and each of them has direct effect on the added value.

Research Model and Instrument Construction

The method of structural equation model (SEM) has mainly guided the construction process of the priori model and the evaluation instrument. The Churchill (1979) eight-step process has helped this process as well (refer to Chapter Three, p. 106). However, given the fact that no debate of critical constructs in the planning of an evaluation instrument can fit all aspects of the WBLE, the universal Usability and Accessibility, Pedagogy, Information quality and Added value have emerged as an important issue and a topic for computing research.

The literature review step has resulted in determining the learning environments that most affect the quality of WBLE, namely the UPAIAv. The supposed items to measure these constructs are selected and the priori model is specified as can be seen in Figure 5.1.

Using the exploratory factor analysis EFA has guided the process of determining the items for each specific factor, while confirmatory factor analysis has guided the process of measuring the goodness-of-fit indices and construct validity reliability of the instrument.

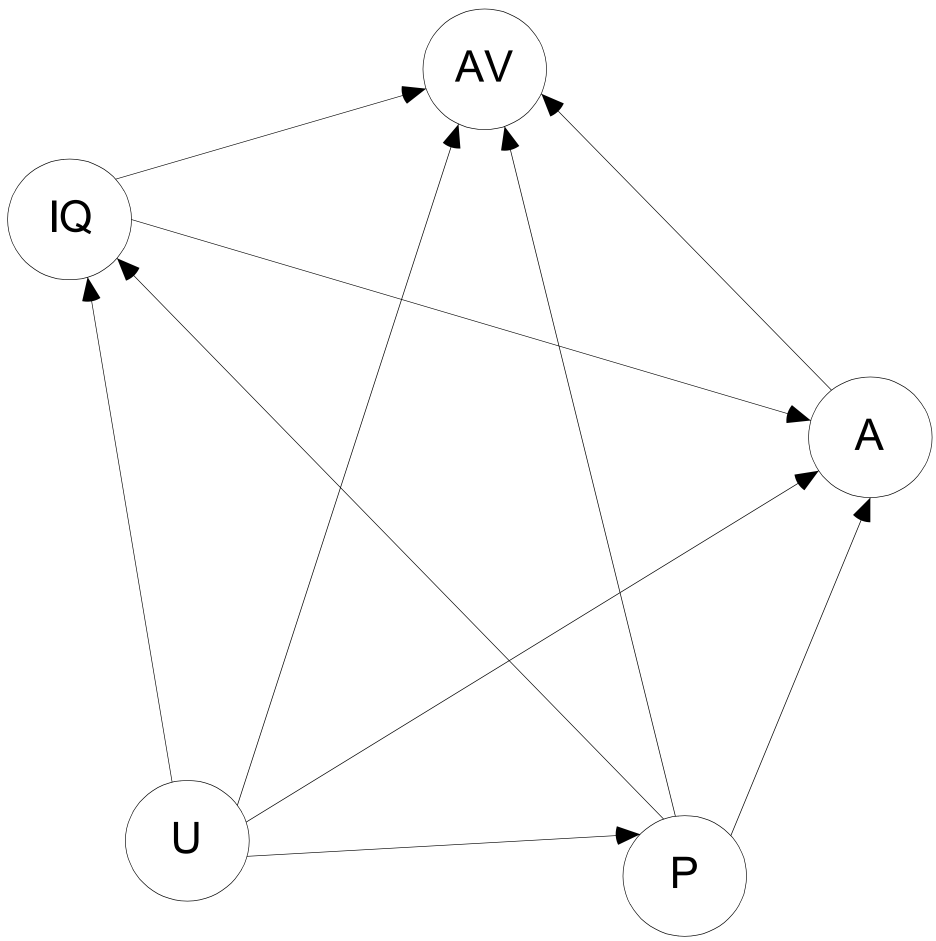


Figure 5.1. The priori model.

Results and Discussion

Exploratory Stage

Factors were extracted based on eigenvalues and the proportion of variance explained by each factor using the principal components of varimax with Kaiser Normalization rotation. Items with factor loading values below the cut-off value of 0.5 on their own scales or greater than 0.4 on each of the other scales were eliminated (Hair et al., 1998).

Exploratory factor analysis. Thus, an EFA, using principal component analysis, was conducted on the first data set (N=247) of participants to determine the factor structure of the 145 items of the instrument. The EFA yielded seven factors for Usability; thirteen factors for Pedagogy; four factors for Accessibility; four factors for Information quality; and four factors for Added value.

Based on the results indicated, 13 items were eliminated from the construct usability (U_P2, U_UI2, U_UI3, U_UI4, U_UI6, U_N5, U_N6, U_IA4, U_IA5, U_IA6, U_C3, U_M2, and U_M3) because they did not contribute to a simple factor structure and failed to meet the mentioned minimum criteria. Thus, a total of 33 items in seven factors were extracted. The total variance explained for Usability is 68.15. A total of 69 items in fourteen factors were extracted for the Pedagogical usability construct. No items were deleted. The total variance explained for Pedagogical usability is 70.31. A total of 12 items in four factors were extracted for the Accessibility construct. The total variance explained for Accessibility is 72.14. A total of 15 items in four factors were extracted for the Information quality construct. The total variance explained for Information quality is 63.67.

A total of 15 items in four factors were extracted for the Added value construct. No items were deleted from the last construct. The total variance explained for Added value is 61.92.

The Internal consistencies for each of the scales were determined by calculating the value of coefficient alpha (Cronbach's alpha). These ranged from .702 to .939.
Refer to Chapter Four, Table 4.9, p. 148; the skewness and kurtosis were in the standard range [-1,+1]. This assumes a normal distribution of the data. Some median scores were little bit higher than the associated mean scores because the scores are negatively skewed. The mode scores indicate how the "4" (Agree) option occurs most frequently (about 60%) throughout the reported scores. However, the second most frequent choice is the "3" (Uncertain). This indicates that students were unable to decide. This probably indicates a possible need for specific areas needing attention to improve. Some selected option "5" (Strongly Agree), the rest of the responses drop-off towards option "2" (Disagree), while very few selected option "1" (Strongly Disagree).

Confirmatory Stage

CFA is employed to measure the goodness-of-fit indices and construct reliability and validity of the instrument as well as to confirm the exploratory model.
Four common model-fit measures were used to examine the model's overall goodness of fit: The Relative chi-square (the Chi-square/degree of freedom: X2/df), the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA).

Fit indices that are affected directly by sample size were excluded. The X^2/DF, TLI, CFI and RMSEA are among the measures least affected by sample size (Carmines et al., 1981; Fan et al., 1999; Marsh et al., 1988).

The Relative chi-square (X^2/df) is an index of how much the fit of data to model has been reduced by dropping one or more paths. The Tucker-Lewis Index is one of the relative fit indices that compare the chi-square for the model tested to the null model. The comparative fit index (CFI) and the Root Mean Square Error of Approximation (RMSEA) are noncentrality-based indices. The CFA was used to compare the existing model fit with a null model which assumes the indicator variables in the model are uncorrelated, while the RSMEA allows for the null hypothesis to be tested more precisely (McQuitty, 2004).

Fit indices. Literature reveals that there is no universal acceptance or consensus index of model adequacy (Doll, Xia, & Torkzadeh, 1994); however, the following standards value of model-fit indices were considered:

The values of Relative χ2 (χ2/df) range between 2.0 as low (Tabachnick & Fidell, 2007) and 5.0 as high (Wheaton et al., 1977). The Tucker Lewis Index (TLI: >.90 acceptable, >.95 excellent; Tucker & Lewis, 1973), the Comparative Fit Index (CFI: >.90 acceptable, >.95 excellent; Bentler, 1990; Bentler & Bonett, 1980), and finally, the Root Mean Square Error of Approximation (RMSEA; <.08 acceptable, <.05 excellent; Browne & Cudeck, 1993).

Confirmatory factor analysis. Using the Analysis of Moment Structures (AMOS), Version 16.0, a CFA was then conducted on the second sample group (n=253) of participants.

All indicated indices fit with the standard goodness-of-fit values recommended in literature (Bentler, 1990; Bentler & Bonett, 1980; Browne & Cudeck, 1993; Hu & Bentler, 1999; Tucker & Lewis, 1973). The following presents a brief discussion of these measurements.

Usability first-order factor model. The construct Usability revealed seven factors (User Interface, Information Architecture, Navigation, Content, Performance, Media Elements, and Basic Attributes) (refer to Chapter Four, Figure 4.1, p. 163). The initial run of the usability measurement model had indicated a good model fit to the data with one item exception. The item (U_M4) indicated a low factor loading (.46). Therefore, this item was excluded. Then, the Usability measurement model appeared to be a good fit to the data.

Indices. The goodness-of-fit indices for the Usability first-order were revealed as follows: the CMIN=519.78, CMINDF = 1.10; TLI = .99, CFI = .99; and the RMSEA = .02. No post-hoc modifications were conducted as there was good fit of the data to the model.

Standardized regression weights (Factor loading). All the remained items loaded significantly onto their respective factors. All the factors have positive effects on their predictors (>.5) (refer to Chapter Four, Table 4.12, p. 159). The highest and lowest predicting items for each factor in the Usability construct are summarized as follows (refer to Chapter Four, Table 4.13, p. 160):

The Highest predicting item for the factor User Interface (UI) is the item: “U_UI1: The main User Interface is not busy” with factor load 0.7; the lowest predicting item is: “U_UI5: I am satisfied with the user interface layout and design” with factor load of 0.65. The highest predicting item for the factor Information Architecture (IA) is: “U_IA6: I am satisfied with the design of the site’s information architecture” with factor load 0.85 while the lowest predicting item is: “U_IA4: Site structure is organised to minimize the number of levels below the homepage” with factor load 0.62.

The highest predicting item for the factor, Navigation (N) is: “U_N1: The navigation design connected all related information in a sequence that made sense to me” with factor load 0.92 while the lowest predicting item is: "U_N4: External links were loaded in a separate window" with factor load (0.70).

The highest predicting item for the factor Content (C) is: "U_C4: The site's content design is satisfactory" with factor load 0.85 while the lowest predicting item is: "U_C2: Longer pages exist only when content should be printed as one document" with factor load 0.60.

The highest predicting item for the factor Performance (P) is: "UP1: No links in the user interface were missing or broken. All links work" with factor load 0.94 while the lowest predicting item is: "U_P3: I am satisfied with the site's performance" with factor load of 0.72.

For the factor Media elements (M), the highest predicting item is: "U_M1: Media elements were of high visual and aural quality" with factor load 0.71 while the lowest predicting item is: "U_M4: Using media was not gratuitously." with factor load 0.52.

The highest predicting item for the factor, Basic Attributes (BA) is: "U_BA5: The system is pleasant, comfortable and acceptable of use" with factor load 0.88 while the lowest predicting item is: "U_BA3: I can easily re-establish proficiency after a period of not using the system" with factor load 0.72.

Regression weight. Referring to the Chapter Four, Table 4.14, p. 161, all the regression weights for factors (User Interface, Information Architecture, Navigation, Content, Performance, Media Elements and Basic attributes) in the prediction of their related items are significantly different from zero at the 0.001 level (two-tailed).

Correlations. Mainly, the correlation is intended to show whether and how strongly pairs of variables are related. Referring to Table 4.15, the seven factors (User Interface, Information Architecture, Navigation, Content, Performance, Media Elements and Basic attributes) indicated a positive correlation. The correlation values ranged from .21 to .45. All these correlation are significant at the 0.01 level (2-tailed). The correlation between Performance and Media Elements is the strongest one (.45) while the correlation between the User Interface and Content is the weakest (.21).

Usability second-order factor model. The Usability second-order factor model indicates a good model fit to the data. The model fit-indices are: (CMIN=527.17, CMINDF=1.08, TLI=.99, CFI=.99, RMSEA=.02, *p*=.11), (Chapter Four, Figure 4.2, p.166)

Standardized regression weights (Factor loading). The seven factors (User Interface (UI), Information Architecture (IA), Navigation (N), Content (C), Performance (P), Media Elements (M) and Basic attributes (BA)) remained stable across the usability second-order factor model and they loaded significantly on the Usability construct (refer to Chapter Four, Table 4.16, p. 164). The factors loaded values ranged form 0.43 to 0.66. The performance factor indicated the highest load value (0.66) while the User interface factor indicated the lowest one (0.43).

*Regression weights***.** All the regression weights for usability (U) in the prediction of the seven related factors are significantly different from zero at the 0.001 level (two-tailed) (refer to Chapter Four, Table 4.17, p. 164). Table 4.17 supports those results from the EFA (refer to Table 4.3 Usability Rotated Component Matrix). That is, Usability is significantly indicated by seven factors; Basic attributes (Learnability, Efficiency, Memorability, Error recovery and User satisfaction) and by Technical Usability (Performance, User Interface, Navigation, Information architecture Content and Media Elements).

Squared multiple correlations. The squared multiple correlation coefficients (R^2), indicate the amount of variance the common factor accounts for in the observed variables. These ranged from 18% to 44%. (Refer to Chapter Four, Table 4.18, p. 165). The least factor explained by Usability is the User Interface (18%) and the Performance is the highest explained (44%).

Pedagogical usability first-order factor model. The Pedagogical usability construct revealed on thirteen factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) (Refer to Chapter Four, Figure 4.3, p. 175). The initial run of the Pedagogical usability measurement model had indicated a good model fit to the data after excluding 12 items (P_LC2, P_CCL3, P_G1, P_G3, P_A4, P_M1, P_M2, P_M5, P_PK2, P_LR2, P_LSS3, and U_M4) which indicated a low factor loading <.5. After the adjustment, the Pedagogical usability measurement model appeared to have a good fit to the data.

Indices. The goodness-of-fit indices for the Pedagogical usability first-order model were revealed as follows: the CMIN=1489.53, CMINDF=1.19, TLI = .96, CFI = .960; and the RMSEA = .03. No post-hoc modifications were conducted as there were a good fit of the data to the model

Standardized Regression Weights (Factor loading). All the remained items loaded significantly onto their respective factors. All the factors have positive effects on their predictors (>.5) (Refer to Chapter Four, Table 4.19, p. 168). The highest and lowest predicting items for each factor in the Pedagogical usability construct are summarized as follows (Refer to Chapter Four, Table 4.20, p. 169):

The highest predicting item for the factor, Structure (P_S) is: "P_S1: Topics were presented in a logical and ordered manner." with factor load 0.82 while the lowest predicting item is: "P_S2: Hierarchies of content are designed of breadth rather than depth" with factor load (0.73).

The highest predicting item for the factor, Course Content (P_C) is: "P_C2: A complete syllabus of the course was available ahead of learning." with factor load 0.76 while the lowest predicting item is: "P_C7: I am satisfied with the course' content." with factor load (0.60).

The highest predicting item for the factor, Cooperative/Collaborative Learning (P_CCL) is: "P_CCL1: Much of learning sessions took place in groups." with factor load 0.91 while the lowest predicting item is: "P_CCL4: I feel satisfied with the cooperative/collaborative learning techniques being conducted in this course." with factor load 0.65.

The highest predicting item for the factor, Motivation (P_M) is: "P_M2: The course topics focus on real-world problems." with factor load 0.79 while the lowest predicting item is: "P_M1: The course topics meet my needs and expectations" with factor load 0.76.

The highest predicting item for the factor Learning Styles and Strategies P_LSS) is: "P_LSS3: The course often provides learning problems with a pre-defined model for the solution." with factor load 0.73 while the lowest predicting item is: "P_LSS4: I am usually rewarded for good answers" with factor load (0.60).

The highest predicting item for the factor Lecturer Role (P_LR) is: "P_LR1: Lecturers perform tasks in a straightforward manner" with factor load 0.90 while the lowest predicting item is: "P_LR5: I am satisfied with the lecturer's role in this course." with factor load 0.66.

The highest predicting item for the factor, Applicability (P_A) is: "P_A1: The course topics accommodated different learning styles" with factor load 0.86 while the lowest predicting item is: "P_A2: I feel that this course has been designed for me" with factor load 0.67.
For Goals and Objectives (P_G), the highest predicting item for the factor is: "P_G2: The objectives show clearly what kind of the assessment I am going to have at the end of semester" with factor load 0.77 while the lowest predicting item is: "P_G3: Special behavioural objectives are identified adequately" with factor load 0.61.

Next, the highest predicting item for the factor Learner Control (P_LC) is: "P_LC2: I have always the feeling that I am responsible for my own learning." with factor load 0.80 while the lowest predicting item is: "P_LC4: I feel satisfied with my control over learning." with factor load 0.60.
The highest predicting item for the factor Evaluation of Previous Knowledge (P_PK) is: "P_PK2: The course topics are designed in such a way to meet different learning levels." with factor load 0.82 while the lowest predicting item is: "P_PK3: The course is not over simplifying learning instead it was designed in new ways to provide appropriate scaffolding and support." with factor load (0.53).
The highest predicting item for the factor, Interaction (P_I) is: "P_I4: Lecturers, frequently schedule specific chat times and conversational spaces to discuss course topics, and to reflect on ideas and learning experiences" with factor load 0.84 while the lowest predicting item is: "P_I6: I feel satisfied with the reaction I got in this class web site" with factor load 0.72.
The highest predicting item for the factor, Feedback (P_FB) is: "P_FB1: There was an adequate help provided within the class" with factor load 0.75 while the lowest predicting item is: "P_FB3: Generally, I am satisfied with the help provided in the class web site." with a factor load of 0.67.

The highest predicting item for the factor Flexibility (P_F) is: “P_F1: The course offers optional routes for my progress” with factor load 0.89 while the lowest predicting item is: “P_F3: The class web site gives me the opportunity to add some comments and suggestions” with factor load 0.76.

Regression weight. Referring to Chapter Four, Table 4.21, p. 171, all the regression weights for factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) in the prediction of their items are significantly different from zero at the 0.001 level (two-tailed).

Correlations. Referring to Chapter Four, Table 4.22, p. 173, the thirteen factors (Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) indicated a positive correlation. The correlation values ranged from .22 to .74. All these correlation are significant at the 0.01 level (2-tailed). The correlation between Lecturer Role and Learning Styles and Strategies is the strongest one (.74) while the correlation between the Structure and Course Content is the weakest (.22).

Pedagogical usability second-order factor model. The Pedagogical usability second-order factor model indicates a good model fit to the data (Chapter Four, Figure 4.4 p. 179). The model fit-indices are: CMIN=1619.65, CMINDF=1.23, TLI=.95, CFI=.95, RMSEA=.03 and p=.001

Standardized Regression Weights (Factor loading). The thirteen factors; Structure (S), Course Content (C), Cooperative/Collaborative Learning (CCL), Motivation (M), Learning Styles and Strategies (LSS), Lecturer Role (LR), Applicability (A), Goals and Objectives (G), Learner Control (LC), Evaluation of Previous Knowledge (PK), Interaction (I), Feedback (FB), and Flexibility (F) remained stable across the Pedagogical usability second-order factor model and they loaded significantly on the Pedagogical usability construct (refer to Chapter Four, Table 4.23, p. 176)

Regression Weights. All the regression weights for pedagogical usability (P) in the prediction of the thirteen related factors are significantly different from zero at the 0.001 level (two-tailed) (refer to Chapter Four, Table 4.24, p. 177). Table 4.24 supports those results from the EFA (refer to Chapter Four, Table 4.4 Pedagogical usability Rotated Component Matrix, p. 138). That is, Pedagogical Usability is significantly indicated by thirteen factors; Structure (S), Course Content (C), Cooperative/Collaborative Learning (CCL), Motivation (M), Learning Styles and Strategies (LSS), Lecturer Role (LR), Applicability (A), Goals and Objectives (G), Learner Control (LC), Evaluation of Previous Knowledge (PK), Interaction (I), Feedback (FB), and Flexibility (F)

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) indicated that the amount of variances ranged from 25.6% to 56%. (Refer to Chapter Four, Table 4.25, p. 177). The least factor explained by pedagogical usability is the Structure (P) (25.6 %) while the Learning Styles and Strategies (LSS) is the highest explained (56%).

Accessibility first-order factor model. The Accessibility construct revealed four factors (Perceivable Content, Operable Content, Understandable Content, and Robust

Content) (refer to Chapter Four, Figure 4.5, p. 183). The measurement model was well fitted with the data. No items indicated a low factor loading. Therefore, no items were deleted.

Indices. The goodness-of-fit indices for the Accessibility measurement model were revealed as follows: the CMIN=73.57, CMINDF=1.94, TLI = .92, CFI = .95; and the RMSEA = .06. No post-hoc modifications were conducted as there were a good fit of the data to the model.

Standardized Regression Weights (Factor loading). All items loaded significantly onto their respective factors. All the factors have positive effects on their predictors (>=.5) (refer to Chapter Four, Table 4.26, p.180). The highest and lowest predicting items for each factor in the Accessibility construct are summarised as follows (Refer to (Chapter Four, Table 4.27, p. 180):

The highest predicting item for the factor, Perceivable Content (A_P) is: “A_P5: Content was presented in a way that is visible and hearable” with factor load 0.70 while the lowest predicting item is: “A_P4: Content was flexibly presented in different ways without losing information or structure” with factor load 0.5. Thus, with Perceivable Content; students recommend the visible and hearable of the Web page content more than others.

The highest predicting item for the factor Operable Content (A_O) is: “A_O3: I am provided with flexible ways to help me navigate, find content, and determine where I am in the site” with factor load 0.73 while the lowest predicting item is: “A_O1: Most user interface functionalities were available from the key board.” with factor load 0.59. Thus, with Operable Content; students recommend the flexibility of being able to navigate within the Web page’s content more than others.

The highest predicting item for the factor Understandable Content (A_U) is: "A_U1: Text content was readable and understandable" with factor load 0.77 while the lowest predicting item is: "A_U2: I can predict the Web pages appearance and operation" with factor load 0.59. Thus, with Understandable Content; students recommend being able to read and understand the Web page's content more than others.

The highest predicting item for the factor Robust Content (A_R) is: "A_R2: Content is accessible (or accessible alternative is provided)" with factor load 0.80 while the lowest predicting item is: "A_R1: Content can be interpreted reliably by a wide variety of user agents, including assistive technologies" with factor load 0.69. Thus, with Robust Content, students recommend being able to access the Web page's content in different ways more than others.

Regression weight. All the regression weights for factors (Perceivable Content, Operable Content, Understandable Content, and Robust Content) in the prediction of their items are significantly different from zero at the 0.001 level (two-tailed) (refer to the Chapter Four, Table 4.28, p. 182)

Correlations. Referring to Chapter Four, Table 4.29, p. 182; the four factors (Perceivable Content, Operable Content, Understandable Content, and Robust Content) indicated a positive correlation. The correlation values ranged from .50 to .57. All these correlations were significant at the .01 level (2-tailed). The correlation between Operable and Understandable Content is the strongest one (.57) while the correlation between the Perceivable and Understandable Content is the weakest (.45).

Accessibility second-order factor model. The Accessibility second-order factor model indicates a good model fit to the data (Chapter Four, Figure 4.6, p.186). The model fit-indices are: CMIN=76.57, CMINDF= 1.91, TLI= .93, CFI= .95, RMSEA=.06, and p=.001

Standardized Regression Weights (Factor loading). The four factors; Perceivable Content (P), Operable Content (C), Understandable Content (U), and Robust Content (R) remained stable across the Accessibility second-order factor model and they loaded significantly on the Accessibility construct (refer to Chapter Four, Table 4.30, p. 184).

Regression Weights. All the regression weights for Accessibility (A) in the prediction of the four related factors are significantly different from zero at the 0.001 level (two-tailed). (refer to Chapter Four, Table 4.31, p.185). Table 4.31 supports those results from the EFA (refer to Chapter Four, Table 4.5 Accessibility Rotated Component Matrix, p. 143). That is, Accessibility is significantly indicated by four factors Content (P), Operable Content (C), Understandable Content (U), and Robust Content (R).

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) indicated amount of variance ranged from 49% to 52% (refer to Chapter Four, Table 4.32, p. 185). The least factor explained by Accessibility is the Robust Content (R) (49%) while the Operable Content (C) is the highest explained (52%).

Information Quality first-order factor model. The Information Quality construct revealed on four factors (Intrinsic, Contextual, Representational, and Accessible information quality) (refer to Chapter Four, Figure 4.7, p. 190). The measurement model was well fitted with the data. No items indicated a low factor loading. Therefore, no items were deleted.

Indices. The goodness-of- fit indices for the Information quality measurement model were revealed as follows: the CMIN=137.64, CMINDF=1.64, TLI = .94, CFI = .95; and the RMSEA = .05. No post-hoc modifications were conducted as there were a good fit of the data to the model.

Standardized Regression Weights (Factor loading). All items loaded significantly onto their respective factors. All the factors have positive effects on their predictors (>.5) (refer to Chapter Four, Table 4.33, p. 187). The highest and lowest predicting items for each factor in the Information quality construct are summarized as follows (refer to Chapter Four, Table 4.34, p. 188):

The highest predicting item for the factor, Intrinsic (IQ_I) is: "IQ_I3: The information was correct" with factor load 0.69 while the lowest predicting item is: "IQ_I1: The information was valid according to some stable reference" with a factor load of 0.58. Thus, with intrinsic information quality; students recommend the accuracy of the Web page's information more than others.

The highest predicting item for the factor Contextual (IQ_C) is: "IQ_C1: The information was applicable and helpful." with factor load (0.77) while, the lowest predicting item is: "IQ_C4: The size of information was corresponding to the context." with factor load (0.58). Thus, with Contextual information quality; students recommend being able to apply and use the Web page's information in the real life more than others.

The highest predicting item for the factor, Representational (IQ_R) is: "IQ_R1: The information was conforming to our technical abilities." with factor load (0.76) while, the lowest predicting item is: "IQ_R1: The structure of the information was matching with the information itself." with factor load (0.76). Thus, with representational information quality; students recommend being able approach the Web page's information more than others.

The highest predicting item for the factor, Accessible (IQ_A) is: “IQ_A2: The system operations were easy to manipulate.” with factor load (0.66) while, the lowest predicting item is: “IQ_A1: The system is giving correct answer to a feasible query in a given time range.” with factor load (0.61). Thus, with accessible information quality; students recommend being able to manipulate the system’s operation easily more than others.

Regression weight. All the regression weights for factors (Intrinsic, Contextual, Representational, and Accessible information quality) in the prediction of their items are significantly different from zero at the 0.001 level (two-tailed) (refer to the Chapter Four, Table 4.35, p.188)

Correlations. The four factors (Intrinsic, Contextual, Representational, and Accessible information quality) indicated a positive correlation (refer to the Chapter Four, Table 4.36, p.189. The correlation values ranged from .28 to .56. All these correlation were significant at the 0.01 level (2-tailed). The correlation between Contextual and Accessible information quality is the strongest one (.56) while the correlation between the Intrinsic and Representational information quality is the weakest (.28).

Information Quality second-order factor model. The Information quality second-order factor model indicates a good model fit to the data (Chapter Four, Figure 4.8, p.193). The model fit-indices are: CMIN=137.77, CMINDF= 1.60, TLI= .94, CFI= .95, RMSEA=.049, and p=.001

Standardized Regression Weights (Factor loading). The four factors; Intrinsic (I), Contextual (C), Representational (R), and Accessible information quality(A) remained stable across the Information quality second-order factor model and they loaded significantly on the Information quality (>.5) (refer to Chapter Four, p.191,Table 4.37)

Regression Weights. All the regression weights for Information quality (IQ) in the prediction of the four related factors are significantly different from zero at the 0.001 level (two-tailed) (refer to Chapter Four, Table 4.38, p.192). Table 4.38 supports those results from the EFA (refer to Chapter Four, p.144, Table 4.6 Information quality Rotated Component Matrix).That is, the Information Quality is significantly indicated by four factors; Intrinsic (I), Contextual (C), Representational (R), and Accessible information quality (A).

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) indicated amount of variance ranged from 29 % to 85 % (refer to Chapter Four, Table 4.39, p. 192). The least factor explained by Information quality is the Representational IQ (R) (29%) while the highest explained is the Contextual IQ (C) (85%).

Added Value first-order factor model. The Added Value construct revealed on four factors (Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies) (refer to Chapter Four, Figure 4.9, p. 197). The measurement model was well fitted with the data. No items indicated a low factor loading. Therefore, no items were deleted.

Indices. The goodness-of-fit indices for the Information quality measurement model revealed as follows, the CMINDF=1.68, TLI = .94, CFI = .95; and the RMSEA = .05. No post-hoc modifications were conducted as there were a good fit of the data to the model.

Standardized Regression Weights (Factor loading). All items loaded significantly onto their respective factors. All the factors have positive effects on their predictors (>=.5) (refer to Chapter Four, Table 4.40, p. 194). The highest and lowest predicting items for each factor in the Added value construct are summarised as follows (refer to Chapter Four, Table 4.41, p. 195):

The highest predicting item for the factor, Flexible Learning (AV_F) is: "AV_F4: I have been supported with efficient and effective systems to access to electronic material." with factor load (0.84) while, the lowest predicting item is: "AV_F3: I have been informed about appropriate materials available electronically." with a factor load of 0.58. Thus, with flexible learning; students recommend being supported by efficient and effective techniques to access electronic materials over the Internet more than others.

The highest predicting item for the factor, Improvement of Teaching Quality (AV_TQ) is: "AV_TQ2: Lecturers knew how could connect teaching e.g. to situations in working life." with factor load (0.72) while, the lowest predicting item is: "AV_F3: I have been informed about appropriate materials available electronically." with factor load 0.50. Thus, with improvement of teaching quality; students recommend the lecturers to be able to connect learning tasks with the real life more than others.

The highest predicting item for the factor, Learning & Communication Skills (AV_S) is: "AV_S2: I have been given the control over learning." with factor load 0.75 while, the lowest predicting item is: "AV_TQ5: Flexible feedback and support are promptly provided throughout the course time." with factor load 0.58. Thus, with learning & communication skills, students recommend having full control over their learning more than others.

The highest predicting item for the factor, Innovative use of Information and Communication Technologies (AV_I) is: "AV_I1: The planning of course structure is closely connected to the course objectives and the teaching methods on the course." with factor load 0.81 while, the lowest predicting item is: "AV_S1: The class web site offers many of collaborative web-based learning tools." with a factor load of 0.67. Thus, with innovative use of information and communication technologies, students recommend that course design and teaching methods be consistent with the course objectives more than others.

Regression weight. All the regression weights for factors; Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies in the prediction of their items are significantly different from zero at the .001 level (two-tailed) (refer to the Chapter Four, Table 4.42, p.196)

Correlations. The four factors; Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies indicated a positive correlation (refer to the Chapter Four, Table 4.43, p.196). The correlation values ranged from .34 to .56. All these correlation were significant at the .01 level (2-tailed). The correlation between Innovative use of Information and Communication Technologies and the factor Learning & Communication Skills is the strongest one (.56) while the correlation between the Teaching Quality and Learning & Communication Skills is the weakest (.34).

Added Value second-order factor model. The Added value second-order factor model indicates a good model fit to the data (Chapter Four, Figure 4.10, p.200). The model fit-indices are: CMIN=130.50, CMINDF= 1.79, TLI= .93, CFI= .94, RMSEA=.056 and p=.001.

Standardized Regression Weights (Factor loading). The four factors; Flexible Learning (F), Teaching Quality (TQ), Learning & Communication Skills(S), and Innovative use of

Information and Communication Technologies (I) remained stable across the Added value second-order factor model and they loaded significantly on the Added value construct (>.5) (refer to Chapter Four, Table 4.44, p.198).

Regression Weights. All the regression weights for Added value (Av) in the prediction of four related factors are significantly different from zero at the 0.001 level. (refer to Chapter Four, Table 4.45, p.199) . Table 4.45 supports those results from the EFA (refer to Chapter Four, Table 4.7 Added value Rotated Component Matrix, p.145). That is, Added Value is significantly indicated by four factors; Flexible Learning (F), Teaching Quality (TQ), Learning & Communication Skills (S), and Innovative use of Information and Communication Technologies (I).

Squared Multiple Correlations. The squared multiple correlation coefficients (R^2) indicated amount of variance ranged from 43% to 53% (refer to Chapter Four, Table 4.46, p.199). The least factor explained by Added value is the Flexible Learning (F) (43%) while the Learning & Communication Skills(S) is the highest explained (53%).

The measurement model for the constructs UPAIAv (Usability, Pedagogical usability, Accessibility, Information quality and the Added value). The initial run of the model indicated a good fit to the data (refer to the Chapter Four, Figure 4.11, p. 205). The indices fit with the standard goodness-of-fit values. No post-hoc modifications were conducted as there were a good fit of the model to the data.

Indices. The goodness –of- fit indices for the UPAIAv measurement model revealed as follows, the CMIN=566.49, CMINDF =1.23; TLI = .93, CFI = .93; and the RMSEA = .03.

Standardized Regression Weights (Factor loading). All factors loaded significantly onto their respective constructs. All the constructs have positive effects on their predictors (>=.5) (refer to the Chapter Four, Table 4.47, p. 201).The highest and lowest predicting factors for each construct are summarised as follows (refer to Chapter Four, Table 4.48, p.202):

The highest predicting factor for the construct, Usability (U) is:" U_P: System Performance." with factor load 0.62 while, the lowest predicting factor is: "U_UI: System User Interface." with factor load 0.50. Thus, with usability; students recommend the efficient and effective system performance more than others.

The highest predicting factor for the construct, Accessibility (A) is:" A_R: Robust Content." with factor load 0.75 while, the lowest predicting factor is: "A_U: Understandable Content." with factor load 0.53. Thus, with accessibility; students recommend the compatibility of the learning system's content with current and future user agents in specific more than others.

The highest predicting factor for the construct, Information quality (IQ) is: "IQ_C: Contextual Information Quality" with factor load 0.61 while, the lowest predicting factor is: "IQ_A: Accessible Information Quality." with factor load 0.51. Thus, with information quality; students recommend the relevancy, timeliness and completeness of the learning system's information more than others.

The highest predicting factor for the construct, Added value (AV) is: "AV_F: Flexible learning" with factor load 0.65 while, the lowest predicting factor is: "AV_I: Innovative use of Information and Communication Technologies." with factor load 0.51. Thus, with added value; students recommend the flexible design and interactive activities of learning process more than others.

Regression weight. Referring to the Chapter Four, Table 4.49, p.203; all the regression weights for constructs (Usability, Pedagogical usability, Accessibility, Information quality and the Added value) in the prediction of their factors are significantly different from zero at the 0.001 level (two-tailed).

Correlations. The five constructs (Usability, Pedagogy, Accessibility, Information quality and the Added value) indicates a positive correlation (refer to Chapter Four, Table 4.50, p. 204). The correlation values ranges from .17 to .55. All these correlation were significant at the .05. The correlation between Accessibility and Added value is the strongest one (.55) while the correlation between the Information quality and Pedagogical usability is the weakest (.17).

The causal structural model for UPAIAv for a WBLE. The initial run of the hypothesized priori causal structural model indicated a good fit to the data (refer to the Chapter Four, Figure 4.12, p. 209). However, the regression weight for Pedagogical usability (P) in the prediction of Information quality (IQ) was not significantly different from zero at the .05 level (two-tailed). Therefore, the path from P to IQ was deleted. All the other regression weights were significant at the .05. The modified model indicated a good fit to the data (refer to the Chapter Four, Figure 4.13, p. 210.)

Indices. The goodness-of-fit indices for the priori causal structural model revealed as follows, the CMIN= 569.05, CMINDF =1.23; CFI = .93; TLI = .93; RMSEA = .03 and the *p*=.001.

Standardized regression weight. All the standardised regression coefficients indicated significant causal positive effect between the constructs (U→P, U→IQ, IQ→P, P→A, U→A, U→AV, P→AV, IQ→AV, and A→AV). The estimates are (.19, .24, .21, .22, .33, .22, .22, .20, and .33) respectively. The highest predicting construct on the added value is the Accessibility (.33) while the lowest one is the Information quality (.19). (refer to the Chapter Four, Table 4.52, p.207);

Regression weight. All the regression weights: U→P, U→IQ, IQ→A, P→A, U→A, U→AV, P→AV, IQ→AV, A→AV are significantly different from zero at the 0.05 level (two-tailed). The p-values are .02, .01, .03, .01, .01, .03, .01, .03, .01 respectively (refer to the Chapter Four, Table 4.53, p.208.

The Direct and Indirect Effect of the UPAI on the Av.

The direct effects. Each construct of the Usability, Pedagogical usability, Accessibility, and Information quality indicated a direct effect on the Added value as follows, U→AV, P→AV, A→AV, IQ→AV with values 0.18, 0.11, 0.17, 0.09 respectively (refer to the Chapter Four, Table 4.55, p. 211 and Figure 4.13, p. 210).

Among these direct effects; the Usability (U) has the biggest direct effect on the added value (Av), while the Information quality (IQ) has the smallest one.

The Indirect Effects. The Usability, Pedagogical usability, and Information quality has indirect effects on the Added value (refer to Chapter Four, Figure 4.13, p. 210).
They are as follows, U→AV, P→AV, IQ→AV with values 0.12, 0.05, and 0.04 respectively (Refer to Chapter Four, Table 4.56, p.212). Among these indirect effects; the Usability (U) has the biggest indirect effect on the added value (Av), while the Information quality (IQ) has the smallest one.

The Total Effects. Total effect is the sum of direct and indirect effects of the constructs: Usability, Pedagogical usability, Accessibility, and Information quality on the Added value. Thus, the total effects of the Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are 0.19, 0.11, 0.17, and 0.09 respectively.
(refer to Chapter Four, Table 4.57, p. 212). The biggest total effect on added vale is the Usability and the lowest one is the Information quality.

The Total Effects- Lower Bounds- Upper Bounds. The boundaries of total effects of Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are: [.39-1.00], [.16-.53], [.12-.42], [.15-.70] respectively (refer to Chapter Four, Table 4.58 & Table 4.59, p. 213).

The Total Effects – Two Tailed Significance. All the– two tailed significances of the total effects of the Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are significantly different from zero at the 0.01 level two-tailed (refer to Chapter Four, Table 4.60, p. 214). All of these are bootstrap approximations obtained by constructing two-sided bias- corrected confidence intervals. The *p*-value of these total effects – two tailed significances of the Usability, Pedagogical usability, Accessibility, and Information quality on the Added value are .001, .001, .003, and .005 respectively.

Recommendations

This section is intended to provide some recommendations to validate the virtual learning environment in the Syria Virtual University and for further research.

Using the factor analysis (exploratory and confirmatory) the study explored and confirmed that five constructs contribute to the evaluation instrument of a Web-based learning environment (The Usability, pedagogical usability, Accessibility, Information quality as well as the Added value). The study validated the causal priori model that depicts the interrelationships among those constructs and the probable effect of Usability, Pedagogical usability, Accessibility and Information quality on Added value. First of all, while the results of this study provide a valuable reference for designers of WBLE, as well as for researchers interested in online learning; the researcher finds importance to declare that the results cannot be generalized to some extent. They have limited generalizability. Some reasons behind are:

- The sample was restricted to SVU, so more virtual universities were expected to give better generalizability of the results.
- The generalizability to other universities out of Syria might be limited due to cultural differences.
- The questionnaire was run after five years of the University establishment. This points to the difficulties may the University have (e.g., The Learning Management Environment currently available in the SVU supports only Windows Systems (Windows 95 up to Windows XP). Windows Vista, Mac OS X, and Linux are not currently supported. Students who are using different operating system are obligated

to install support programs such like VM Ware or MS Virtual machine, and so forth.

Thus the recommendations of the study are as follows:

Usability. The EFA with Usability yielded seven factors; Basic attributes, Performance, Information architecture, User interface, Navigation tools, Content, and Multimedia (refer to Chapter Four, Table 4.3, p. 133). The results indicated that Performance is the highest predicting factor for Usability while the System User Interface is the lowest one. This looks strange to some extent as usually the user interface is the most fantastic element in the system. However, students prefer the performance of the system to its attractiveness. In case of the Basic Attributes; results indicate how students recommend being able to easily accomplish the system's basic tasks, recover easily from errors, and so forth. Above all, the students expressed that they are happy and comfortable with the system. In case of the Performance, students recommend the availability and validity of the Web pages' links more than others when using the learning system. In case of Information Architecture, research results indicate how students recommend that the system is compatible with all browsers, pages require less time to load, and so forth; and most of all they wanted Web pages to be free from broken links. In case of the User Interface, research results indicate that students preferred consistency between foreground and background, consistency in text formatting techniques, and particularly simplicity in the interface (not a busy user interface). Results also indicate that students recommend effective Web page headings, information be positioned according to priority, and most of all students want to be satisfied with the information architecture. In case of the Navigation, the results indicate that students recommend navigation tools (e.g., links) connect all the Website pages clearly and flexibly, the external links to be loaded in a separate window, and specifically, that the information is connected in a sequence.

In case of Content, research results indicate that students recommend that pages are free from all misspelling and grammatical errors, the longer pages are very few and, if they exist, be just for printing purposes, and that above all students should be satisfied with the Website content. Finally, in case of the Multimedia elements, results indicate how students recommend that the media names reflect the real content and effect, the visual and auditory media are provided with equivalent text, and so forth; and most of all, the media elements are of high visual and aural quality.

Accessibility. The EFA with Accessibility yielded four factors; Perceivable Content, Operable Content, Understandable Content, and Robust Content (refer to Chapter Four, Table 4.5, p. 143). However, results indicated that the Robust Content is the highest predicting factor for Accessibility while Understandable Content is the lowest one. Likely this is expected because the accessibility of the content is one and first condition. In case of the Perceivable Content; research results indicate how students recommend being provided by text alternatives for any non-text content (e.g., images), content is flexibly presented in different ways, and most of all, that content is visible and audible. In case of the Operable Content; research results indicate how students recommend that content be very concise, quiet, and understandable and avoid causing seizures (e.g., flashes), most user interface functionalities are available from the keyboard, and above all, that content is provided with flexible ways to help them navigate flexibly within the site's pages. In case of the Understandable Content, students recommend being able to predict the Web page appearance and operation, and most of all they recommend that text content be made readable and understandable. In case of Robust Content, students recommend that accessible alternatives are provided, and most of all that content can be interpreted reliably by a wide variety of user agents, including assistive technologies.

Universal Usability and Accessibility. In conclusion, students of any learning management system are looking for ease of use, comfort and a pleasant system. Students should not have to navigate more than a very few pages nor should they require more than a few seconds to find out the information they are seeking. Therefore, designers of virtual and Web-based learning are invited to design pages that avoid putting "too much" on the Web page; they need to use short line lengths and short paragraphs, provide very flexible navigation tools and an effective help menu to satisfy student requirements. Furthermore, designers should not use large images because this will require fast Internet download, which is unavailable for many students.

With regard to Accessibility, it is known that designing for users with disabilities is difficult to some extent and designing learning environments accessible to everyone with a disability is not practical as well. However, students of any learning management system are looking for learning environments that meet a minimum set of accessibility requirements (let us say, hearing and vision specifically; e.g., pictures have descriptive text; Web pages are screen reader-friendly, etc.).

To sum up, the following are general recommendations for designers for universal usability and accessibility:

- To provide a text-only site map text. This can provide a useful overview of the site assisting with navigation and searching. This is useful for screen reader and screen magnifier users in particular and for those with reading difficulties.
- To limit the number of links on a Web page. Too many links on a Web page creates a painful mental workload for those using screen readers and students with dyslexia too.
- To allow the user to specify text and background colours.

- To avoid blinking or moving text/images because these may cause difficulties for those students with a visual impairment, dyslexia and learning difficulties.
- To provide consistent navigation. This is particularly important for those with visual impairments and reading difficulties.
- Avoid scrolling text boxes. People with dyslexia often have short-term memory problems. All the information should be on display on one screen if possible.

Finally, I would recommend the SVU designers to consider accessibility as part of their policy and design culture.

Pedagogical usability. The EFA with Pedagogical usability construct yielded thirteen factors; Structure, Course Content, Cooperative/Collaborative Learning, Motivation, Learning Styles and Strategies, Lecturer Role, Applicability, Goals and Objectives, Learner Control, Evaluation of Previous Knowledge, Interaction, Feedback, and Flexibility) (refer to the Chapter Four, Table 4.3, p. 138). However, results indicated that the Cooperative/Cooperation Learning is the highest predicting factor for Pedagogical usability while Feedback is the lowest one. This is very reasonable in the e-learning situation as students miss the physical social relationships and this corresponds with literature. In case of the Structure, research results indicate how students recommend that hierarchies of content are designed of breadth rather than depth, no gaps in structuring the information, and most of all, that topics be presented in a logical and ordered manner. In case of the Course Content they recommend that content is rich with multimedia components, content is built upon their prior knowledge, be provided by complete syllabus of the course ahead of learning, and above all that students be satisfied with the course content. In case of the Cooperative/Collaborative Learning, students recommend being allowed to participate frequently in online discussion with other team members and classmates, and that, above all, being authorized to know what other learners have been doing in the learning material. In case of Motivation, students recommend that course topics are completely new, the topics focus on real-world problems, meet needs and expectations, and so forth; and most importantly the students suggest that course topics be interesting. In case of the Learning Styles and Strategies, students recommend that learning problems be provided with a pre-defined model for solution, to work collaboratively with other class members on assignments, to be rewarded for good answers, and so forth; most of all they wanted lecturers' support (feedback) to be presented as scaffolding. In case of the Lecturer Role the students recommend that lecturers use the technology well and reliably, perform tasks in a straightforward manner, and reply emails periodically; most of all they recommend that lecturers manage the discussions and forums helpfully.

In case of Applicability, students recommend that course topics accommodate different learning styles, the course teaches the skills that they really need, and more than others students recommend that the available examples in the course are helpful and compatible with assignments. In case of the Goals and Objectives, students suggest that objectives be built using simple language, clearly state the outcomes of the course, and so forth; and more than others students recommend that objectives show clearly what kind of assessment would be conducted at the end of semester.

In case of Learner Control, the students wanted to be responsible for their own learning, spend as much time as they want or need during learning of course material, control over the media elements, and so forth, and above all, to be satisfied with their control over learning. Regarding the Evaluation of Previous Knowledge, students recommend to be assessed ahead relating to some required skills and techniques, and most of all students recommend the course be structured to go over earlier material before starting to teach a new topic. In case of Interaction, students recommend designers to frequently schedule specific chat times and conversational spaces, and so forth; and more than others they recommend that progress reports and assignment feedback be frequently communicated to them. In case of the Feedback, students preferred being provided with adequate technical online support, and more than others they recommend that lecturer's expectations be clearly communicated to them. Finally, in case of Flexibility; students recommend that courses offer optional routes for their progress, contain diverse assignments and so forth, and most of all students recommend that the class web site give them the opportunity to add some comments and suggestions.

In conclusion; learning should take place in authentic and real-world environments. No unique method can fit everyone; lecturers are invited to incorporate a variety of instructional methods and strategies that will be most successful in the online teaching environment. Therefore, some lecturers need training in instructional design and the pedagogy of teaching online first, and then in the courseware tool and related software (LMS).

For pedagogically effective online environments, the recommendations were put forward for the design and development of efficient pedagogical usability. Therefore, the designers and developer are invited to:

- Think seriously how to cope with increased student numbers.
- Share and re-use resources.
- Extend and validate the collaborative work.
- Ensure that learning is student-centered.
- The Instructors are invited to have clear and adequate communication with students via email.

- Reduce the administration burden as much as possible; and finally to
- Validate the staff Development technically and scientifically.

Information quality. The EFA with Information quality yielded four factors; Intrinsic, Contextual, Representational, and Accessible information quality (refer to the Chapter Four, Table 4.7, p. 144). However, results indicated that the Contextual Information Quality is the highest predicting factor for Information quality while the Accessible Information Quality is the lowest one. This looks strange also to some extent as students prefer the quality of information more than the ease and privately of the information. In case of the Intrinsic information quality, research results indicate how students recommend that the source of information be in high standing, correct, and so forth and more than others be unbiased. In case of the Contextual information quality; students recommend the information be applicable and helpful, up to date, and more than others the information completely covers the context of any given activity. In case of the Representational information quality, students recommend that information be consistent, conform to their technical abilities, and above all, be comprehended. In case of the Accessible information quality; students recommend that information is passing privately through the system, the learning system is giving correct answer to a feasible query in a given time range, and so forth, and more than others the system operations are easy to manipulate.

In conclusion, information quality of any learning system plays a fundamental role in the process of learning. On the other hand, poor data and information quality can have a significant negative impact on the learning quality in WBLE. The security of information system, current information, accuracy, and consistency are critical characteristics which must be considered in any WBLE.

Added value. The EFA of Added value yielded four factors; Flexible Learning, Teaching Quality, Learning & Communication Skills, and Innovative use of Information and Communication Technologies (refer to the Chapter Four, Table 4.9, p. 145). However, results indicated that the Flexible learning is the highest predicting factor for Added value while the Innovative use of Information and Communication Technologies is the lowest one. So the flexibility in planning the interactive activities in the course and the freedom to choose leaning modes and access electronic learning are preferred by students than the technological expertise by lecturers. This is likely reasonable as online learning is mostly learner-centered. In case of the Flexible Learning; research results indicate how students recommend being supported with efficient and effective systems to access to electronic material (e.g., flexible borrowing systems), recommend lecturers to flexibly plan the interactive activities, and so forth., and above all students recommend that the class web site opens up the opportunities for them to cross over different education levels, fields and organizations to increase information sharing, expertise and knowledge (via Internet-based resources or together with hard resources). In case of the Teaching Quality, students recommend that lecturers adequately use the web-based learning environments tools, course materials are produced by specialists, and so forth, and more than others students recommend that flexible feedback and support be promptly provided throughout the course time.

In case of the Learning & Communication Skills, students recommend being given the control over learning, that collaborative and individualized teaching be used effectively in every context and situation, and so forth., and more than others the class web site offers many of collaborative web-based learning tools (e.g., problem-based learning). In case of the Innovative use of Information and Communication Technologies, students recommend that the planning of course structure be closely connected to the course objectives and the teaching methods on the course, and more than others students recommend that the technological tools provided in the class web site be superior to those in the previous learning environments.

The effect of Usability, pedagogical usability, information quality and Accessibility on the Added value. Two points are recommended here:

- While the Accessibility is the highest predicting construct on the added value and both of them have the strongest correlation, this may mean that as far as the WBLE is accessible as far as it is likely to provide more added value.
- While designers of WBLE have to consider that because of direct effect the poor Usability, Pedagogical usability, Accessibility, and Information quality will affect so far the learner's perceived Added value of this WBLE, designers should consider more the indirect effect of the Usability, Pedagogical usability, and Information quality on the Added value as the direct effect is obvious while the indirect is not.

The correlations among the Usability, Pedagogical usability, Accessibility, Information quality and the Added value. As results indicated positive correlations among these constructs, this is expected to recall the designers of WBLE to consider these constructs in total in such away that the design process looks as it walks in five lines all together at the same time.

Further research. For further research it is recommended that researchers discover if there are any differences among female and males according to the priorities of universal usability and accessibility, pedagogical usability and information quality. One more important area is to discover if there are any differences among students according to the priorities of universal usability and accessibility, pedagogical usability and information quality based on different courses and backgrounds. I would recommend that further search also involve the lecturers in such a survey.

Finally, future research can use different methodologies, such as longitudinal studies, focus groups and interviews.