Human Computer Interaction and Web-Based Learning Platforms: e-Learning Website Features vis-à-vis Student Perception

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DEDICATION

I dedicate this humble effort to:

my mother who gave me care, compassion and endless love throughout my life,
my father who sacrificed everything to show me the light of the day, and
my wife thank you for her encouragement, patience, sacrifice and understanding.

May Allah bless you with faith.

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Looking back further, I perceive that this thesis is a physical representation of the continuous interchange of ideas and encouragement of my father, H.E. Prof. Dr. Abdulaziz Alsagar Alghamdi.

Finally, whatever I have achieved until now owes a great deal to the sincere efforts and regular prayers of my family, friends and companions in the United Kingdom and the Kingdom of Saudi Arabia.

DECLARATION

I declare that this thesis is original work undertaken by me for the degree of Doctor of Philosophy, at the Software Technology Research Laboratory (STRL), Faculty of Technology at De Montfort University. No part of this thesis has been submitted for the award of any other degree or qualification in this or any other university or college of advanced education.

Faisal S. Alghamdi

ABSTRACT

The utilisation of web-based e-learning platforms is increasing throughout the Kingdom of Saudi Arabia. The majority of these platforms were developed initially by institutions in the West; only later were menus and icons translated into Arabic to assist Arabic-speaking students. Users have observed that during the development, adaptation, and implementation (adoption) stages, insufficient attention was directed toward usability. Within the industry it is common practice to apply Nielsen' heuristics, as a measure of usability, to designs intended for business or commercial uses, these heuristics are considered a standard measure.

This study focuses on the application of Nielsen's heuristics to web based learning platforms to evaluate usability. The aim is to understand and evaluate the usability of these applications from the perspective of students and to compare and contrast these with the findings of a Heuristic evaluation of these platforms by groups of professionals.

The study includes the development of a usability guideline framework and an extensive set of criteria to be applied to evaluate web based learning platforms (WBLP). The analysis of the data collected and applying the heuristic evaluation of experts demonstrate that a high correspondence with previous sources. The research concludes that a heuristic evaluation, based on Nielsen's model, is an effective, appropriate and sufficient usability evaluation method, as well as a relatively easy tool. It also identified a high percentage of usability problems in the target WBLP, Arabic version of BlackBoard™, which contributes to part of research conclusions.

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Chapter 1: Introduction

1.1 Introduction

As teaching and learning move from the traditional classroom to web based learning, "ease of use" and the usability of Web Based Learning Platforms (WBLP) has become of paramount importance. The aim of this research project is to study WBLP usability from the perspective of those students' who use them. Usability is defined as the ease of use associated with man-made objects and technology but the concept and definition of usability, especially in the WBLP context vary. Usability is not automatically programmed into computer applications and rather it is a result of the application designer's ability to anticipate user requirements and system uses successfully. This research explores the meaning of usability in the context of a web based learning platform at one university in Saudi Arabia (i.e., King Saud University, Riyadh). The study attempts to evaluate the effectiveness and appropriateness of the measure, Nielsen's heuristics, for testing the usability of WBLP, and to contrast and compare its results with student's viewpoints/perceptions regarding the usability of such platforms. Card, Moran and Newell (1983) state that society will only realise the potential benefits of computer-based activities if system design fulfils the criteria of interactivity, efficiency and ease of use.

The last decade witnessed the transformation of Web technology from a mere hypertext tool, initially developed for targeted research and scientific use, into an everyday medium of communication used by people from diverse socio-economic and educational backgrounds for everything from e-commerce to education (Winograd and Flores, 1987; Crampton Smith and Tabor, 1996; Barbules and Callister, 2000; Swiss and Horner, 2000; Eachus and Cassidy, 2006; Friedman, 2006; Bonk and Zhang, 2008). Friedman (2006) states that this digital

revolution is a consequence of the widespread affordability and use of PCs on one hand and the development of user-friendly operating systems with graphical user interfaces (WIMP-operating systems) on the other. An easy to use GUI or WIMP interface enables a novice user freedom to use the PC to perform everyday tasks, navigate and access files and applications without the need for knowledge of computer science, programming or technical skills. This amplified reliance on a PC requires digitised materials to be accessible on the computer. This phenomenon of digitisation has been fuelled by the invention of ADSL technology, cheap Internet access and the free distribution of web browsers, such as Microsoft's Internet Explorer, Safari and Google Chrome, some of which are bundled with the operating system. It has also led to a demand for digitisation of multiple documents and file types, to be sent to intended users via the Internet (Friedman, 2006). Digitisation of documents, a service once only available to researchers and scientists or computer professionals, is now widely available to all sectors of society, from students to housewives.

The World Wide Web has become a primary tool supporting instruction, leading educational institutions across the globe to make use of it (Weinreich, et al., 2008; Katz, 2008; Naidu, 2003). The availability of teaching and learning materials on the web has made learning available anytime, anywhere, in a time efficient and cost effective manner. Moore (2003) argued that the invention and growth of faster telecommunications network capabilities and Web 2.0 tools, supporting computer-oriented communication inspired and motivated many academics to use WBLP to teach beyond the campus and outside the classroom. Consequently, unconventional Web Based teaching and learning techniques and tools have gained widespread acceptance (Katz, 2008). Allen and Seaman (2010) reported that in the last 5 years, enrolment on online courses increased by 12.9% annually, although growth in the student population in the higher education sector in the USA is merely 1.2%.

Furthermore, development and change in practice is affecting the demographics of learners, changing it from the traditional 18-22 year olds to mature adult learners seeking up-skilling and retraining opportunities (Bonk and Zhang, 2008; Katz, 2008; Allen and Seaman, 2007, 2008). Many are retraining as technological advancements are fuelling the need for up-skilled and technically savvy workers. In this context, WBL platforms offer an excellent framework in which to deliver training when it is required in a cost effective and efficient manner. Peters (2003) states that in a traditional pedagogy time saving and comfort were not a concern, but these are clearly priorities to contemporary learners. This influx of new types of learners into the sphere of education, especially higher education has given rise to another phenomenon, i.e., a generation gap between the two sets of learners i.e., 18-22 youngsters and mature and adult learners. Bonk and Zhang (2008) argued that both groups have different life experiences of teaching and learning - on the one hand and technological experiences on the other, moreover, they have different expectations.

According to Eachus and Cassidy (2006), the Internet and web technology has transformed web access and the ability to use the Internet into a social norm, a 'must have' skill for everyone. They further observed that despite the web becoming increasingly intuitive, novice users continue to encounter many challenges and difficulties. For example, the hypertext based design and structure of the websites remains problematic and challenging, especially, for learners. Hackos and Redish (1998) rightly argued that any difficulty a learner faces in accessing course material when using a web based portal places an additional cognitive load on the learner, thereby distracting them from the task of learning.

For designers, the amplified expectations and dependence on web-based teaching and

learning has placed great emphasis on insuring the usability aspects of the design of WBLP to support and promote the learning process and to ensure the requisite learning goals and objectives can be met. To produce an effective, teaching and learning centred Human Computer Interaction (HCI) for a WBLP, developers must understand and prioritise criteria affected by users' computer efficacy/literacy, learning objectives and tasks (Garrett, 2003; Barnum, 2002). This implies a need to design a user centred approach to designing an HCI, rather than a designer focus offering access to the features and functions of a WBLP. This form of HCI design will provide learners with a natural way in which to navigate and interact with a learning platform (Wood, 1998; Hackos and Stevens, 1997; Dourish, 2001). The main objective of the HCI designer is to design an interface that does not encroach on the learner's activities (Laurillard, 2002).

The above discussion demonstrates clearly that the end-users, i.e., learners, are the best evaluators of the usability of a WBLP. Therefore, to meet the aims of this study, the researcher recruited learners registered on undergraduate courses at King Saud University (KSU), Riyadh.

1.2 Statement of Research Problem

The learners who participated (the sample population of the study) in the research were undergraduate students at KSU. They considered flexibility and convenience to be the most important elements of any learning platform. At KSU, BlackBoard™ is used across the university, offering many different courses. The aim is to guarantee students convenience and the option to learn from their homes. In 2010, during an end of course evaluation of an online course offered by KSU, learners made the following comments:

- “unclear design of the website”,
- “scattered and disorganised”,
- “difficulty with speedily find information on the site”,
- “too much time spent finding the learning material”,
- “some sections of the instructions were in unlikely places”,
- “in my opinion the application designer and the tutor did not discuss the design”,
- “complete bewilderment about finding the material on the portal”,
- “next time I would like a well-structured and designed portal where ALL the guidelines are placed together”, and
- “informed the instructor that the layout is difficult to navigate and confusing ……” .

The above examples highlight some of the challenges faced by those students who regularly use the WBLP for learning. These comments provide further evidence of the need to test the usability of WBLP, and to interpret students’ perceptions and experience of these platforms, so that a user friendly HCI of WBLP can be designed based on strategies and guidelines that will effectively enhance and improve the HCI of the current platform (Gall, Borg, and Gall, 1996). User centred appraisal and testing of a WBLP will help the researcher to understand the basis of the students’ problems and requires a development of a framework and guidelines to conduct evaluations and improve the design of learning portals.

The need for the development of HCI design guidelines and strategies originated from several different sources of discontent and dissatisfaction. The design of commercial websites does not always focus on the end-users’ needs, as the end-user and the designer approach the HCI from different perspectives. In recent studies of WBLP’s acceptance differences have been identified and cause varying levels of perplexity and dissatisfaction among learners.

Due to wide spread usage and reliance on web based learning, the need and demand to study the usability and effectiveness of WBLP from the standpoints of accepted design principles and the learner perspective has increased. There are different WBLP with varied design approaches available on the market; some of these platforms support professionals (i.e., medicine, accountants, project management, and marketing), while others focus on offering a structured program of study in subjects such as computer science, biology or economics. At KSU the BlackBoard™ course management system is used to develop and offer eLearning options.

1.3 Research Question

A set of research questions helps researchers to frame research, providing a focus on the problem to be investigated and helping to identify its parameters. Furthermore, a clearly defined and well-focused set of research questions establishes the direction of research by providing help to select the research methods, and identifying the data required to answer the research questions.

This research seeks to fill a gap identified in previous studies, i.e., that despite the wide spread demand for web based learning platforms, the usability of available WBLP or courseware has not been well evaluated (Zaharias, 2006). Vrasidas (2004) stated that usability features are frequently not considered when designing WBLP, mainly because educationists/instructors and application developers are not trained to do so and/or lack the necessary expertise and technological skills. Kjeldskov, Skov and Stage (2004) argued that usability the evaluation stage is typically ignored due to reasons such as expense, time-consuming nature of assessment and difficulty to conduct.

Elsewhere in software engineering, there is a variety of techniques available to conduct usability evaluations, such as analytical, expert heuristic evaluation, observational, survey and experimental evaluations. However, emphasis is typically on utlising cost-effective and efficient methods to determine the nature of usability problems, as is the case with WBLP (Hartson, Andre and Williges, 2003).

In summary, this research spans two main areas of knowledge: Human computer interaction (usability and usability evaluation methods) and e-Learning. Thus, the main research question for this study is:

> **What criteria and techniques are appropriate for the evaluation of usability of web-based learning platforms (These should measure the effectiveness and efficiency of user evaluation and compare and contrast it with heuristic evaluation)?**

Answering the above question requires the researcher to ask a number of questions to define the parameters of the construct of "usability"; in particular, how this construct is defined on a WBLP through the experiences of learners, (i.e., end users), and learners' perceptions of the usability of findings and technical evaluation conducted by experts using Nielsen's guidelines. Hence, the primary research question gives rise to the following sub-questions:

1. How do learners perceive the construct of usability?
2. How efficient and effective are usability evaluations by experts, performed using Nielsen's usability heuristics?
3. To what extent do the findings of a heuristic evaluation conducted by experts

(Nielsen's usability heuristics) and a survey evaluation among learners correspond?

4. What are the differences in the perceptions of user interface and ease of use, features, impact and usefulness, as attributed to gender, age and self-efficacy?

1.4 Research Aims and Objectives

In light of the above discussion, the main objective of this research was to assess the usability of a Web Based Learning Platform used by a large public university in Saudi Arabia, based on student's perceptions and Nielsen Heuristics. This will further understanding of web-based learning applications from the perspective of students and compare and contrast these with the findings of Heuristic evaluations of platforms, performed by groups of professionals.

The study aimed to determine: (1) the significance and meanings of the concept of usability from a learner's standpoint, (2) the comparison of the outcome of Nielsen's heuristics to students' verdicts on WBLP, and (3) to establish a set of guidelines to be used when evaluating WBLPs.

1.5 Research Methodology

In order to achieve the research goals and answer the above research questions, after reviewing literature in the field of e-learning, HCI and instructional design, a set of heuristics (i.e., criteria) were derived, intended to be appropriate for the evaluation of WBLP. To achieve this, a set of heuristics, as developed by Nielsen (1994) was adopted and incorporated as a basis for expert evaluations. This basic set were then augmented by integration of criteria

and heuristics from a wide variety of other sources, and structured into different categories, forming extensive newly-synthesised sets of criteria and sub-criteria in the form of evaluative statements. Subsequently, four experts were employed to conduct a heuristic evaluation using these heuristics.

Secondly, a set of structured questions, based on these heuristics, were developed as a basis for a survey evaluation among the end users, i.e., the learners.

Thirdly, the experts were asked to apply a severity analysis to the problems that emerged from both evaluative techniques, i.e., heuristics and the survey results of the end users.

Finally, the findings of these two evaluation techniques were compared to deliver a set of criteria to effectively evaluate the WBLP and develop a cost effective and effective technique for usability evaluation.

1.6 Significance of the Study

In recent years many books and articles have been written about e-learning, and WBLP, but few have focused on the end-user's perceptions of the design of WBLPs. This is also true in Arab-Gulf states. Alley and Jansak (2001) observed that the strategies discussed in the literature provided little or no help, as instructors begin to setup their own websites to publish their teaching material. In concluding their literature review they reported that literature and research in the field of eLearning typically focused on the following themes:

a. Learning environment;
b. Learning outcomes;

c. Characteristics of learners; and
d. Administrative and institutional factors (Tallent-Runnells, Thomas, Lan, and Cooper. 2006).

They therefore argued that, because of the important role played by the design of the WBLP in learner's achievements there is a need for appropriate, efficient and excellent design. This demands further research in the field of HCI, especially in the context of WBLP, even more so in settings where there is heavy or total reliance on WBLP.

The evaluation of the usability of the WBLP is a relatively ignored area of research in the field of e-Learning. Usability studies by Jakob Nielsen, a Usability Guru, focused on business and commercial websites, which have different aims and objectives to WBLP; and therefore, as rightly observed by, Hall, Watkins, and Eller (2003) the proposed evaluation framework is not entirely relevant to WBLP. It is also worth noting that recently several attempts have been made to devise strategies and guidelines to enhance the usability of WBLP, and to employ Web 2.0 online tools (i.e., discussion forums, self-paced tests, quizzes and surveys) (e.g. Duffy and Kirkley, 2004; Bonk and Dennen, 2003; Hannafin, Oliver, Hill, Glazer, and Sharma, 2003). Hence, the lack of research into the usability evaluation of WBLP requires well-researched evaluation frameworks and strategies. The US Department of Education (2009) emphasised the need for research-based guidelines to improve the effectiveness and usability of WBLP. Due to lack of WBLP specific HCI guidelines, many designers and tutors have developed their portals without being certain of the user requirements (Katz, 2008; Bonk and Zhang, 2008), thereby resulting in a wide range of HCI designs, portal structures, and content available to choose from in the market (Oblinger and Hawkins, 2006). Duffy and Kirkley (2004) observed that due to a lack of WBLP specific HCI evaluation guidelines,

learners have frequently found learning platforms over complicated and difficult to use, for these reasons they have failed to engage the learners (Winograd and Flores, 1987) and resulted in underachievement (Duffy and Kirkley, 2004).

Cress and Knabel (2003) studied the difficulties users' might encounter when navigating educational sites and WBLP. They stated that learners can experience a "structural disorientation" because they are unable to locate material or identify their target materials within a learning site. Dias and Sousa (2007) identified the complex hypertext framework as a cause of "conceptual disorientation", which can lead learners to experience difficulty interrelating and connecting different concepts. They also found that learners did not find sitemaps helpful for navigating the site. Meanwhile Otter and Johnson (2000) argued that the interface design of WBLP should be based on the mental model, i.e., adopting a user centred approach when developing HCI for WBLP.

1.7 Structure of Thesis

This thesis is comprised of six chapters. The first chapter provides a brief summary and overview of the research. Furthermore, the need for the study, aims of the study, research questions, and additional procedural issues are also discussed.

Chapter 2 is an attempt to develop a theoretical and conceptual framework for the research by conducting a critical review of existing literature on usability, especially in the context of a WBLP. Chapter 3 attempts to outline the research methodology used to answer the research questions. The main question raised in this work involves studying the viability and applicability of Nielsen's heuristics to evaluate the usability and effectiveness of the WBLP.

This question was studied by contrasting and comparing learners' viewpoints about WBLP with a professional evaluation of usability employing Nielsen's usability heuristics. In summary, this research employs two instruments to collect data to answer the research questions: (i) a survey using a questionnaire to study student perception of usability, and (ii) Nielsen's Heuristics to conduct a technical usability analysis conducted by experts. It provides a rationale to choose these instruments and to assess their reliability and validity. Chapters 4 and 5 are analytical in nature and facilitate discussion of the findings of the survey questionnaire and the expert evaluation of usability, while Chapter 6 concludes the thesis by combining the outcomes of the two approaches and providing a conceptual framework to adapt a user-centred approach to design and develop the WBLP.

Chapter 2: Literature Review on E-Learning and Usability Evaluation of WBL Platforms

2.1 Introduction

The development of a quality web-based learning application is more complicated than simply placing instructional materials online; rather, it is like designing a virtual classroom in which people can learn at their own pace and develop their own skills. The development process should take into account elements of graphical design, instructional design and site design, as well as offering content that meets the needs of the target learners and the goals of the educator (Dupuis, 2003; Ruffini, 2000).

2.2 A Brief History of E-Learning

Although the subject is beyond the scope of this research, it is interesting to see how computers and technology have changed the world of education. Over the last four decades, educationists have used computers and technology as a means of delivering knowledge across different domains; during this time, information and communication technology has evolved and its availability has increased immensely.

In the 1960s and 1970s, educational computing occurred primarily in large universities, using mainframe computers, and was mainly restricted to reading and the typing of text. With advancements in the technology and HCI, however, interaction with computers progressed from text alone to include graphics, audio and the ability to point and click with a mouse. Furthermore, the release of personal computers (PCs) in the early 1980s resulted in wide expansion of computer use in education. The development in computer networks, from LANs to WANs, and then to the Internet, permitted the sharing of information and resources. In the early 1990s, the creation of part of the Internet known as the World Wide Web (WWW), or the Web, transformed the entire computing landscape. The Internet developed from a network that was predominantly used by academia and government for the exchange of textual material into a worldwide multimedia resource; it is now used by millions of people across the globe for activities such as learning, shopping, research and the exchange of textual, audio and graphical information. These advances have been accomplished through a dramatic decrease in cost (Alessi and Trollip, 2001).

Educational computing commenced with a small number of large projects focused on mainframes and minicomputers (Jay Cross, 2004). These systems were sophisticated and had features similar to those available on the Web today, yet their communication costs and other expenses were high. This, in addition to the advent of microcomputers, led to the takeover by desktop computers, though an unfortunate consequence was that many of the benefits that had been gained in networked computers were lost. Furthermore, several years passed before microcomputer-based authoring software became available for developing instructional programs which were as sophisticated as their mainframe predecessors. Current educational computing faces a range of problems, such as a lack of practitioners skilled in developing quality courseware and disagreements on how computers should be used in education.

Despite these drawbacks, the use of computers for training and education is expanding rapidly, largely due to the popularity of the Internet and the WWW (Alessi and Trollip, 2001).

The field of educational computing is still evolving (Tavangarian et. al., 2004). Though conclusive research is not available to determine the gains and effectiveness of using computers, there is a general consensus among educationists that computer-based instruction (CBI) offers, at the very least, time efficiency; furthermore, if used to their full potential, computers can also improve learning effectiveness and efficiency. Though progress has indeed been made, much remains to be understood with regard to the best ways in which to harness the capacity of technology. The proliferation of educational and training applications on the Internet will, hopefully, result in improvements in the quality of materials for instruction and learning (Alessi and Trollip, 2001).

2.3 Theoretical Context

This study will attempt to examine the usability of WBLP from the learner's perspective, and is based on a conceptual and theoretical framework drawn from the fields of teaching and learning, instructional design and human–computer interaction.

The most recent decades were witness to a digital revolution and information technology has now penetrated through all strata of life, especially with the advent of the Internet and ADSL Broadband, which made the WWW a necessity for modern life. The speed of the Internet and the development of web-based tools developed the web into a medium of instruction for both classroom (face-to-face) teaching and distance learning (Vrasidas, 2004). The web's

capability to display information through different mediums on any subject in any order (Jun, Gruenwald, Park and Hong, 2002), and most importantly independent of location (Morrison, 2003), has elevated the demand for WBLP in the educational and training sectors (Feinberg and Murphy, 2000).

This widespread use of the web has not only evolved the lifestyles of individuals, but has also changed the attitudes and requirements of learners and educators, giving rise to the demand for new forms of teaching and learning, for example the themes of 'anytime' and 'anywhere'. In recent years learning has progressed from the traditional classroom, which is based on face-to-face teaching and printed course materials, to virtual web-based portals, which rely solely on digital material. This phenomenon raises a few questions, such as: do users find this change useful, and how they perceive the usability of this new medium of instruction and media distribution?

It is a fact that despite widespread use of WBLP, particularly in higher education institutions, minimal effort has been made to critically examine their usability (Zaharias, 2006). Vrasidas (2004) reported in his research that during the development of WBLP, the usability features were frequently ignored. He further argued that this was predominantly because developers lacked understanding of the teaching and learning process, and that instructors were not fully trained and did not comprehend the required technological skills. This is also true in the case of the Kingdom of Saudi Arabia, where a great deal of universities have developed learning portals and educational websites, but without any consideration with regard to usability (Van Greunen and Wesson, 2004). On the other hand, Kjeldskov, Skov and Stage (2004) argued that cost, time and difficulty were the three main reasons for the lack of attention to usability evaluation during the development of WBLP.

This thesis describes a study of usability constructs, by applying two different methods, and then considers the findings in order to determine whether heuristic evaluation is sufficient for usability evaluation of WBLP; later, the findings of these two evaluation methods are compared to formulate a framework for future developments. However, the evaluation findings could also be used to improve the existing system, resulting in a secondary benefit. This part of the research relies on the concept of usability and the role of it in the development of virtual-learning environments.

In the computing world, a number of techniques are used to evaluate usability, such as analytical evaluation, expert heuristic evaluation, observational evaluation, survey and experimental evaluations (Shneiderman and Plaisant, 2005; Brinck and Wood, 2002). However, as stated above, given that many tutors and developers are not familiar with those detailed, it is important that an efficient, economical and accessible method be used to determine the usability problems of WBLP (Hartson, Andre and Williges, 2003). This aspect of the research requires exploration of the theoretical underpinnings of usability evaluation methods.

2.4 Usability and Web-Based Teaching

There is no universally acceptable definition for the term ‘usability’, and it is defined variously across different domains of knowledge; however, ISO adopted a user-centric approach to their definition: “It is the degree to which a specific user can achieve specific goals within a particular environment; effectively, efficiently, comfortably, and in an acceptable manner” (ISO, 1998). It is a well-researched and documented fact that the

majority of website designs, including WBLP, are based on technological requirements and aesthetic dimensions as opposed to usability (Barnum, 2002; Cooper, 2002). Failure to meet usability standards in a website, or ignoring the construct of usability in the initial development process, and raises a question that warrants exploration: how, and to what extent, does the failure to meet usability standards affect the learning process or educational effectiveness of WBLPs? According to Veldof (2003), usability should be considered as a necessary requirement of a WBLP in order to improve effectiveness, while on the other hand Granic, Glavinic and Stankov (2004) have argued that to ensure the effectiveness of WBLP, a thorough usability evaluation should be performed during its development process. Additionally, Costabile, De Marsico, Lanzilotti, Plantamura and Roselli (2005) suggested that the usability evaluation of educational software should be based on pedagogic effectiveness and ease of use.

Shackel (1991) developed a model to explain the concept of usability. This framework is based on (i) User, (ii) Task, (iii) Tools and (iv) Environment, and takes into account all systems comprising technology and a human user, which possess these components.

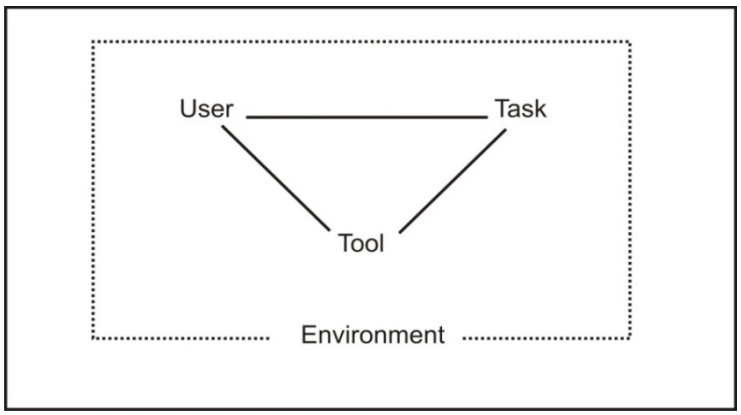

Figure 2.1: Bunion–Machine System's Four Principle Mechanisms (Shackel, 1991)

Shackel's framework, shown above, defines usability as (i) Effectiveness, (ii) Ability to learn,

(iii) Flexibility and (iv) Attitude. In Shackel's opinion, usability can be measured by quantifying these criteria.

Dumas and Redish (1999) linked usability with the ease and efficiency by which a product could be utilised to accomplish the required task. Their statement relied on four assumptions: (i) focus on end-users, (ii) products are used to be productive, (iii) users want to be time efficient and (iv) usability is best judged by the user. Goto and Cotler (2002) defined a website's usability as the ease with which the user interacts with and navigates the site, and how they find their required information on it. Nielsen (2003) considers ease of use to be a main construct of websites, stating (1993) that the level of usability depends on:

- Satisfaction
- Efficiency
- Ability to learn
- Errors
- Memorability

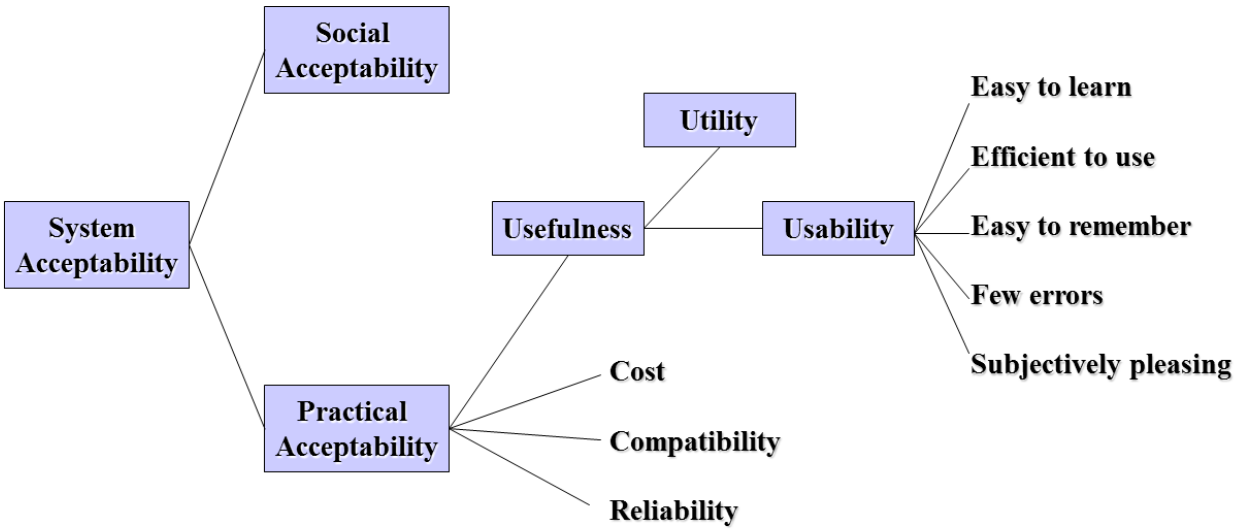

Figure 2.2: Nielsen's Usability Framework (Leventhal and Barnes, (2007))

Alternatively, Rosson and Carroll (2002) based their definition of usability on three

characteristics: (a) Time, error and human performance, (b) Mental models of plans and actions, for example human cognition, and (c) Workplace context, i.e., collaboration and group dynamics. Leventhal and Barnes (2007), after explaining the controversy surrounding the definition of usability, stated that it is a process that fulfils the function of task, user and system.

In computer science, usability is considered as a 'built-in' element, and must have features of every HCI, because the user needs to be able to communicate and interact with the system using a display; it is disconnected from the tools necessary to accomplish the required task. In the teaching and learning context, the learner is disjoined from a physical learning environment by a virtual environment, and therefore course-management system tools must take the construct of usability more seriously, in addition to considering usability as a factor in the design of a WBLP.

Tufte (2006) suggested that WBLP would be more useful to learners if they could access easily the necessary information and course material to support their learning. He further suggested that learners should be able to make strategies in order to achieve their learning goals, view their options and be able to access instructions on how to complete a given task. Amadieu, van Gog, Paas, Tricot and Mariné (2009) proposed that WBLP should provide learners with a facility to plan their study and create a mental model; furthermore, in the opinion of Bonk and Zhang (2008), learners should be part of the learning community.

Nielsen (2000) considers ease of use to be the key factor of the usability feature of any website. In the learning and teaching context, as observed by Hannafin, Oliver, Hill, Glazer, and Sharma (2003), ease of use becomes a more important factor within the design decision,

because the learners, being web users, can become confused or lost, which does not help the learner to find their required information. The design of a website is completed as a means of facilitating the administrator or maintainer, as opposed to the user (Friedlein, 2006); this claim is further supported by Barnum (2002) and Cooper (2002). This point indicates that there are hurdles to be overcome in order to ensure that the user is not confronted with problems when using web portals that have been designed for distant-learning purposes; if this does not happen, users may become dis-encouraged by the learning process.

Frequently, well-defined syllabi do not provide learners with the initiative or inspiration to study. The results of the website are not dependent on technical effectiveness or production of creative designs, but on how these elements are perceived by learners (Berge, Collins and Dougherty, 2000); indeed, it is incorrect to state that the designer should not put effort into design and creating an appealing webpage. Rather, researchers such as Garrett (2003), Cress and Knabel (2003) and Cooper and Reimann (2003) support that the design should be such that it assists in the learning itself, making the learning process easier and contributing to the level of retention of what is being learnt.

The instructional requirements must not be compromised, instead the reader and learner should use an element of creativity and also supportive material that will help in easing understanding of instructions (Smith and Ragan, 2004; Oblinger and Hawkins, 2006). Without this, efforts may prove unproductive, for example by communicating the wrong message, or misinterpretation or lack of usability (Baggerman, 2000; Nielsen, 1993; Otter and Johnson, 2000; Cress and Knabel, 2003). In the absence of usability there is no website productivity, as educational websites are intended for education not merely entertainment. The usability should include understanding of content, understanding of layout,

understanding of how to submit assignments through the web portal and the ability to achieve meaning from the content. Roblyer and Wiencke (2003) suggest that a portal should go beyond offering mere usability at an individual level, and that it should also provide facilities for group activities such as discussions and reviews.

Feedback concerning the usability of web portals has provided results, which indicate that a significant number of students could not effectively understand the layout of the website studied; they experienced issues in terms of understanding the design and navigating the site. Investigation to what the students perceived, whether they felt satisfied and what they achieved contributed to a degree of clarification regarding the needs of learners, and also provided some evidence concerning the effectiveness of the layout of the course in practice. Hackos and Redish (1998) and Hackos and Stevens (1997) supported the principle that by having an appreciation of the strengths and weaknesses of website layout and design, as indicated by the user guide, the administrator could thus concentrate on the improvements required in order for the design of the course to enhance learning. Gall, Borg and Gall (1996) found during their research on education that providers are in the process of developing new ways in which learning can be made more effective and in which the education process can be simplified.

2.5. Design Layout and Learning

The use of WBLPs to aid distance learning is increasing, along with its acceptance, extent of usage and distribution across the web and related technologies. It has also altered the methods and types of learning available on the Internet, such as lectures, discussions, presentations, demos, etc. Thus, it is not one component that has changed; rather the entire structure is new.

The speed and availability of the features of web-based learning are attractive to users and are therefore broadening beyond initial boundaries. The gap between the learner and the teacher is becoming minimised; a student can ask a question or submit an assignment at any time without the need to wait for their teacher to be available. The interaction between teacher, students, classmates and subject matter has been designed so that it is not restricted by time or distance, rather the web tools enable learning outside of these limits.

The process of learning and teaching has witnessed substantial changes since the dawn of IT. Conventional teaching and learning has been largely replaced by distance learning, which is facilitated by the web. Naidu (2003) said that some aspects of web-based teaching and learning have changed the way education is delivered and received, such as design, the role of e-publications, electronic distribution, content delivery on the web, online lectures, intellectual property rights of patents and copyrights. Not only the pace, but also the scope, has broadened too; the design of education delivery today is more convenient, accessible and appreciative of knowledge than it has been previously.

2.6. Design of Instructions

Instructional design has an impact on web-based learning, but in what way and the extent are yet to be studied. The impact of instructional design on usability and web-based instruction, in addition to the challenges faced by students when undertaking web-based learning, will be considered in this study.

Instructional design was being used long before the advent of IT; during WWII the military

were required to deploy a procedural approach for laying down instructions (Seels and Glasgow, 1990), with the basic idea behind this being that a person should not learn something by chance. Rather, there should exist a proper method by which what to learn, when and how can be decided upon. Instructional design also requires the acquired knowledge to be measurable in quantitative terms, as based on the theory that learning should occur in an ordered process which incorporates measurable outcomes (Seels and Glasgow, 1990). The results of such measurable and structured knowledge help the educator as well as the learner to understand how much has been learnt, the speed of the learning and which aspects of the subject matter are easier to learn than others. It is beneficial to know if educational goals have been met, as if the educator and the student are both satisfied that these goals have been achieved then it is implied that the instructional design used was positive and successful. On the other hand, if the teacher and student locate some gaps in the design, the flaws can be identified and the design can be improved collaboratively (Smith and Ragan, 2004), a process that can take place at any time as requirements change and updates are carried out. With the arrival of new technologies and applications, designs must be adjusted continually (Dijkstra, 1997).

Instructional design is not only a procedure but also a discipline that provides an educational setting in the form of a product (Orellana, Hudgins and Simonson, 2009). A definition of instructional design has been given by Smith and Ragan (2004), in that it is a systematic process of translating the principles of learning and instruction into strategies for instructional resources and activities. Furthermore, instructional design is considered to be a complete process of examination of learning needs and objectives, also providing a delivery system that aims to achieve learning needs and involves the development of instructional resources and well-designed and evaluated events.

It has been argued that well-considered and well-sought procedural planning is primarily significant when the mode of instruction is not a conventional teacher (Smith and Ragan, 2004). Sadik and Reisman (2009) reported that the web and online sources providing educational material do not have clearly set educational objectives for the delivery of educational and learning material. This lack of goal-related clarity may prove to be problematic at a later date, as when the goals and objectives of a web portal are clear, there is an obvious direction of action to be taken, and they are thus more effective than those web portals that provide education without set goals.

It is natural that whenever an idea, product or service is in high demand not only do those who are experts in their fields begin to offering the product or service, but so too do many potentially naive businessmen and individuals. This is also true in the case of web-based learning, as since there are vast opportunities and simple regulations for providing online education, many web portals have been developed that do not work in relation to regular and procedural instructional designs. Therefore, such web portals have only increased the competition in the market, but the quality of service has not necessarily followed suit. Morrison and Anglin (2009) stated that without a proper instructional design to help calculate and measure educational efforts and learning a web portal cannot be effective.

It is a fact that a poorly designed WBLP lacks a procedural and structural approach through which to offer learning content. Such learning material cannot be understood by the student and they then require a teacher to guide them through it, the result of which is that the course is not ‘online’ in the true sense of the purpose, as it merely offers information and knowledge which is hard to comprehend or memorise (Morrison and Anglin, 2009). This method is

different to uploading learning material from a faculty; when a faculty uploads learning content, it not only considers quantity of knowledge but also the quality of the material uploaded. A faculty ensures that the material uploaded is learnable and understandable, and that it can be measured in terms of success. A properly designed course will be as convenient as web-based learning content and as effective as face-to-face teaching (Garrison and Vaughan, 2008), as opposed to course designs that do not fit successfully in effective learning environments, which have been described as "instructionally unsound" by Morrison and Anglin (2009). The learner's ability to understand online content can be increased by the presence of applications or functions such as drop-down lists, check lists, relevant links, hyperlinks and graphics (Rogers, 2000), which are incorporated into the design of the web portal and contribute to making the learning process both simpler and quicker.

2.7. Design Evaluation

The number of learners is increasing along with levels of unemployment and fee structures within education. Today, both young and old are often required to continue to learn for their employment and leading to increasing popularity for online learning (Allen and Seaman, 2008). Additionally, it is essential to improve the quality of the educational material offered, since learners are only willing to pay money and give their time when they recognise added value (Orellana, Hudgins and Simonson, 2009).

It is commonly observed that in every educational process which involves online sources and web portals, the standard criteria of success is how quickly the material is learnt, what is learnt and the grades and percentages achieved as a result (Dupin-Bryant, 2004; Rovai, 2002). Some web portals also take into consideration the attitudes of educators and learners

(Abrami, Bernard and Lou, 2004); Bonk and Dennen (2003) also analysed training, standards, design and tutoring in online distance-education programmes, and noted a lack of awareness regarding web-based learning and teaching tools. Research on the effectiveness of web-based learning portals remains in progress and is thought to be insufficient by Hannafin, Hill, Oliver, Glazer and Sharma (2003). Studies have either been too localised or too narrow in terms of the scope of the web portals considered, so that the results of each study cannot then be globally generalised. Confusion regarding design and layout exists primarily in areas where web-based learning is in its early phases or at a stage of development.

Rouet and Levonen et. al. (1996) stated that cognitive activities are involved in using hypertext, whatever the nature of the context. The researchers found that there is a need for experimental revisions of hypertext for the purposes of teaching and learning, with the suggestions including: (i) to recognise cognitive processes involved and seek to know how these are influenced by specific design structures, (ii) to demonstrate how documents can successfully help complete teaching and learning activities, and (iii) to let hypertext designers make effective decisions regarding the design, based on student requirements and teacher suggestions rather than guesswork or superficial observation.

The influence of, and relationship between, the learning process, knowledge outcomes and self-efficacy has been evaluated by Moos and Azevedo (2009), as well as the characteristics of web-based learning environments. In this study, they found that there are ways in which the system can be improved, such as altering the research methodology in order to achieve further benefits for online educational systems. The connection between online learning and education develops with the acquisition of knowledge. Additionally, different aspects of web-based self-efficacy are linked to different computer-based learning environments (CBLEs).

The self-efficacy principles relating to one activity can be applied to general and similar activities, but the research concluded that when there are more exact and distinct scopes of self-efficacy, the ability to generalise increases between the links of self-efficacy to CBLEs.

There are also a number of studies conducted by the US Department of Education (2009), in which comparisons between face-to-face learning and online leaning have been made; these took place in 1996 and 2006. The results of the studies demonstrate that education which occurs via online portals is more successful than conventional learning, and that even as little as half of the web-based learning involved was more helpful and gave better results than the full range of traditional learning practices, as online learning provides greater support and access to materials than traditional learning methods. The results of the study showed that (i) adding extra educational media such as video did not significantly improve learning outcomes; (ii) using e-Learning portals such as Blackboard, Moodle, etc. and tools like queries and puzzles do not significantly improve learning results; and (iii) the online medium is less important than the course content.

Research shows that it is important to apply web-based learning procedures properly. The researchers, however, did not place sufficient focus on the usability or interface design of the courses offered over the web through various portals. Therefore, there is enough of a gap and need in the field to substantiate seeking to discover more about the usability and design of web-based learning.

2.8 Differences

There are a large number of teachers who have the ability to design instructional materials to facilitate the face-to-face teaching environment, such as lectures, demos, cases, problem-solving examples, group discussions, videos, lecture minutes or summaries, slides or related visuals. A teacher may base their lecture on an event reported in a newspaper or a television broadcast; scheming online courses is different to planning normal courses, however. In normal face-to-face teaching the whole course is planned ahead of time, as course material is written, corrected and presented using different mediums prior to being made available to learners via the course management system, as stated by Alley and Jansak (2001). Courses which are designed for web portals require greater technical and instructional support and expertise (Oblinger and Hawkins, 2006), and it has also been argued that the learner experience is different when the teaching is conducted through the medium of a computer or the web (Maeroff, 2004; McCarthy and Wright, 2004; Swan, 2004). A student may have to rely solely on a virtual interface, which does not reflect a classroom setting or class structure, in order to learn the content of the course. Rather than interacting directly with the learning environment, the teacher and learner must both use a computer and the Internet as the mediums through which to interact with each other and their peers; this is termed a "classroom of one" by Maeroff (2004) and a "window" by Swan (2004).

2.9 Usability and Aesthetics

A correlation study conducted by Kurosu and Kashimura (1995) evaluated determinant data of visible and inherent design and layout of web portals. The visible usefulness has an impact on the graphics and appeal of a web portal, enhancing the functionality of the site as well as facilitating navigation. Research supported the theory that content alone is fairly unimportant,

rather the layout, use of design and effective patterns does more to help increase the usability of the website in terms of growing and improving the results of the learning. It was found by Tractinsky that though there is little scientific evidence regarding the significant impact of aesthetics in increasing the use of interactive systems, there is no lack of theoretical, practical and observable proof that such an impact is present (2004). In addition to the aesthetical design, it was observed that emotional design plays a role as well (Tractinsky, 1997, 2004; Kurosu and Kashimura, 1995; Norman, 2002, 2004), as emotional designs create a bond between the learning content and the learner, which catalyses the process of learning. This helps to achieve the learning objectives more quickly.

2.10 Interface Design and Usability Guidelines

In his study, Nielsen formulated appropriate guidelines that were subsequently appreciated and applied by a number of commercial websites; his guidelines ensured that the utility and usability of the web portal were differentiated. Utility is defined as the functionality presented by a website or another system, which equates to the inherent usability that Kurosu and Kashimura (1995) discussed. Usability, on the other hand, is basic technological functionality, and a concept that Kurosu and Kashimura (1995) termed ‘usability’. Usability has five features, as stated by Nielsen (1993, 2004), which are learnability, efficiency, errors, memorability and satisfaction. If learning takes place because of these five features, the web portal offering the learning has usability, which means that the website itself offers greater interaction for the learners and demonstrates a feature of a successful site.

2.11 Summary

During recent years, there has been a dramatic increase in the number of learners and

educators registering themselves with online educational websites. These sites offer a platform for distance learning that reduces the time and costs associated with learning and acquiring knowledge. The usability of these sites lies in the learnability offered to the user and the level of facility felt, as usability removes error and provides a smoother learning process. The sites, which offer web-based learning, should work to a thoughtfully designed and highly structured approach, and should also provide content to match students' requirements, and tools to measure the knowledge acquired as a result. Creative educational tools, such as videos, puzzles and quizzes, may help to accelerate the process of learning.

Chapter 3: Research Methodology

3.1 Introduction

This research aims to analyse the usability of the e-Learning system in use at King Saud University (KSU), Riyadh. Dumas and Redish (1999) stated that usability means that the user can utilise the product easily, quickly and efficiently in order to achieve their objective or complete the intended task. In the WBLP context, this means that the learners who use the portal are the best judges of its usability; therefore, this research is an attempt to study the concept of usability as viewed by the learners themselves. It will compare and contrast the student perception of usability through expert evaluation and the employment of an expanded set of usability principles, the usage and derivation of which will be made more explicit with a set of shorter and more general heuristics as used in Nielsen's heuristic evaluation.

This chapter outlines the methodology that was used as a means of conducting the usability evaluation, and will also describe the research design, the sample and procedures. This research will employ two methodologies (an end-user survey using questionnaires and expert evaluation using Nielsen's heuristics) in order to collect quantitative data that will measure the effectiveness and efficiency of user evaluation, and will compare and contrast it with heuristic evaluation. Section 3.4 describes the heuristic evaluation technique and the heuristics used in this research, while Section 3.5 outlines the questionnaire technique employed to study the end-user evaluation.

3.2 Research Design

This study compares student perception with that of the expert evaluators of the e-Learning website under consideration, forming a comparison of findings through two different evaluations and two different paradigms. A survey research method was used to study the student perception of the usability of the e-Learning platform, as Crowl (1993) and Shavelson, (1996) proposed usage of descriptive statistics in order to provide a thorough summary of the data required to accurately describe the findings of the empirical research and afford answers to the research questions. Descriptive research is considered a useful tool to study a wide range of topics in educational contexts; it is a reliable tool to study preferences, attitudes and opinions (Gay and Airasian 2000). Survey questionnaires are effective tools to conduct empirical research with regard to study perceptions, beliefs, attitudes, thoughts and values (Johnson and Christensen, 2000). For these reasons, a questionnaire survey was constructed in order to collect the data and thus answer the research questions.

3.3 Research Questions and Data Collection

This study possesses features of two research techniques: qualitative research and quantitative research. A mixed-method research approach has been adopted for this study, specifically the case-study method, in which the case is the WBLP used by KSU, whose usability is evaluated through use of Nielsen's heuristics and the collection of quantitative survey data.

To gain an understanding to WBLP's usability through learner perception and experiences, one application of this study will be to develop a strategic framework for the HCI design of a

web-based learning platform. These guidelines will be based on empirical data analysis, for example what learners said about the usefulness of the WBLP. The themes, identified from the students' responses (data collected from questionnaires), will be mapped to Nielsen's (1994) heuristics in order to match learner experience and their verdicts concerning WBLP to the expert evaluation as based on Nielsen heuristics.

3.4 Heuristics Evaluation: Expert Evaluation Based on A System Checklist

Nielsen (1994) published his heuristics in order to provide a way to evaluate the usability of websites that provide benchmark guidelines, which are utilised to create usable websites. Following a description of the selection criteria for heuristic evaluation and the rationale behind selecting this technique, this section outlines the validity and reliability of the instrument: Nielsen's heuristics.

Heuristic evaluation is an inspection technique by which to evaluate usability. In this technique, more than one expert, most commonly three to five users (Nielsen, 2000), employs a set of recognised usability principles called heuristics in order to independently evaluate the usability of a website and the compliance of its interface with an established usability checklist, commonly known as 'heuristics'. It is recommended that more than one but not more than five experts (Nielsen, 2000) evaluate the usability of the interface to ensure that most, if not all, usability problems are identified, however the exact number of experts used would depend upon the cost-benefit analysis. This means that greater numbers of expert evaluators are required in situations where large payoffs are expected due to the mission-critical nature of a system. Nielsen and Landauer (1993) developed a formula to estimate the number of problems found in a heuristic evaluation: Problems Found (i) = N(1 - (1-l) i) [in

which N is the total number of usability problems]; using this prediction formula they observed that five evaluators can locate 75% of the existing usability issues.

3.4.1 Web-Based Learning Platform and Heuristics Analysis

Squires and Preece (1999) emphasised the usability of learning undertaken in a constructive way, a theory that Nielsen also favoured. Nielsen's views with regard to cognitive learning and social-constructivism are positive and demonstrate that the best method of learning is through practical experience. According to the school of constructivism, cognitive learning references the personal experience of the learner and supports them in creating a developed image, which encompasses all aspects of the learning process. This form of learning encircles three key elements:

a. Credibility, as this type of learning involves personal and practical experience, and the concept will be highly developed.
b. Complexity, as this type of learning involves practical experiences and therefore involves a degree of complexity.
c. Ownership, as this type of learning is encouraged by personal experiences.

By utilising the above three traits, the cognitive learning process can be completed and it is beneficial to the learner.

Squires and Preece (1999) identified a relationship between credibility, complexity, ownership, collaboration and curriculum on one hand, and were also able to relate them to Nielsen's usability heuristics on the other:

- **Credibility –** This has a strong relationship with Nielsen's heuristics and includes the following aspects:

a. **Feedback and designer/learner models:** Tasks should be presented to learners according to the designer's mental models, and the system should provide specifically designed interactive feedback. This is consistent with constructivism, which emphasises active engagement and feedback on performance.

b. **Cosmetic authenticity:** Avoid over-use of highly structured multimedia, which would lead to a superficial and potentially misleading matching between images and the real world.

c. **Representational form:** Interaction with the software must not detract from the experience of learning, and there must not be a high cognition from the learners in terms of interface. Symbols, icons and names must be employed to complete the required tasks.

d. **Multiple views/representations:** Educational software should be flexible and use various representations so as to support constructivist learning. Different forms of media, in combination or separately, may be used to support different perspectives.

e. **Interaction flow:** Customers need an even flow of interaction. At times different forms of feedback, such as error messages or hints, may hinder specific task-based learning. Thus there must be a sense of balance to solve the contradictory difficulty related to communication flow and feedback.

- **Complexity –** The relationship between heuristics and complexity includes the following aspects:

a. **Navigation:** Navigation is possible in two senses: firstly, there must be a clear set of possibilities related to past, present and future in order to influence the required application; and secondly, learners should be able to represent the tasks they are undertaking.

b. **Representation of the real world:** Interfaces should be analogous to some aspect of the real world; additionally, metaphors should correspond to real-world objects or concepts.

c. **Symbolic representation:** Objects, such as symbols and icons, should represent educational concepts in a way that assists learners. Concepts and terminologies should be used consistently, as on the web, learners are likely to experience issues with regard to lack of consistency, but in the presence of a well-designed single instructive application, the design would be consistent.

d. **Peripheral cognitive errors:** As mentioned previously, there are two types of errors in educational applications: software usability errors and cognitive errors. The former originate from manipulation of software and need to be minimised as they limit efficient manipulation of the learning aspect of the application. Cognitive mistakes, on the other hand, occur when one develops and refines concepts in order to be aware of the complications in an education environment. From the constructivist approach to learning, cognitive errors should be part of educational applications, since students need to make and correct mistakes, particularly cognitive ones, as they learn.

e. **Superficial complexity:** This is the use of multimedia, such as sound, graphics and video, for the complex representation of concepts and without a great deal of learning content. This should be discouraged and multimedia should rather be used to simplify the understanding of complex educational concepts.

f. **Pedagogical techniques:** This is a constructivist principle in which students learn by their mistakes and they, as learners, have the right to a comfortable and diverse environment to convey the various ideas of individuals in order to investigate different solutions to problems.

g. **Learners' support material:** Learners require simple, specific problems and tasks to help them focus their attention prior to encountering more complex learning environments.

- **Ownership** – The ownership of ideas is vital for knowledge and includes the following relationships with heuristics:

  a. **Learner control:** Constructivists stress that students should express their own knowledge, which means that they should try to discover solutions to their problems through their own learning experiences. The web enables learners to explore information in order to locate what they require and to discuss these issues with peers and educators globally. Educational software should include high levels of learner control, which would in turn help the learner to gain a sense of ownership over their education.

  b. **Tailoring the interface:** Learners must know how to tailor the interface in order to uphold their individual needs and learning practices; this is referred to as 'customisation'.

  c. **Meta-cognition:** Learners should utilise their individual cognition in order to assist future learning; this self-appraisal improves the capacity to learn.

- **Collaboration –** Though collaboration is a new concept in web-based education, it is an important component of the social constructivist approach and demonstrates the following relationships with the heuristics:

  a. **Shared responsibility:** Peer-group learning enables learners to delegate some command over their learning and skills to other members in the group. In this instance, an educator assumes the role of the catalyst of the given education method, as opposed to being its conveyor.

  b. **Consistent protocols:** Learners should develop some rules or guidelines to

conduct effective working practices if they are to learn by collaboration, as they need to be consistent in the way they share resources across networks.

- **Curriculum –** This relationship with Nielsen's heuristics includes:
  a. **Subject content:** The scope of educational applications should maintain correspondence with the curriculum; this is comparatively easy to analyse for subject-specific applications, but rather difficult with generic applications such as spreadsheets.
  b. **Teacher customisation:** Educational applications should be customisable so that educators can adapt them to suit the specific needs of their learners.

Squires and Preece (1999) refer to some elements within their set of evaluative heuristics as being "learning with software". The above discussion indicates clearly how Nielsen's heuristics are co-related to the theories of cognitive and contextual authenticity. Thus, in this section, the following sets have been developed following analysis of the discussion detailed previously:

1. **Match between learner and designer models:** Though it is not necessary for there to be an identical designer and learner model, there must be no logical distinction between them, as this ensures consistency between the two and minimises misconceptions by learners. Feedback from the system should provide an understandable representation of the cognitive task at hand.
2. **Navigational fidelity:** This relates to navigational structures, cosmetic validity, partial demonstration of the real world and superficial complexity. Good interface usability is important, but it should not compromise authenticity by producing a naive representation of the actual world.
3. **Appropriate level of learner control:** Learner command and shared accountability,

along with tailoring of the interface and consistent protocols, can provide learners with a feeling of control and ownership with regard to their knowledge within a supportive environment, with their peers or teachers assuming the role of facilitators.

4. **Prevention of peripheral usability errors:** There is a connection between complexity and inaccuracy avoidance. Cognitive inaccuracies are permissible when they are appropriate to the foremost learning issues, but marginal usability-related inaccuracies should be predicted and avoided.
5. **Understandable and meaningful symbolic representation:** This is related to figurative forms and the application of symbols across various other applications. The relation between the educational concepts and the given symbols, icons and names would help users to learn and remember these symbols.
6. **Support for individual approaches to learning:** This is implemented by multiple representations, student support resources and meta cognition. It must be apparent which learning styles have been supported and the features that relate to learning style characteristics should be clearly identified.
7. **Recognising cognitive inaccuracy and planning a diagnosis and recovery cycle:** The cycle relates to problems that arise from pedagogical techniques and learning issues; there should be strategies to promote this cycle.
8. **Match with curriculum:** Relevance to the curriculum should be considered, as educators should be able to customise the application according to learner-specific needs and the required scope.

3.4.2 Evaluation Criteria for Web-Based Learning

Various heuristics have been discussed in the previous section. Squires and Preece's (1999)

heuristics take into account both learning and usability, but while this is a comprehensive set of heuristics, some elements are rather general and thus, instead of combining usability and learning in this new synthesis, an approach similar to that of Albion (1999; also recommended by Zaharias, 2006) will be adopted to categorise the heuristics in this thesis. There are three categories, containing twenty criteria in total. They are numbered for ease of reference:

- **Category 1 – General interface design heuristics:** These are based on Nielsen's heuristics but with some alterations (Squire and Preece, 1999) to place the focus on educational applications. They predominantly concentrate on the general usability of interfaces but are within the context of WBLP:

    1. The clarity of the system status,
    2. The difference between reality and the system,
    3. Control given to the learner and they may exercise it freely,
    4. Consistency is necessary for the learner in learning any process,
    5. The learning process is accomplished by recognition, not memory recall,
    6. The learner feels flexible and efficient when using of their knowledge, and
    7. The learning process is diagnosed previously as it involves personal experience.

- **Category 2 – Website-specific design heuristics:** Although the heuristics in Category 1 also apply to web-based applications, there are others specific to websites; as such, they should be:

    1. Simple, analysed, organised and structured, and
    2. Relevant to the educational content.

- **Category 3 – Learner-centred instructional design heuristics:** There are further specific guidelines that have been identified throughout this study as being necessary and

relevant to e-Learning. The heuristics in this category are grounded in current learning theories and models, and aim for effective learning within educational software applications:

1. Clear objectives and goals, and their output;
2. Mutual learning process;
3. Judgement of learner's knowledge;
4. Personal approach of learning through practical experience;
5. Mistakes in personal learning, their diagnosis and their solutions;
6. Feedback and guidance for the learner during the learning process, along with criteria of assessment in reference to the guidance; and
7. Learner may enhance any creative skills that encompass active learning.

Table 3.1 displays the twenty heuristics, with a number of evaluation guidelines or sub-criteria being given for each. Applying a heuristic need not be limited to the guidelines provided, for its use depends on the context. The right-hand column gives references for each sub-criterion; firstly, to the section in the dissertation, and secondly, a reference to the original source.

Table 3.1: Nielsen's Heuristics for WBLP

Category 1: General Interface Design Heuristics

1. System Status Visible • The WBLP gives the learner appropriate, constructive and well-timed feedback. • The learners are kept informed with regard to their status. • To help learners understand the result of their action the system provides an audio/visual response each time. • Easy and simple data entry. • The system responds to every action.
2. Designer Model vs Learner Model • The metaphors and icons represent real world objects or concepts. • The technical symbols, terms and phrases correspond to every day work/software used. • No jargon. • Natural and logical order of information model.

- The use of multimedia without a valid reason (i.e., with a lack of learning content) is avoided.
- Complex concepts are explained using multimedia animations.
- Cosmetic authenticity, for example misleading usage of colours and images, is avoided (e.g. using red and blue colours to represent oxygenated and deoxygenated blood).

3. User Control and Choice

- The learner used the system with full control.
- The system is controlled by the user.
- In case of a mistake the learner can leave or log off the system.
- 'Redo' and 'undo' options are available to override a mistake.

4. Following Design Standards and Maintaining Consistency

- Throughout the system there is consistency in the usage of images, colours, actions, situations and words.
- The order of actions to perform a task is consistent throughout the system.
- Design consistency, for example: prompts, images, menus, sequence of screens, fonts (size/colour).
- Page or screen (dialogue box) labels are consistent with the page of the system.
- A general design for GUI (WIMP) principals or icons is used.

5. Prevention of Error (preventing errors related to peripheral access and usability)

- The system's inbuilt protection system prevents serious errors.
- Every user error generates a relevant error message.
- Easy-to-follow steps to recover from an error.
- Data validation and verification techniques are employed to avoid type mismatch or illegal values.
- A WIMP-based GUI is used rather than a command line.

6. Recognise Instead of Recall

- The user not need memorise steps taken to perform actions; actions are supported by a suitable graphical interface in every instance.
- There are easily retrievable and visible 'how to use' instructions.
- Information is structured to be displayed on a single page rather than multiple pages.
- The display of information is simple and clear.
- There are easy steps by which to load or print required information.

7. Efficiency and Flexibility

- The learner can customise the WBLP to their personal taste or efficacy.
- The learners can adjust settings to suit themselves.
- The users with different levels of computer efficacy (novice to expert) can use the system to supplement their learning.
- Expert users can follow shortcuts (abbreviations, special keys, hidden commands or macros), while novice users can follow simple steps to perform a task.

8. Validity and Minimal Design

- Dialogues box titles are consistent.
- Dialogue boxes contain only necessary information, presented in plain English and avoid any distraction from the task at hand.

9. Diagnosing, Recognising and Recovering from Error

- Simple and informal terms are used in error messages.
- Error messages relate to a specific problem and clearly explain the error.
- Error messages provide constructive, accurate and specific guidelines to recover from error.
- If an error has resulted in a typed command, the user can correct the entry (e.g. correct the spelling or syntax) rather than typing the command again.
- 'Undo' and 'redo' help to reverse and recover from error.

10. Documentation and Online Help

- Online help is available to support the learner.
- System documentation, presented in simple language, is available to support the learner.
- The system documentation and online help have a search facility.
- The system documentation and online help provide a list of steps to be carried out in order to perform a specific task.
- An FAQ and glossaries supplement the system documentation and online help.

Category 2: WBLP Specific Design Heuristics

11. Content Organisation, Site Navigation and Structure

- Learners are always aware of their location on the site.
- Learners always have options to choose in terms of their next action.
- Limited navigation avoids distraction from the task at hand.
- Site map and site search options help the learner.
- The homepage is accessible from everywhere in the system.
- Standard web conventions are used for link colours (i.e., non-visited in blue and visited in purple or green).
- Instructions are presented in a well-structured manner by maintaining related or interlinked information in the same place or page
- Hierarchical structure of information (i.e., moving from general to specific).
- Important information is made clearly visible (e.g. by placing it at the top of the page so the user not need scroll).
- Common standards used in web browsers are followed.

12. Applicability of the Contents Presented to the Learner

- Contents and information presented on the WBLP are relevant to the learner's educational needs.
- Teaching and learning contents are appropriate and relevant for the course.
- Teaching and learning contents are engaging and inspire the learner.
- The contents are neutral with regard to gender, belief and race.
- Offensive and biased contents are avoided.
- The teaching and learning contents are updated on a regular basis.

- The contents clearly display the date of creation, version number, update date and author (or any copyright issue).
- Copyright and non-copyright material is clearly marked.
- Learner activities, participation and achievements are recorded and logged.

Category 3: Instructional Design Heuristics

13. Learning Objectives, Goals and Outcomes are Clear to the Learner

- The goals and objectives of every learning activity are communicated clearly to the learner.
- At the start of the task there is an explicit and clear presentation of the intended and anticipated outcome.
- All intended outcomes are quantifiable and measurable.
- Every document clearly states the purpose, objectives and goals.

14. Collaborative Learning

- WBLP facilitates group tasks.
- WBLP provides facilities for collaborative problem solving, group discussion and team work/group projects.
- WBLP provides facilities to create class groups; members of the group can edit and upload files to a central repository.
- Learner–learner interactions are encouraged and supported.
- Constructive collaboration is encouraged and competition among learners is avoided.
- Other instructors can participate in the group discussions.
- In a collaborative or group activity the teacher plays the role of mentor or facilitator.
- Both synchronous and asynchronous communication is possible.

15. Learner Control

- Learners can control the system to learn at their own pace.
- Learners take ownership of their learning.
- Learners can choose what to learn, how to learn and the order in which this happens.
- Learner has the freedom and control to create their own learning pathways.
- The WBLP could be customised to meet individual needs and strategic demands.
- Instructors can customise learning activities and tests for individual learners.

16. A Range of Different Approaches to Learning are Supported

- The WBLP hosts multiple versions and representations of learning materials, documents and tasks.
- The WBLP caters to demands for differing learning strategies.
- The supported learning style is clearly described.
- WBLP is used in conjunction with other mediums of teaching to supplement the learning.
- Every concept is introduced to the learner using specific problems or examples, before learners are provided with the details.
- The learners are encouraged to self-improve and develop transferable skills.

- The knowledge is delivered in small pieces and scaffolding and knowledge 'pegs' are provided to support the learners

17. Cognitive Errors: Recognition-Diagnosis-Recovery Cycle

- Problem-based learning technique, scaffolding, knowledge pegs and cognitive conflict strategies are used in the recognise-diagnose-recover cycle.
- Learners are encouraged to express their own ideas.
- Learners can experiment with different techniques to solve a problem, learning from their mistakes.
- Learners can recover from cognitive errors.
- Learners can develop and follow different strategies to solve a problem.

18. Guidance-Feedback-Assessment

- Frequent and appropriate feedback from tutors and peers, using the WBLP facility.
- Regular and consistent feedback regarding the knowledge and concepts being developed.
- Tutors guide learners in the correct direction, providing appropriate and timely feedback to facilitate the development of the concept at an appropriate pace.
- Guidance incorporates hyperlinks to other sites, definitions of terms and concepts, exemplifying the concepts and cross-referencing.
- Model answers can be found by referring to the appropriate sections of the material.
- To help learners gauge their performance, measureable and quantifiable feedback is provided (e.g. grading the learner).

19. Context is Purposeful and Meaningful to the Learner and Subject Matter

- The learning activities will engage and inspire learners.
- Authentic knowledge is presented in a meaningful and purposeful way in order to support effectively the learning process.
- Abstract instructions are replaced by contextualised activities and tasks.
- Learning occurs in an applied manner, where transferable knowledge and skills are developed.
- Intuitive names, icons and symbols are used in the context of skills, knowledge and information being delivered.

20. Active-Thinking, Motivation and Inspiring Creativity

- The WBLP inspires and motivates the learner.
- Grades and rewards are used to motivate learners.
- Voice, music and animation is used to inspire learners and enrich their learning experience.
- The platform encourages creativity by allowing learners to develop their own strategies.
- The contents are regularly updated and new material is made available to attract, engage and retain the learners.
- To initiate inquiry the learners are encouraged to take part in group discussion and to pose and answer questions.
- Learners are encouraged to start their own threads.
- Active learning is promoted by inspiring users to analyse different problem-solving strategies, classify and analyse learnt concepts and knowledge, relate to real-world situations and deduce information from different scenarios.
- Reinforcement is completed by presenting enjoyable tasks at the successful completion of an educational task.
- Differing levels of challenges to meet the needs of all learners.
- Simulating activities and quizzes to encourage learner–learner competition, but on a limited scale.
- Shorter session lengths to avoid disengagement.

3.4.3 Validity of Nielsen's Heuristic Technique

Nielsen (1994) studied 249 of the most frequently found problems in usability interfaces and conducted a factor analysis; this was conducted using nine sets of usability heuristics, and the findings from all the heuristics were compared subsequently with the usability problems that had previously been identified in eleven different software projects. The findings of the different heuristics were later compared to ascertain the set of most efficient heuristics.

Table 3.2: Outcome of Nielsen's Factor Analysis

Heuristic	Percentage Errors	
	Cumulative Proportion	**Proportion of Errors**
Consistency	23	23
Language familiar to the user	39	16
Feedback to user	52	13
Pointing vs typing	69	7
Simple design	65	7
Accelerators and shortcuts	71	6
Commonly known conventions	76	4
Error recognition/recovery/help	80	4
Undo/redo	83	3

Nielsen (1994) reported that the aforementioned heuristics successfully identified 85% of the known usability issues; later, based on the outcome of this analysis, he presented twenty heuristics to evaluate the usability of the website interface. Xerox Corporation took Nielsen's project further and developed a Xerox Heuristic Evaluation: A System Checklist (1995).

3.4.4 Reliability

Nielsen (1994) found that in order to identify a maximum number of usability problems, more than one heuristic evaluator was required. It is always the case that in software and websites some problems are obvious and easily noticed by all expert testers, while other, more obscure problems are identified by a minority.

Nielsen (1994) reported that heuristic evaluation could identify 86% of all known problems related to the usability of an interface. Therefore, this evaluation technique is considered a categorical measurement. The WBLP in use at KSU was evaluated by employing the heuristic evaluation technique based on a system check-list developed by Xerox, known as the Xerox Heuristic Evaluation: A System Checklist, in which 296 usability issues are divided into thirteen different categories.

To examine the usability of the KSU's WBLP, the case under examination in this study, the expert evaluator characterised the usability features as:

- Present: 2
- Absent: 1
- Not Applicable: N/A.

In this research, the percentage of agreement between four expert evaluators was calculated in order to achieve a reliable heuristic score. As a means of ensuring the internal validity of the data collected through expert evaluation, SPSS was used to calculate Cronbach's alpha ($\alpha = 0.76$).

3.4.5 Application of Nielsen's Heuristics

By employing Nielsen's heuristics to evaluate the usability of the WBLP in use at KSU, the researcher managed to assess the usability of the portal and to collect the necessary data to answer the research question. Four expert evaluators were employed to independently evaluate the selected e-Learning platform, using the system checklist developed from Nielsen's heuristic evaluation. A spread sheet model was created in line with Table 3.3, and

for the purpose of analysis, it was populated with the data generated from the expert evaluation.

Evaluators were provided with an evaluation sheet, on which they used appropriate codes to evaluate the portal:

- Present: 2
- Absent: 1
- Not Applicable: N/A

Nielsen (1994) recommended that evaluation should be conducted in two phases in order to achieve an accurate measurement. In his opinion, the first phase provides an overall impression, while the second allows the opportunity to more closely inspect the interface. However, in Nielsen's evaluation technique, the evaluator is free to choose the number of passes to make on each page (Nielsen, 1994); in this study, it was noticed that the expert evaluators made two complete passes and examined some usability characteristics more closely than others. Each independent evaluation session lasted approximately three hours, and subsequent to completing the evaluation task, the evaluators met to discuss and compare their findings. In the case of differing verdicts concerning the existence or otherwise of a usability characteristic, open and friendly discussion helped to achieve a consensus, and inter-rater reliability was achieved through these discussion sessions.

3.5 Student Evaluation of WBLP

A questionnaire was developed as a means of studying the learners' perceptions of usability. This questionnaire was used to collect quantitative data to consider learner satisfaction and perception concerning the usability of the WBLP they accessed.

The questionnaire helped to measure the learners' perceptions of usability and satisfaction across the following categories:

a. Structure and appearance of the site,
b. Navigation and hyperlinks,
c. Technical compatibility,
d. Teacher expectations and class procedures,
e. Delivery of contents, and
f. Features of communication between learners and teachers.

In Phase I, a draft of the questionnaire was developed based upon discussion with the faculty and learners at KSU, and was then used to conduct a pilot study. As a result of the subsequent feedback, the questionnaire was redrafted and made available to all students registered at KSU in Phase II. In Phase III, the data from these questionnaires was assimilated and analysed through use of SPSS.

3.5.1 Data Collection Procedure

3.5.1.1 University and Participant Consent

Once the researcher had met all the requirements necessary in terms of the ethical considerations laid out by the Research Ethics Committee at De Montfort University, the committee granted permission for the survey to be conducted. Later, an application that included both versions (i.e., English and Arabic) of the questionnaire was submitted to the Ministry of Higher Education, Kingdom of Saudi Arabia, and King Saud University's Dean of Research in order to seek consent to conduct the survey using the proposed questionnaire.

To ensure confidentiality and minimise the effects of a response bias, the respondents were provided with a written explanation of the aims of the study and the intended usage of the data obtained from the questionnaire. The participants were assured that their participation was voluntary and that completed questionnaires would not be personally identifiable.

3.5.1.2 Translation of Questionnaire

As detailed previously, the population at KSU is primarily composed of Arabic-speaking native students, and therefore in order to eliminate the risk of language bias and avoid ambiguity, the survey questionnaire was professionally translated into Arabic. Later, the translation was tested by a small number of PhD students of Arab origin (one Saudi and others from UAE and Bahrain), all of whom were confident in both English and Arabic, and a specialist translator was hired to translate the Arabic version of the questionnaire back into English. By comparing the translation with the original questionnaire in this way, on one hand the Arabic-translated questionnaire was validated and on the other reliability was achieved. This exercise demonstrated that there were no significant differences between the translated and the original versions of the questionnaire. Finally, to confirm the accuracy of the translation and ensure that the language was appropriate for the subject matter (i.e., usability evaluation of WBLP), two faculty members at KSU reviewed the final version of the questionnaire.

3.5.2 Validity

In the first phase of the questionnaire design, following the Stewart, Hong and Strudler (2004) guidelines, five colleagues at KSU reviewed the questionnaire to ensure the validity of the contents. They were given a copy of the questionnaire and were asked to remove questions which they deemed irrelevant to a WBLP and to add any questions or categories which they felt were relevant and lacking.

3.5.3 Reliability

Cronbach's alpha was used to measure the internal consistency of the data collected by using questionnaires. This calculation was performed twice, once at the pilot stage and then repeated with the final data.

3.6 Summary

As stated previously, the purpose of this study is to understand and evaluate the usability of web-based learning applications from the perspective of students, and to compare and contrast this with the findings of a heuristic evaluation of these platforms by groups of professionals. A dual research approach was employed to achieve this goal: (i) an end-user evaluation using a survey questionnaire and (ii) a heuristic evaluation conducted by experts. This chapter outlined both of these methodologies. The focus of the following two chapters will be the analysis and findings of these two techniques.

Chapter 4: Usability of WBLP through An Analysis of Student Perspective

4.1 Introduction

A questionnaire was administered to 600 foundation degree students at King Saud University, to collect data, to understand students' perceptions of the usability of web based learning platforms. The King Saud University uses an Arabic version of the leading web based learning platform BlackBoard™. The Arabic version of BlackBoard™ has menu options and icons presented in Arabic. However, the translation into Arabic, has meant that some aspects of the platform have lost their usefulness due to cultural and language barriers. This study aims to shed light on the benefits of the web-based platform from a student's perspective.

The usability evaluation analysis of learners/students was divided into the following sections:

- Questionnaire design;
- Pilot study;
- Sample; and
- Actual evaluation.

4.2 Questionnaire Design

In order to assess the data, statistical methods of testing were applied and therefore questionnaires were designed to support this through the inclusion of common international

criteria and checklists. Students at King Saud University, who all employ e-learning processes in some way, completed the questionnaires. Their answers illustrate their experiences in relation to computer and Internet usage. To support ease of analysis, simple, clear and consistent questions were used on the questionnaire, and it was prepared in both English and Arabic, and distributed in two formats: online and paper.

The questionnaire comprised of two main parts. Part-1 contained the participants' demographic information, and Part-2 contained the usability questions. In the demographic section, the respondents were required to provide their personal details, but none of these related to the users' identity, and all the responses were limited. However, in other sections the respondents were required to answer questions in relation to their experiences using computers and their exposure to web-based and other types of e-learning applications in general. This section contained usability questions, which were divided into three sections. The first section was based on both a user interface and ease of use, and contained 25 questions. The second section contained 20 questions related to features of BlackBoard™, whereas the third section was based on Impact and Usefulness and the respondents were required to answer eight questions. Two different scales were used in the questionnaire. The first was a Likert five point scale, which is also a uni-dimensional scale. The second scale used was a check scale, offering the responses yes, no or not applicable.

Likert uni-dimensional Scales:

In contemporary research, the Likert uni-dimensional scale is one of the most popular means employed to collect and measure data. There are five positions on the scales, which are,

‘strongly agree’, ‘agree’, ‘uncertain’, ‘disagree’ and ‘strongly disagree’. In addition, scores are offered to these positions, from 5 to 1 or 4 to 0.

The above mentioned positions were specified as ranging from 5 to 1 or from 4 - 0. For example, if an interviewer agrees with a question that indicates a positive attitude, then the number for the option strongly agree will be used, and vice versa, i.e., 1 to 5 or 0 to 4. In addition, an ‘uncertain’ score of 3 was used with both scoring methods, and these scores were calculated and added for inclusivity. Any additional items would be expected to indicate the same attitude, and therefore be termed uni-dimensional.

Internal consistency checks were carried out during the pilot stage to investigate their uni-dimensional attitude. Statistical packages for the social sciences (SPSS) were used as an authoritative technique for checking results according to the categories of answers. According to Rodeghier (1996), because the object of the question is consistently measured, this is a more reasonable and reliable option than using a five point scale. Moreover, general linear modelling techniques, such as reversion or regression are suitable when scale points are larger in number. Once all the documentation for administering the questionnaire was prepared, a pilot study was conducted, as discussed in the next section.

4.3 Pilot Study

Before carrying out a large study, and to improve the quality and efficiency of the main study, a small test or experimental study, called a “pilot study” is beneficial to check logistics and gather information. This helped to identify gaps and inconsistencies in the design of the research and methods, prior to conducting the main study. This then gives the researcher the opportunity to improve the tools before expending time and the resources on the main study.

In a study to determine the usability of a library search system, Peng et al (2004) conducted a pilot study with ten users from a set of 100 participants, in order to discover inadequacies in the questionnaire design. Shneiderman and Plaisant (2005) stated that questionnaires must be tested with a small population set before carrying out a survey. This view is supported by Olivier (1999) and Giliham (2000b), who recommend that a pilot study be carried out to avoid problems, such as respondents misunderstanding instructions, or confusing questions.

According to Peat et al. (2002), there are a number of benefits to the researcher from conducting a pilot study. Some of the reasons are as mentioned below:

- The competency of the research instruments can be tested and developed;
- The possibility of success in a full scale survey can be assessed;
- Helps with designing the research protocol;
- The sensibility and workability of the research can be assessed;
- The effectiveness of the sampling frame and technique can be established;
- The likelihood of success of suggested recruitment methods can be assessed;
- Logistical limitations when using proposed approaches can be identified;
- Flexibility of results to determine sample size can be estimated;
- Helps to collect preliminary data;
- Various resources for planned studies such as financing, staff etc. can be determined in relation to the research;
- Proposed data analysis methods can be analysed to expose potential problems;
- Assists in developing research questions and plans;
- Assists in training a researcher in various fundamentals of the research process;
- Assists in exposing the competency and knowledge of the research team in order to convince the funding bodies;

- Assists in showing the feasibility and worthiness of the study in front of funding bodies;
- Helps to convince other supporters and stakeholders that a study is worth supporting;
- Authentication of the questionnaire can be improved;
- Ambiguities and limitations can be identified by asking for the feedback from subjects;
- Time consuming to finish the questionnaires, and the justifications can be recorded and judged;
- Responses and their adequacy to answer each question can be assessed;
- Success in interpretation of the required information can be established;
- Check that every question can be answered;
- Assists in reworking or remodelling unanswered questions; and
- Assists in summarising, revising and piloting again if necessary.

During this research, a pilot study was performed to build up the dimensions and the adapted scales. It was also carried out to ensure internal uniformity and reliability of the questionnaire. 30 students from King Saudi University participated in the pilot study and returned the completed questionnaire on time. In general, data collected from this pilot study represented a satisfactory high alpha reliability coefficient, as all items were above 0.70. Consequently, all items were reserved for the main research. Also, the distribution of the questionnaire to the sample was reasonable. With the help of the researcher's observations during the study, and the feedback obtained from this pilot study, a final questionnaire was compiled and used for the actual evaluation.

4.4 Survey

4.4.1 Sample and Data Collection

The respondents, also known as the participants/subjects, were contacted to complete the questionnaire. The researcher briefly discussed the research goals and instructions with the participants.

Some of the participants also participated in the pilot study. The subjects who participated in the pilot test did not participate in the final test.

Permission from King Saud University to carry out both the pilot study and the main research was sought and approval given. During the course of usability testing, the test participants and the researcher required protection. This involved issuing informed consent documentation to demonstrate the rights of the participants. There were three aspects emphasised in the informed consent:

1. Understanding or comprehension;
2. Information; and
3. Voluntariness.

Understanding or comprehension; the research was fully explained to the participants in detail and discussions undertaken related to the research outcomes. Great emphasis was given to research ethics.

In the information section of the informed consent, the following were demonstrated:

- Freedom of the participants to opt out from the test or a study;

- Disclosure if any risks if the test was undertaken;
- Freedom of the participants to ask questions;
- Purpose of the test;
- Procedures undertaken to carry out the research;
- Voluntariness – there are some rights for participants in relation with the usability testing;
- Activities involving the participants;
- Protection of the privacy of all participants;
- Participants can take a break at any time; and
- Participants can withdraw from the study at any time without penalty.

According to Burmiester (2000), there is a huge difference between confidentiality and privacy. Confidentiality is not the same as privacy. It requires that the storage of a participants' data, such as original names of the participants, should be changed and true identity should not be disclosed at any point during the research. Information should be given to the participants about how the collected data will be used and whether the information will only be used for a particular study or whether it will be used for extended or different studies as well.

4.4.2 Analysis

As discussed earlier, the questionnaire contains two main parts. Part one collects demographic information from the participants. In this section respondents were required to provide personal details without disclosure of their identity. Whereas in other sections they were required to answer questions related to their experiences using computers in general,

and exposure to web-based and other types of e-learning applications. The second part, contained usability questions, and was divided into three sections.

4.4.3 Validity

The experts' evaluation helped the author to amend the original mechanism. This amended mechanism was uploaded to the web and 25 students from the King Saud University participated in evaluating it. For clarity, the learners undertook an evaluation of the instructions for each item on the mechanism. Those learners who participated in the evaluation were allowed to add missing dimensions or items that were applicable to the WBLP. On the basis of the recommendations obtained from the experts and student evaluators, a final mechanism was then developed. A consensus of 90% of all evaluators were used as a reference point for the inclusion of each question.

Construct validity was used to estimate the validity of the research tool. A positive relationship between student satisfaction and the user interface's ease of use and features, was expected to impacted on usefulness and encourage others to use an e-learning platform. As predicted, a significant relationship was found. This provided additional validity parameters.

4.4.4 Reliability

For the questionnaire survey a Cronbach's alpha test was used to ensure the internal consistency (i.e., reliability) of the data. Cronbach's alpha is calculated when there are multiple Likert scale based questions on a survey or questionnaire. Cronbach's alpha is used to verify if the scale is reliable, and is applied across a variety of disciplines, including social sciences, business and nursing, etc.

The value of Cronbach's alpha is between 0 and 1. The higher the Cronbach's alpha coefficient, i.e., the closer to 1, the greater the internal reliability of the given scale. According to George and Mallery (2003), the rule below can be applied:

$$\geq .9 - Excellent \geq 0.8 - Good \geq 0.7 - Acceptable \geq 0.6 - Questionable$$

$$\geq 0.5 - Poor\ and \leq 0.5 - Unacceptable$$

In this research the Cronbach's alpha was calculated to estimate the internal reliability of the test scores. The Cronbach's alpha for the research tool (all dimensions) was 0.964. This is an indication of high internal consistency. Also, other sub-scales were found to have a high internal consistency (user interface and ease of users =0.925, features=0.924, impact and usefulness =0.888). One can conclude that the research tool is highly trustworthy with high validity and reliability coefficients.

4.5 Data Analysis

To analyse the data this section is divided into 4 parts, i.e., sample characteristics, user interface and ease of use. Features, impact and usefulness are further discussed in detail. In this section of the data analysis, some important questions emerging from each of the above sections were evaluated closely.

4.5.1 Characteristics of Samples

As mentioned previously, 600 students using the same BlackBoard™ system (classes were selected randomly) were requested to participate in the study. The questionnaires were distributed to the sample and 548 questionnaires were returned to the researcher. Of the 548 respondents only 25.4% were females who took part in the survey; thus, the number of males

participating was almost three times that of the females. The average age of the participants was 18 years old.

Table 4.1 presents the sample characteristics. More than half the sample group were students from Science Colleges and more than a third of those were from Humanities Colleges. Around half of these had used e-learning tools and more than half had taken courses in e-learning prior to their university enrolment. Around a third of the participants used Microsoft office applications and less than half used a programming language, around half used graphs and more than a third used databases, although almost all of them owned a computer. Almost none had previous knowledge of e-learning platforms.

Table 4.1: Sample Characteristics

Variable		Frequency	%
College	Sciences	360	65.7
	Humanities	188	34.3
	Total	548	100
e-learning tools' usage	Yes	262	47.8
	No	286	52.2
	Total	548	100
Educational level of using e-learning tools	Pre-High school	19	3.5
	High school	159	29
	Pre andat High school	83	15.1
	Total	261	47.6
Taking It courses pre university	Yes	295	53.8
	No	253	46.2
MO applications' Usage	Never	101	18.4
	Sometimes	256	46.7
	Always	191	34.9
	Total	548	100
Using Programming Language	Never	297	54.2
	Sometimes	177	32.3
	Always	74	13.5
	Total	548	100
Using Graph	Never	283	51.6
	Sometimes	190	34.7
	Always	75	13.7
	Total	548	100
Using Databases	Never	330	60.2
	Sometimes	159	29.2
	Always	59	10.8
	Total	548	100
Own Computer	Yes	532	97.1
	No	16	2.9
	Total	548	100

Previous knowledge of e-learning platforms	Yes No Total	30 518 548	5.5 94.5 100
Period of usage	< one year One year Two years > two years Total	8 15 1 2 26	1.5 2.7 0.2 0.4 4.7

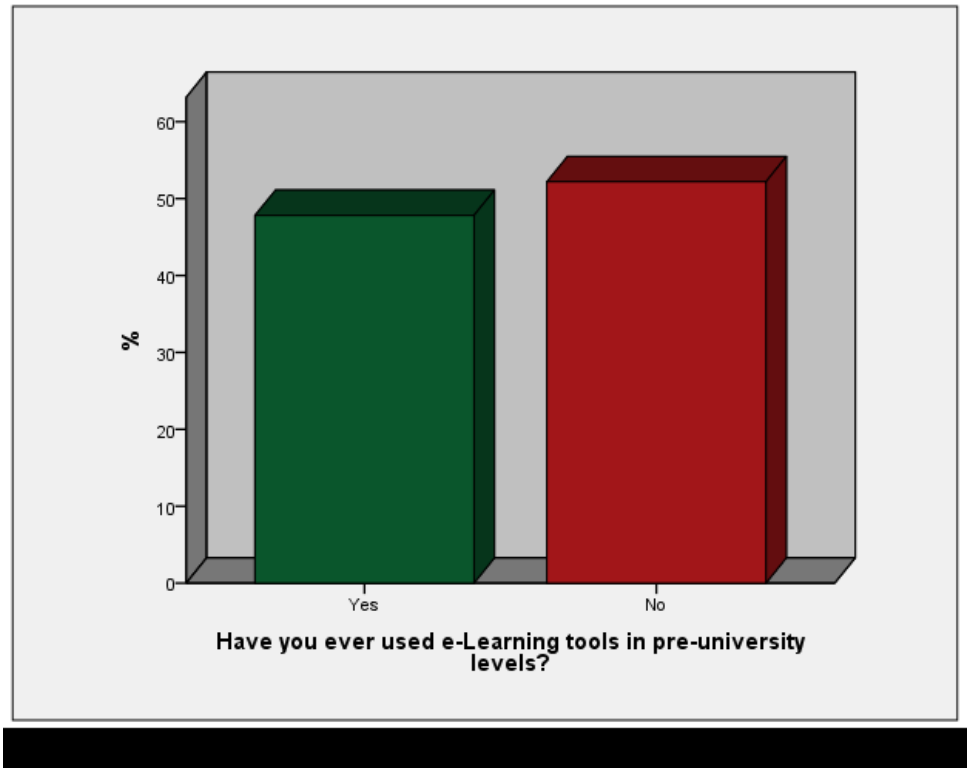

Figure 4.1: Usage of e-learning Tools at Pre-university Levels

The sample was selected from foundation degree students at King Saud University, and of the total numbers of respondents, 92% were aged between 18 and 20 years and only 8% were aged between 21 and 33 years.

The sample characteristics also show the majority of respondents were from engineering and scientific colleges, while only 34.3% respondents were from King Saud University humanities college. The reason for this was that students from the engineering and scientific colleges were more familiar with e-learning programmes and computer usage because of their

course material, which demands more interaction with computer-based application, when compared to those from the humanities college.

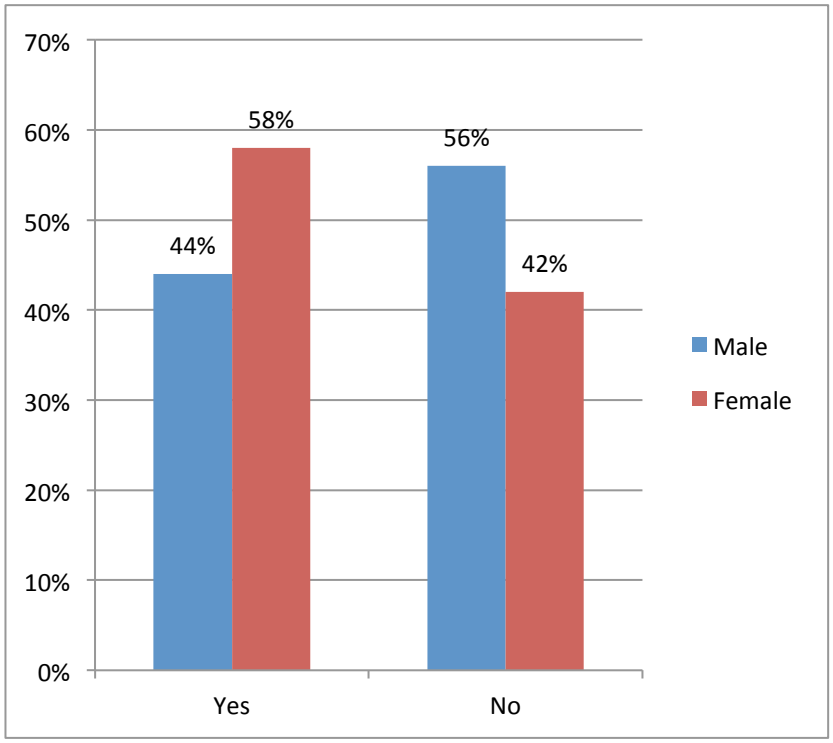

Figure 4.2: Usage of e-Learning Tools in Pre-university Levels by Gender

4.5.2 Interface and Ease of Use

In the section related to User Interface and ease of Use, 25 questions were asked to those students at King Saud University.

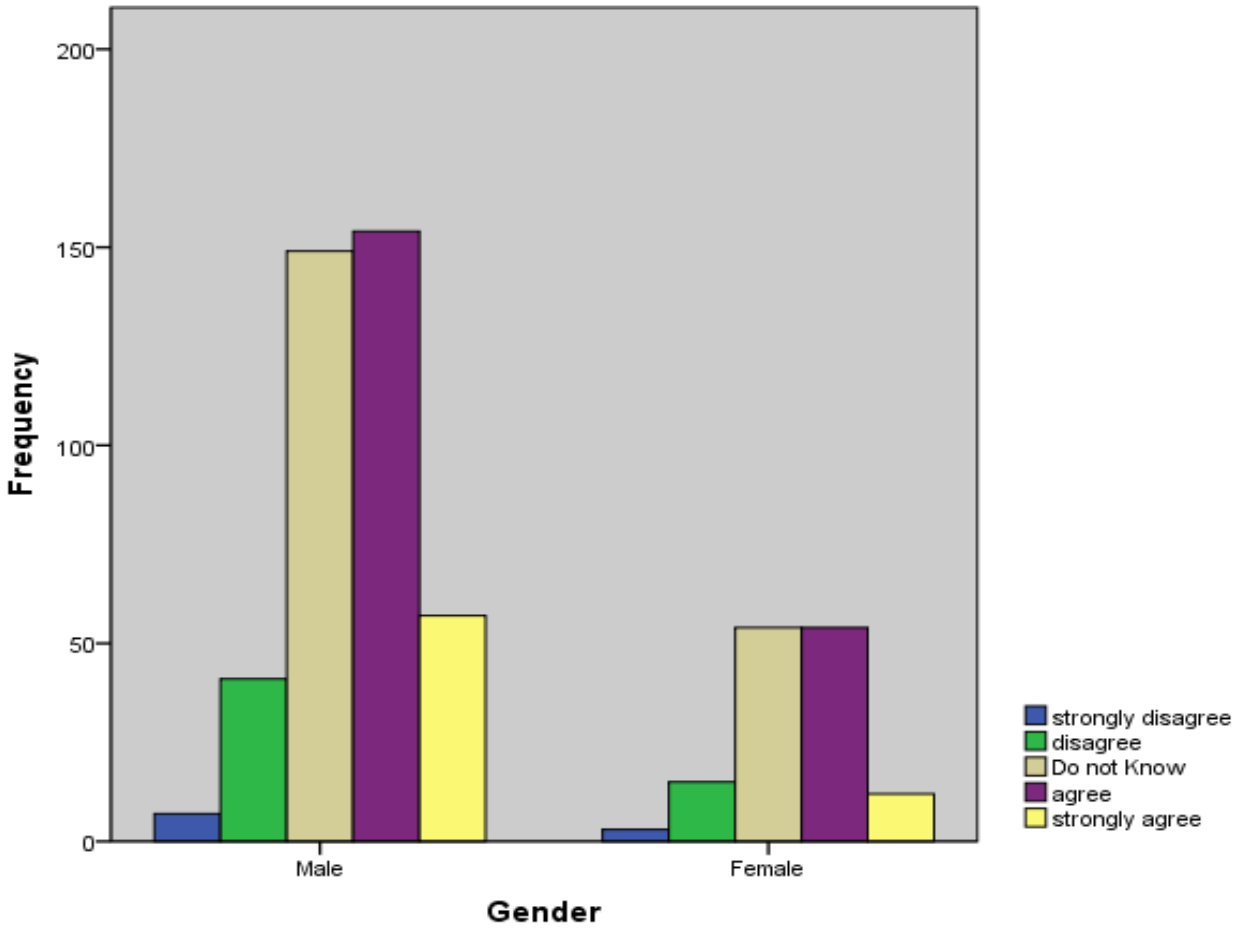

Figure: 4.3 Responses to System by Gender

Table 4.2: System Being Responsive by Gender

Gender		Strongly disagree	Disagree	Do not Know	Agree	Strongly agree	Total
Male	Count	7	41	149	154	57	**408**
	% within Gender	1.7%	10.0%	36.5%	37.7%	14.0%	**100.0%**
	% within system	70.0%	73.2%	73.4%	74.0%	82.6%	**74.7%**
	% of Total	1.3%	7.5%	27.3%	28.2%	10.4%	**74.7%**
Female	Count	3	15	54	54	12	**138**
	% within Gender	2.2%	10.9%	39.1%	39.1%	8.7%	**100.0%**
	% within system	30.0%	26.8%	26.6%	26.0%	17.4%	**25.3%**
	% of Total	.5%	2.7%	9.9%	9.9%	2.2%	**25.3%**
Total	**Count**	**10**	**56**	**203**	**208**	**69**	**546**
	% within Gender	**1.8%**	**10.3%**	**37.2%**	**38.1%**	**12.6%**	**100.0%**
	% within system	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

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	% within Gender	1.7%	10.0%	36.5%	37.7%	14.0%	**100.0%**
	% within system	70.0%	73.2%	73.4%	74.0%	82.6%	**74.7%**
	% of Total	1.3%	7.5%	27.3%	28.2%	10.4%	**74.7%**
Female	Count	3	15	54	54	12	**138**
	% within Gender	2.2%	10.9%	39.1%	39.1%	8.7%	**100.0%**
	% within system	30.0%	26.8%	26.6%	26.0%	17.4%	**25.3%**
	% of Total	.5%	2.7%	9.9%	9.9%	2.2%	**25.3%**
Total	**Count**	**10**	**56**	**203**	**208**	**69**	**546**
	% within Gender	**1.8%**	**10.3%**	**37.2%**	**38.1%**	**12.6%**	**100.0%**
	% within system	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
	% of Total	**1.8%**	**10.3%**	**37.2%**	**38.1%**	**12.6%**	**100.0%**

Responses to all the questions were based on a Likert scale 1-5 i.e., strongly disagree, disagree, do not know, agree and strongly agree. It was observed that more than 50% of respondents agreed (agree and strongly agree) with the statement that the system was responsive, and that the e-learning platform interface was easy to understand. However, Figure 4.2 shows that the percentage of males (52%) agreeing to this was greater than the percentage of females (48%) who agreed.

It was also found that more than 50% of all respondents agreed that the platform reacts as expected, which is consistent with another response, whereby almost the same numbers of respondents were happy with the web based learning because they found the interface simple and uncomplicated; i.e., that it was not cluttered with unnecessary text or graphics.

In contrast, more than 20% of respondents encountered difficulties because the platform did not allow them to remedial actions. It was interesting to learn that more than 15% of respondents disliked the way in which the platform requests a confirmation from users

whenever a critical action is carried out. This is consistent with the number of respondents (almost 15%) who said that the error messages were not friendly or understandable.

Moreover, almost 10% of the total respondents expressed displeasure with the e-learning techniques, because according to them, the icons and the symbols used in the platform did not represent familiar real-life objects and the colours were not appropriate and did not work well together. This percentage (10%) was almost the same as that for respondents whose answers disagreed with the statement that the user interface was consistent and followed a standard structure in terms of colours, fonts, layouts and navigation. They considered the navigational structure to be illogical and disorganised. In addition, according to more than 58% of respondents, the platform settings were flexible and easily customisable by users, although for almost 50% the information on each page was reported as organised properly and not cluttered.

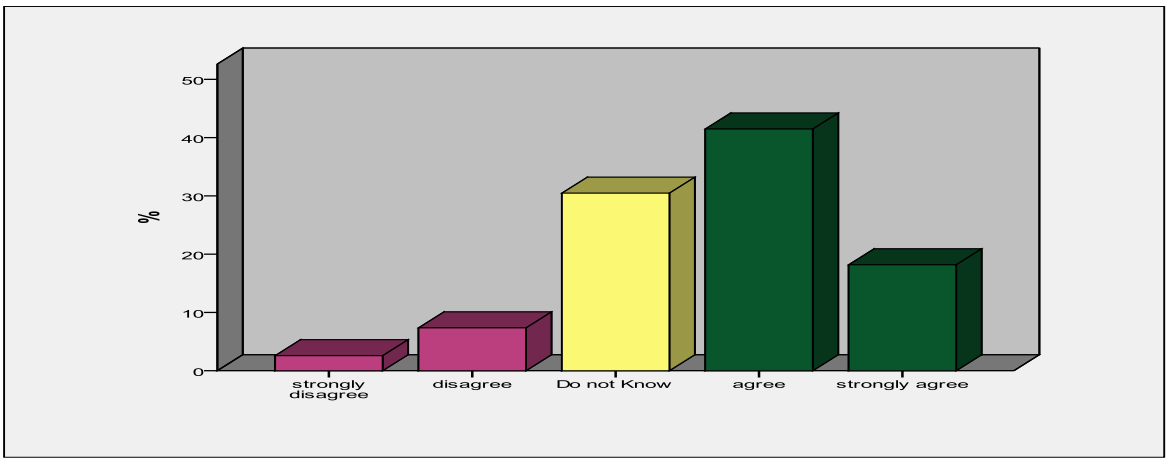

Figure 4.4: Interface of e-Learning Platform Being Easy to Understand

Furthermore, when a cross comparison was made between the data collected from both male and female respondents, the percentage of females (68%) who agreed to the statement that the interface for the e-learning platform was easy to understand was higher than that of males

(56%). From Figure 4.4, it was also observed that more than 50% of both male and females liked the general appearance and feel of the platform.

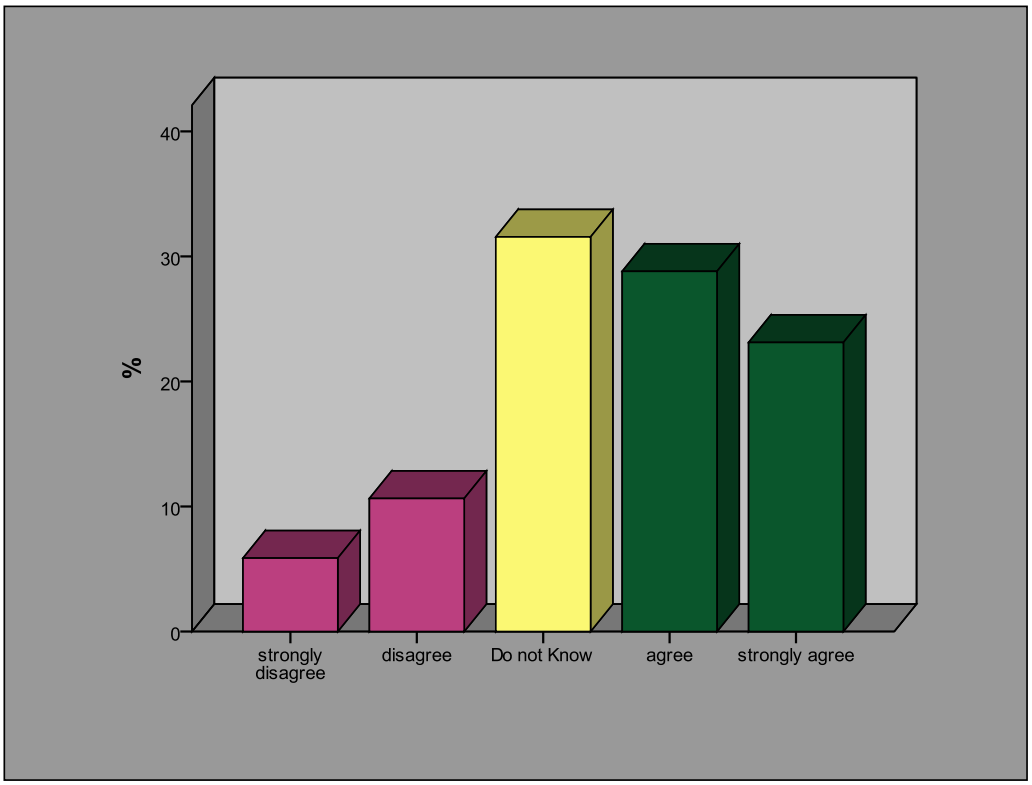

Figure 4.5: Students Liking Overall Appearance and Feel of Platform

4.5.3 Features

While analysing data from the features section of the questionnaire, it was noticed that almost 50% of the respondents agreed with the statement that concept and related knowledge were presented in a meaningful context.

More than 50% of all respondents agreed with the statement that the e-learning platform delivered contextualised tasks rather than abstract tasks. However, of this 50%, 13% strongly agreed with the above statement. This was consistent with the number of respondents who

also believed the learning platform was flexible and supports different styles and learning approaches.

Moreover, almost 15% of the respondents strongly felt that the web based learning content was inclusive and relevant. These participants also reported that the web based learning platform supported their activities, whether they were working independently or in a group. Furthermore, almost the same number of respondents thought that the short test and quizzes were of an appropriate level of difficulty.

In addition, 21% of total respondents were very satisfied with facilities such as forums, chat room facilities, course calendar, reminders, etc. Almost 29% of respondents agreed that collaboration and group work tools were very useful to them. Alongside this, they also found the feedback system for their activities, and the levels of understanding provided by the e-learning platform were also appropriate to them.

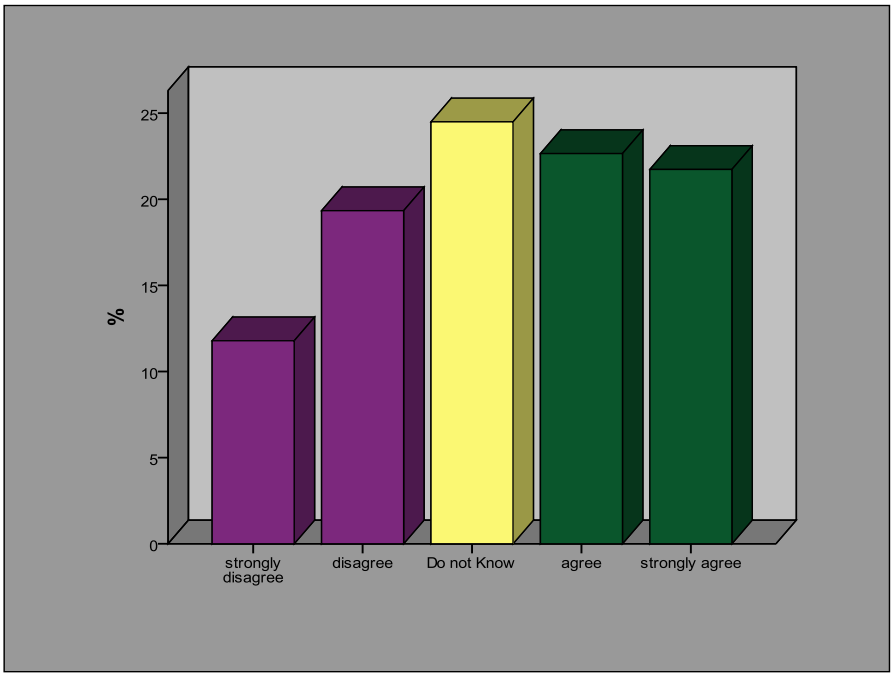

Figure 4.6: Forum and Chat Room Facilities being Useful

Figure 4.6 above shows that 24% of all males strongly believed that the forum and chat room facilities were useful to them, whereas 15% of all females also felt the same.

4.5.4 Impact and Usefulness

In this section, the participants were asked a total of 8 questions. They responded using the Likert scale. More than 50% agreed that the e-learning platform encouraged self-motivation and only a very small percentage (5.48%) strongly disagreed with the above statement. The number of respondents who agreed with the above statement was consistent with the number of respondents who believed it was very useful to obtain teachers' feedback via the e-learning platform. In other words, more than 50% of all respondents agreed that they could get feedback from their teacher readily with the help of the e-learning platform.

In addition, it was also noticeable that approximately 50% of all those students who participated in the study agreed that the e-learning platform allowed them to practice and apply learned skills and knowledge. Finally, of the total respondents, i.e., including both males and females, almost 43% opined that the e-learning platform presented course-related material in a manner that engaged students.

4.5.5 Gender Differences

An independent t-test can be used in circumstances that involve two experimental conditions and which present different subjects within each condition. Two different equations can be used to calculate the t-statistic, depending on whether the samples contain an equal number of people. As with the related t-test we can calculate the t-statistic using a numerical version of the equation. With the dependent t-test we can examine differences between pairs of scores, because they are derived from the same subject and so individual differences between conditions can be eliminated. Hence, the difference in scores should reflect the effect of experimental manipulation. Now, when different subjects are involved in different conditions then pairs of scores will differ, not just because of the experimental manipulation, but also because of other sources of variance (such as individual differences between subjects' motivation and IQ etc.). If we cannot investigate differences between conditions on a per subject basis (by comparing pairs of scores as we did for the dependent t-test) then we must compare them on a per condition basis (i.e., by considering the general outcome of a condition).

The differences between the overall means for the two different samples can be taken into account, rather than considering the differences between pairs of scores. This can effect the differences expected between the means of the two populations, i.e., the real source of the

samples. If the null hypothesis is proved true, then the samples have been drawn from the same population.

In this research, the means of the two samples relating to a given variable were not significantly different. Tables 4.1 and 4.2 reveal that all the p values were lower than 0.05, which means we accept the null hypothesis; i.e., that there is no statistically significant difference between the two groups, i.e., male and female, and that the data collected was reliable as it was not gender biased or age biased respectively.

Table 4.3: Independent Sample t-test by Gender

Dependent Variables	Gender	N	Mean	Std. Deviation	T	df	p-value
User Interface and Ease of Use	Male	409	3.5397	.63860	-1.570	546	.00117
	Female	139	3.6355	.56845			
Features	Male	409	3.4772	.70833	-.346 [a]	279.498[a]	.00730
	Female	139	3.4986	.59798			
Impact and Usefulness	Male	409	3.4299	.83756	.303	546	.00762
	Female	139	3.4055	.75429			

(The *T* and *df* were adjusted because variances were not equal)

4.5.6 ANOVA Analysis

ANOVA has the advantage that it can be used to analyse situations in which there are several independent samples. In these situations, ANOVA tells us the overall difference between the samples in dependent variables. Significant differences can be attributed to the independent variable. The following table shows no significant differences between age groups in the dependent variables.

Table 4.4: Independent Samples t-test by Age

Dependent Variables	Age Groups	N	Mean	Std. Deviation	T	df	p-value
User Interface and Ease of Use	18-20	504	3.5700	.61457	.766	546	.0444
	21-33	44	3.4950	.71077			
Features	18-20	504	3.4880	.68073	.619	546	.00536
	21-33	44	3.4216	.69613			
Impact and Usefulness	18-20	504	3.4331	.81271	.911	546	.0363
	21-33	44	3.3162	.86282			

4.5.7 Supplementary questions

To summarise the overall data for analysis, three supplementary questions were asked to the respondents.

Question 1: How well does the e-learning platform perform as a supplement to class instruction?

In relation to the above question, Figure-6 below shows around 5% of all respondents were dissatisfied with the performance of the e-learning platform as a supplement to classroom instruction. However, 34% of the respondents believed it to be beneficial to use an e-learning platform as a supplement to class instruction.

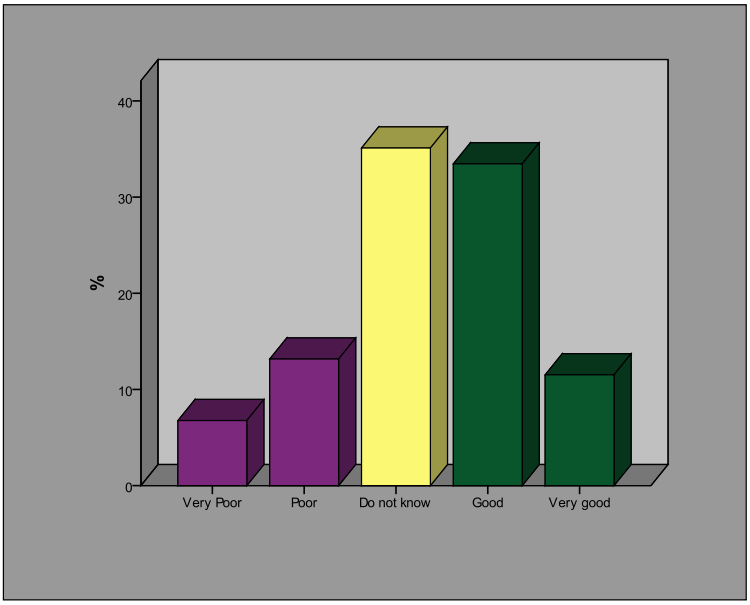

Figure 4.7: How Well e-Learning Platform Performs

Question 2: How satisfied are you with the e-learning platform?

Responses to the above-mentioned question are depicted in Figure 7. According to the Figure, more than 40% of all respondents were satisfied with the e-learning platform. Of these 10% were completely satisfied. It can be assumed that 10% of students fully enjoy each and every faclity and feature of the e-learning platform.

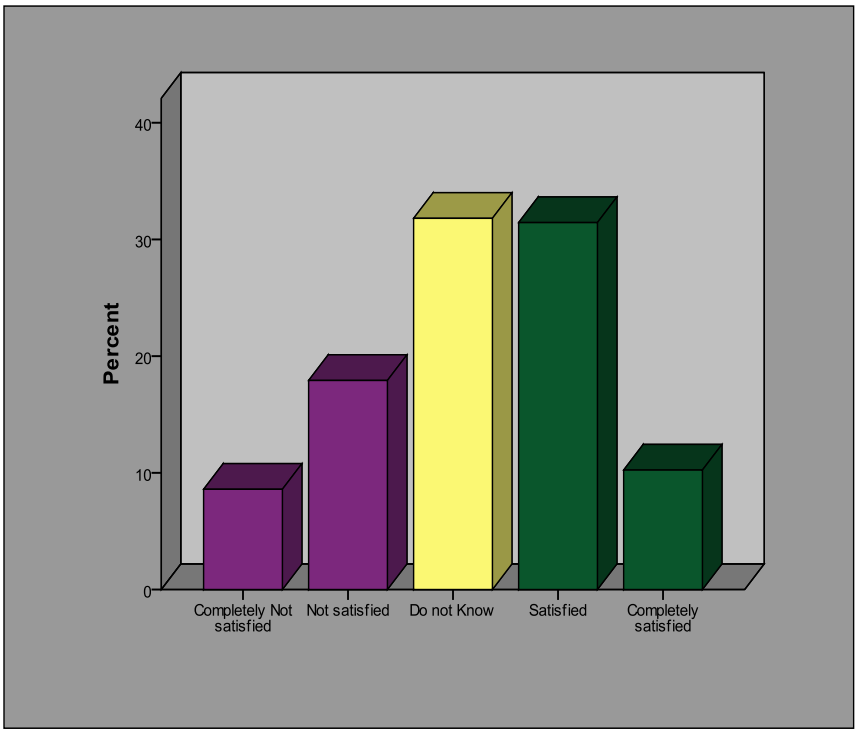

Figure 4.8: How Satisfied with e-Learning Platform

Question 3: Would you encourage others to use e-learning platforms to enhance their learning?

It is evident from Figure 4.8 that almost 80% of all respondents were willing to encourage other students or their peer groups to opt for the e-learning platform as a tool of learning. However, 20% of all respondents continued to encounter problems related to the impact, features or usefulness of e-learning platforms, and so would not encourage others to use them to enhance their learning.

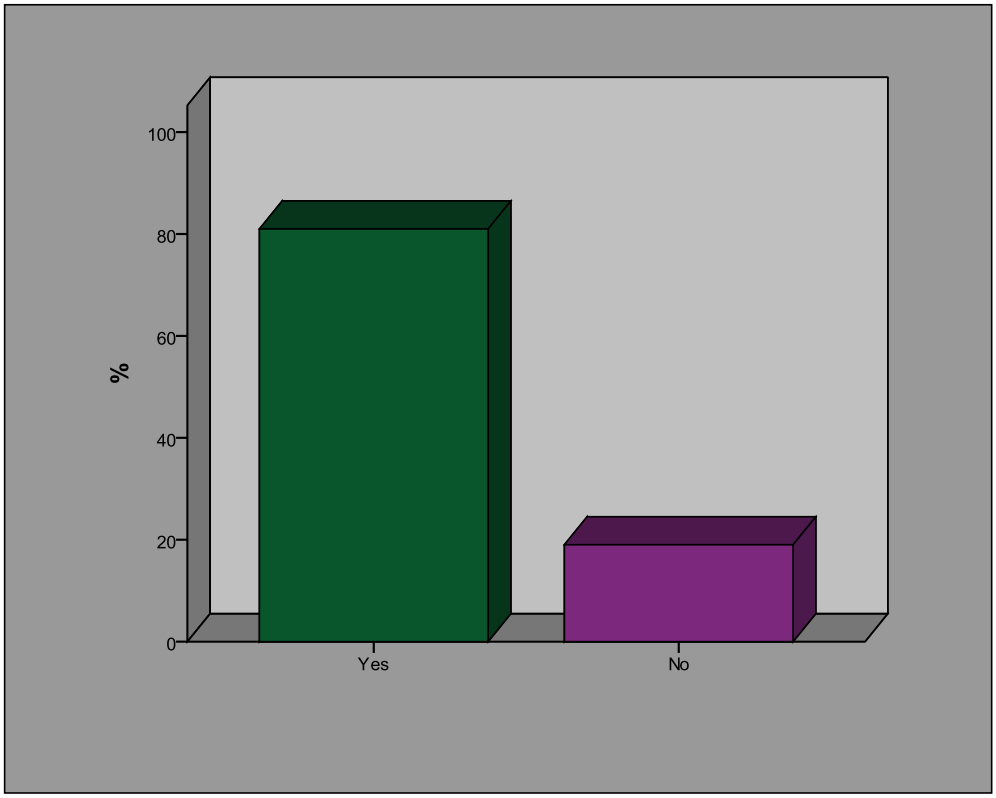

Figure 4.9: Whether to Encourage Others to Use e-Learning Platform

4.5.8 Satisfaction and Encouraging Others, Use, Features and Impact

As can be seen from Table 4.5, all Pearson correlation coefficients are significant. A positive relationship was detected between 'Satisfaction with the e-Learning Platform', 'User Interface' and 'Ease of Use' features, and 'Impact and Usefulness'. A negative significance was found between satisfaction and encouraging others to use e-Learning platforms (1=yes, 2=no). This means that the more satisfaction users report, the more likely they are to encourage others to use e-Learning platforms.

Table 4.5: Correlations between Satisfaction and Encouraging Others

		Satisfaction with the e-Learning Platform	Encouraging others to use e-Learning platforms	User Interface and Ease of Use	Features	Impact and Usefulness
Satisfaction with the e-Learning Platform	Correlation	**1**	-.399**	.521**	.545**	.521**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	547	547	547	547	547
Encouraging others to use e-Learning platforms	Correlation	-.399**	**1**	-.274**	-.263**	-.314**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	547	547	547	547	547
User Interface and Ease of Use	Correlation	.521**	-.274**	**1**	.749**	.620**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	547	547	548	548	548
Features	Correlation	.545**	-.263**	.749**	**1**	.797**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	547	547	548	548	548
Impact and Usefulness	Correlation	.521**	-.314**	.620**	.797**	**1**
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	547	547	548	548	548

4.5.9 Problems Identified by Students

Further analysis of the nature of the problems identified by the learners is summarised in Table 4.6. Table 4.6 lists the statements with the highest average ratings (average ratings of 2.9 and more**)**

Table 4.6: Problems Identified by Learners

	Problem	*No.*
	Category 1: General interface design heuristics	
1	**Visibility of system status**	
	1.1 If a user changed his/her answer to a question the system failed to confirm that the new answer was accepted.	1
	1.2 Time to complete a quiz should be made known to the learner	1
2	**System reflects the real world i.e., user model vis-à-vis design approach**	
	2.1 Symbols are not meaningful.	8
	2.2 Some terminologies are unfamiliar.	5
	2.3 Calendar should be termed Diary.	1
3	**User control and freedom**	
	3.1 Redo and Undo options not available	16
	3.2 Slow response from the system	13
	3.3 No option to quit the portal	12
	3.4 The learner should have the option to revisit and change his answers if the task is completed earlier	7
	3.5 No option within the portal to print material from the portal	2
4	**Adherence to standards and Design Consistency**	
	4.1 Confusing icons/symbols sometimes represent different things.	7
	4.2 Background colour is white on some pages and blue on others.	6
	4.3 In order to be consistent, the format for the self test should be the same as that of the quiz/test.	2
	4.4 All pages should have a title, but the Introduction page does not.	1
	4.5 On the Course Material page, the size and layout of the 'Databases' icon should be consistent with the other icons by not having a different size and shape.	1
5	**Prevention of errors**	
	5.1 In order to prevent errors the system failed to allow prompts or messages.	3
	5.2 When doing a quiz/test, the system should inform the user immediately he/she tries to move away from a question, that the answer selected is not saved. Instead, the user is informed at the end of the quiz/test.	3
	5.3 Whatever is entered into the system is accepted. There are no ways to avoid erroneous/meaningless entries.	2
6	**Emphasis on recall instead of recognise**	
	6.1 Instructions on how to perform tasks should be visible, for example, they should be bold and/or in large font sizes. Examples: 1. On the View Results page for multiple choice questions for quizzes/tests, the row in which the correct answer is located should be bold so as to be easily recognisable. 2. Some links, default links, such as Resume Course, are difficult to recognise as they are labelled in small fonts.	3
	6.2 There is no obvious relationship between controls and their actions.	1

7	**Flexibility and efficiency of use**	
	7.1 It is not easy to navigate the system using only the keyboard.	7
	7.2 The system cannot be customised.	5
	7.3 There are no shortcuts provided.	4
	7.4 The system is not flexible "you do exactly what is required and leave it that way".	3
	7.5 The system does not cater for novice users.	2
	7.6 It is not easy to use the Help System. For example, the structure of the Help System is confusing.	1
8	**Authenticity and minimalism in design**	
	8.1 Notices on the Notice Board should show the dates when items were posted.	10
	8.2 When starting a quiz /test, there is too much information in one window.	2
	8.3 The use of a three-window design for the Table of Contents makes it difficult to read the contents.	1
	8.4 Instead of saving each answer one-by-one, there should be one Save Answers button for the entire quiz/test, to minimise time loss.	1
9	**Diagnosis, Error Recognition and Recovery**	
	9.1 Confusing and misleading error messages	7
	9.2 When there is a typo/typing error, the system does not allow correction of the mistake only, rather it requires the whole command to be retyped	3
	9.3 When the wrong password is entered for a quiz/test, the error message should be in a text box instead of appearing on the screen where it is entered.	1
10	**Help and documentation**	
	10.1 It is not easy to search for information on the site.	3
	10.2 The Help System is not appropriate for the user, since it refers to issues more relevant to the designer than to the learner.	2
	10.3 There is no FAQ section.	1
	10.4 There is no section relating to how to use the site.	1
	Category 2: WBLP specific design heuristics	***f***
11	**Content Organisation, site navigation and structure**	
	11.1 Apart from the buttons provided by the browser, there should be a Back/Previous and Forward/Next button within the application.	19
	11.2 There should be colour differences between the visited, non-visited and current site links. For example, the colours of links should be consistent with web conventions, i.e., non-visited links blue and visited ones green or purple, and the Course Menu should show where the user is.	3
	11.3 On the Home page, options should be arranged in a more natural order.	2
	11.4 There should be links to sections inside the same page/document to minimise scrolling.	1
	11.5 The link to the library under Useful Links should link to the relevant materials in the library, but not to the library's search section.	1
	Category 3: Instructional design heuristics; Learner Focused	

13	**Learning objectives and Outcome is clear to the learner**	
	13.1 Calendar information is not sufficient.	6
	13.2 Course goals are not clear.	3
	13.3 Links on the main page should be accompanied by brief explanations of what is found in the sections to which they are linked.	2
14	**Collaborative learning**	
	14.1 Although facilities exist for learner-learner and learner-teacher interactions, there are no procedures in place to encourage their use.	3
	14.2 There are no facilities to support synchronous communication such as video conferencing.	1
18	**Feedback, guidance and assessment**	
	18.1 The guidance provided via the system about the learners' activities is limited. For example, diagrams and pictures should be used to illustrate learning concepts.	4
	18.2 Glossary is not sufficient. More terms/phrases need to be defined.	3
	18.3 Class lecture slides/notes, and quiz/test and assignment solutions should be available on the site.	3
	18.4 In Question 1 of the quiz/test done during the evaluation, the word 'metadata' is shown as the correct answer but 'Metadata' is marked wrong. However, learners were not informed that the system is case sensitive.	2
	18.5 The feedback provided via the system about the learners' activities (such as tests and assignments) is limited.	2
	18.6 There should be links to previous years' learning material.	1
20	**Motivation, creativity and active learning**	
	20.1 The activities to attract learners to the site are inadequate.	3
	20.2 More content is required to encourage learners to compare, analyse or classify information to promote active learning and intuition	2

The high ratings indicate that, in general, learners disagreed with the statements, thus indicating problem areas. Of the eight statements, two (Statements 1 and 8 in Table 4.4) indicated problems with the level of user control over the system, due to the lack of navigation buttons, such as an Exit button. Statements 2, 5, 6 and 7 (in Table 4.4) demonstrate that when learners made errors, they found it difficult to recover, especially since the Arabic version of BlackBoard™ does not have a convenient Help System. Statements 3 and 4 indicated that it was difficult for users to customise Info3Net, or to manipulate it using a variety of interactive devices.

Table 4.7: Statements from Questionnaire with Highest Ratings

	Statement	**Rating**
1	In case of an error I can close the site, using the Exit option.	3.1
2	Easily searchable help is available	3.1
3	The portal is suitable for all users with differing levels of expertise.	3.0
4	The system is easy to personalise and customise.	3.0
5	Help features like FAQ's, Glossary of terms and online help are useful.	3.0
6	Error messages lead to a possible remedy.	2.9
7	The error correction mechanism is easy to follow	2.9
8	Action can easily be reversed using Redo/Undo options.	2.9

Confirmation of the lack of such features derived from the learner's identification of the following problems:

- The system cannot be customised;
- The system is not flexible: "you do exactly what is required and leave it in that way";
- The error messages given are not helpful, as they do not provide any instructions explaining how to fix errors.
- The guidance provided via the system about the learner's activities is limited. For example, diagrams and pictures should be used to illustrate learning concepts.
- There are inadequate activities to attract learners to the site.

These are problem areas that should be addressed in any future upgrade of BlackBoard™ for Arabic users.

It is noticeable that the main aim of the learner's questionnaire was not to assess BlackBoard™ conformance levels to each of the heuristics, but rather that it stressed identification of problems.

The statements given for each criterion/heuristic were merely there to help learners grasp the meaning of a particular criterion, and not to define the criterion exhaustively. Consequently, the average ratings for each statement within a given criterion cannot be used as a precise measurement of that particular criterion, but do serve as pointers to specific problem areas in the application.

4.6 Summary

The literature review chapters provided an overview of the theoretical concepts that were incorporated into the evaluation criteria applied and explained in this chapter. Some of these criteria have roots in tenets of constructivist learning. Others emphasise the value of interactivity, flexibility, and feedback. The Arabic version BlackBoard™, on the other hand, having been developed in the mainstream BlackBoard™ environment does not readily support all these features, as shown by the problems identified herein.

The next chapter combines the problems identified by learners with those identified by experts to produce a final consolidated list. Further analysis of problems that relate to each criterion, the number of problems in each category (General, Web and Educational), and a discussion of the severity of each problem, is also undertaken.

Chapter 5: Usability of WBL Platform through Analysis of Heuristic Technique

5.1 Introduction

BlackBoard™ is a software manufacturing company that designs software for various uses such as education, training and business. Its main business objective is to deliver distance-learning tools. The company's stated mission is "to facilitate educational modernisation everywhere by linking people and technology." Blackboard first went into business into 1997 and its first online learning application came onto the market in 1998. In 2006, the company merged with WebCT, previously its main competitor. This merger ultimately made BlackBoard™ the largest online applications and solutions provider to educational institutions throughout the United States (Blackboard.com, 2007).

An ever-increasing number of features used by the company can act as substitutes for the traditional classroom. Moreover, these features are effective enough to create a classroom environment in which students and teachers only meet virtually. BlackBoard™ provides solutions for instructors, which range from posting course documents such as course calendars, announcements relevant to the course, course documents, assignments, and PowerPoint presentations to a grade book feature that enables instructors to keep a log of grades and make them available for students to access.

For instructors, BlackBoard™ helps them to administer assessments. To identify students, a visual roster is used that shows pictures of students taken from student identification cards. The email feature informs students about current events and provides various updates regarding the course. The instructor can also use the email feature to provide updates and information to the whole class as well as to selected individuals. Furthermore, one feature allows threads to be set up to discuss various topics relating to the course or to facilitate general discussions among students and instructors. A form of group effort facilitates live discussion.

In 2000, the Wichita State University campus introduced BlackBoard™ for the first time. It was given preference over a number of competing products, such as WebCT™ and Web Course in a Box. Initially, BlackBoard™ was only used by system administrators to operate course outlines based the preferences of the instructors. Due to unfamiliarity with the software, different levels of training were provided to instructors. In 2003, a major upgrade to BlackBoard™ and a new server were purchased by the university. In 2006, a further update was installed and BlackBoard™ was made available to every instructor as well as to each class and section. The vast software-related expansion led to training for all instructors becoming mandatory, which immensely increased the administrative costs for the university. However, due to the enormous number of courses and the cost involved in training, offering training to all faculty members became a less viable option and training eventually became optional. In 2006, another upgrade of BlackBoard™ was released, along with a new system called ‘Banner’. In addition to the automatic upgrade, updates in relation to class timetables and rosters were initiated in the system server.

5.2 Heuristic Evaluation by Experts

The heuristic evaluation methodology is described in Chapter 3. This research is based on the following approach presented by Nielsen (1994):

- Identifying and defining the heuristics to be used;
- Selection of evaluators;
- Briefing the evaluators;
- Data collection; and
- Heuristic evaluation of results.

In this research, the heuristic evaluation was conducted with a functioning application to enable the results of the evaluation of the system to be compared at two different stages. These stages and the accompanying results and analysis are each explained in the coming sections.

5.2.1 Identification of Heuristics

The heuristic evaluation criteria or checklist for e-learning, as described in Chapter 3, was employed for this evaluation. However, some elements such as 'Support for important approaches to learning' are excluded, as this would require either the involvement of individual learners or assessment of the subject content. Fifteen heuristics were used for the evaluation.

5.2.2 Selection of Evaluators

Expert evaluators were selected on the basis of their academic background and experience. In Chapter 3, it was explained that Nielsen recommended that three to five evaluators are

required to conduct such an evaluation. As the number of evaluators increases, so too does the proportion of problems. However, the actual figure depends on cost-benefit analysis, which is highest when three or four evaluators are employed. Regardless of this, the optimal number of evaluators is still an important topic of discussion. A similar study by Avouris et al (2003) that aimed to verify the usability of a web portal for university staff and students used 11 experts. However, Karoulis and Pombortsis (2003) maintain that two to three evaluators who are specialists in Human Computer Interaction (HCI) (referred to as double experts) and in the domain area can draw attention to a similar number of usability problems as can three to five 'single evaluators'.

Following the findings of Karoulis and Pombortsis (2003), four professionals from King Saud University were selected to perform the heuristic analysis. Experts in teaching, educational design and user interface design were invited to be evaluators.

Table 5.1 presents the profile of the four experts who took part in this evaluation exercise. All four were full-time faculty members at KSU. They all had some experience of HCI, with a strong background in Computer Science and/or Information Systems, and had sufficient knowledge of the system.

Table 5.1: Expert Evaluators

1	An assistant university professor in the Department of Business Education (Faculty of Business Management) who teaches Information and Communication Technology (ICT).
2	A lecturer in the Department of Information Systems (IS) who teaches software engineering modules.
3	An associate professor in the Department of Computer Science with a certificate in education.

4	A senior lecturer in the Information Technology department with a BSc in IT education.

5.2.3 Briefing Evaluators

The above-mentioned evaluators were informed of the aims and objectives of this research and particularly their role in this evaluation exercise. In particular, they were briefed about:

1. The heuristic evaluation method used in the research;
2. The domain of use of the system being evaluated; and
3. Work scenario whilst using the system (Levi and Conrad, 1996; Nielsen, 1994).

A set of documents relating to the features described above was compiled and given to each evaluator (see Appendix B):

- Phases - This specified general instructions relating to the whole assessment procedure, including the severity rating phase. It explained the stages involved in the process, the documents required and the estimated time needed to carry out the evaluation.
- System and user profile: Information related to the system and the learners involved was presented in this section. Moreover, information relating to the layout of the system used by the learner was included. It was important that evaluators knew the learners' level of capability of using the system.
- Procedure: This explained the system to follow in order to conduct the HE. It contained the website login details, the scenarios to fulfil and the methods used to perform actual assessments and to obtain the report on usability problems.

In addition to this, all evaluators received a consent form (see Appendix B). It was important that all the evaluators read all the documents before performing the actual evaluation and familiarised themselves with the heuristic used in the study:

- 2 – The problem exists
- 1 – The problem does not exist
- N - I don't see this as a problem (Not applicable)

The letter 'N' is entered as an alternative to allocating a non-problem a weight of zero. A similar scale was used by Albion (1999) in an HE of educational multimedia. In Albion's scale, 1 stands for poor and 5 stands for excellent, with an additional rating of NA for 'Not Applicable'. A list of problems recognised by all the evaluators and learners was merged to make a single set of all the problems. The problems were classified according to the standard they violated. On the basis of the number of experts who identified it, a descending order of problems for each standard was made. Appendix D shows the severity rating form.

Table 5.2: Five-point Evaluation to Mark Severity of Usability Problems ***(Pierotti, 1996)***

Type of Problem	Score
Cosmetic problem: The use of the system will not be affected. If possible, fix it.	1
Minor problem: The user can simply resolve the problem. A low priority can be given to fixing the problem.	2
Medium problem: This problem will occur but users will adjust to it. Fixing this problem should be accorded medium priority.	3
Major problem: A difficult problem for the users but they may be able to sort it out. It is vital to fix the problem. Fixing it should be accorded high priority.	4
Catastrophic problem: users cannot continue working because of this problem. Fixing the problem is compulsory.	5
Not Applicable (N/A): this does not seem to be a problem to me.	N

The completed forms were returned by all expert evaluators within three days of receipt. An

average of 10 minutes was taken to complete the exercise. The results of the severity rating exercise are presented in Appendix C. As an expression of gratitude, the expert evaluators were given a gift token gift for their participation in the evaluation exercise. However, no payment was made for this exercise.

5.2.4 Data Collection

Although a checklist and screen dumps were given to every evaluator, only specific methods for data notation were allowed. All the evaluators made use of the checklist and the screen dumps. In the post-evaluation interview, all the evaluators felt confident that they had recorded most heuristic problems. The heuristic results are discussed in detail in the next section.

5.2.5 Heuristic Evaluation Results

5.2.5.1 Problems Identified by Individual Evaluators

As described in the previous section, four experts participated in the heuristic evaluation of the e-learning application for this study. In the beginning, these experts identified 77 unique problems (listed in Appendix B). However, as previously discussed, closely related learning problems were consolidated and combined in the same manner. This resulted in a total of 58 problems being suggested by the experts. This list is shown in Table 5.3. The *Evaluator(s)* column indicates which expert evaluator/s identified the problems and *f* (for frequency) indicates the number of experts who recognised them. For example, Problem 2.1, that some labels/names are not meaningful, was identified by Evaluators 3 and 4, giving a frequency of 2. Table 5.4 indicates the problems which each evaluator identified for each heuristic.

Table 5.3: Final Set of 58 Problems Identified by Expert Evaluators

	Problem		
	Category 1: General interface design heuristics	*Evaluator(s)*	***f***
1	**Visibility of system status**		
	1.1 When doing a quiz/test, if an answer has already been saved and the user changes his/her mind, selects another answer and clicks the Save Answer button, feedback should be given by the system to confirm that the later answer is the one accepted.	3	1
	1.2 When submitting a quiz/test, the following message is given in a dialogue box: "All questions have been answered and all answers have been saved. Do you want to proceed?" It is accompanied by an OK and a Cancel button. In this case, the cancel option is confusing, since it is not clear whether it refers to the cancellation of this step or of the whole quiz/test.	3	1
	1.3 When starting a quiz/test, the only button on this page is 'Begin Quiz'. It is surprising that, when the Enter key is used, the system displays the same page, still with the 'Begin Quiz' button, with the exception of the textbox and the instructions for entering the password.	2	1
	1.4 In rare circumstances, when some of the links on the Course Menu (site index) are clicked, the message "BlackBoard™ has not been configured to run with framesets" appears and the Course Menu disappears. This is a surprise action.	4	1
2	**System represents the real world**		
	2.1 Some labels/names should be changed if they are to be meaningful. For example, when notes are taken for the first time, the button for saving them should not be labelled 'Update', and the Calendar object should be called a Diary.	3,4	2
	2.2 Symbols such as the icons used on the Home Page are not meaningful.	3	1
	2.3 Some terminologies are unfamiliar. For example, under Discussions, the status of a topic could be 'Public, Unlocked'. Learners (users) do not understand this. Similarly, the phrases 'Content module' and 'Content page' used by the Help System are unfamiliar to users.	3	1
	2.4 The options, such as 'Content module table of contents', given in the dropdown list on the Search page should match those on the Course Menu options.	3	1
	2.5 On the Communicate page, the options should be arranged in alphabetical order, namely Discussion, Mail and Notice Board, instead of Discussion, Notice Board and Mail, as is currently the case.	2	1
	2.6 The visual layout of the Course Menu should be more intuitive in that items at the same site level should have the same alignment. For example, those on the Home Page (Level 1) should have the same alignment.	2	1
3	**User control and freedom**		

	3.1 A printable version of the course material is not available	1,2,3	3
	3.2 Undo and redo is not possible	2,3	2
	3.3 The system is sometimes slow to respond	4	1
	3.4 There is no system exit button	4	1
4	**Consistency and adherence to standards**		
	4.1 In order to be consistent, the format for the self-test should be the same as that of the quiz/test. For example, a mark/grade should be allocated as is done with a quiz/test.	2,3,4	3
	4.2 The same symbols or icons can represent different things. For example, on the Home Page the icon for Student Resources is the same as that for Assessment.	4	1
	4.3 There should be consistency in the spacing and size of items. For example, some of the spaces between the Leaner Guide sections are single and others double.	3	1
5	**Preventing Errors**		
	5.1 The system does not give error messages to prevent errors from occurring.	3	1
	5.2 In some cases, there is no way of avoiding avoid erroneous/meaningless entries. For example, in Discussions, whatever is entered as a title or message is accepted.	3	1
6	**Recognition rather than recall**		
	6.1 It is sometimes difficult to recognise the relationship between different sections, between actions and their results or between controls and their actions. For example, in the Take Notes section, when the View All option is selected, it is difficult to know which notes relate to which section, and it is not easy to recognise that by clicking on the arrow next to the 'Course Menu' label the Course Menu window disappears or reappears.	1,2, 3,4	4
	6.2 Instructions on how to perform tasks should be visible; for example, they should be bold and/or in large font sizes.	2,3	2
	6.3 When starting a quiz/test, after entering the password, there should be an Enter button next to the textbox for the password, instead of the Begin Quiz button which is several line spaces down from the textbox.	2	1
	6.4 When there is a space in a fill-in-the-answer question in a quiz/test, it is not clear whether to insert the answer in that space or in the text box after the question.	3	1
	6.5 On the View Results page for quizzes/tests, 'Attempt: 1/1' is confusing since the '1/1' could be mistaken for a score.	3	1
7	**Efficiency of use and Flexibility**		
	7.1 System customisation is not possible	1,3,4	3
	7.2 No shortcuts are provided.	3,4	2
	7.3 It is not easy to perform tasks using some of the facilities such as the Calendar, Discussions and Help System.	3,4	2
	7.4 The system is not flexible in its use.	4	1
	7.5 The system does not cater to different levels of users.	4	1
	7.6 When entering date/time values, in order to speed up data entry, the default values should be '00' instead of '--'. For	2	1

	example, if the user needs to enter the time as 13h00 in the Calendar, he/she should not be forced to select the '00' to replace the '--'.		
8	**Authenticity and minimalism in design**		
	8.1 Notices on the Notice Board should show the date they were posted.	3	1
	8.2 When starting a quiz/test, there should be one window with instructions on how to do the test followed by another window for entering the password. This would be preferable to clustering all the information on one window.	2	1
	8.3 The use of a three-window design for the Table of Contents makes it difficult to read the content.	1	1
9	**Error Diagnosis, Recognition and Recovery**		
	9.1 The error messages given are not helpful, as they do not provide any instructions to fix errors.	3,4	2
10	**Help and documentation**		
	10.1 It is not easy to search for information on the site.	2	1
	10.2 The Help System is not appropriate for the user, since it refers to issues more relevant to the course designer (or educator) than to the learner.	3	1
	10.3 No obvious help is given to show how to reduce the three-window design to a two- or one-window design.	1	1
	Category 2: Heuristics specific to educational website design	**Eval.**	***f***
11	**Simple Navigation and Structure**		
	11.1 Site content is not arranged hierarchically, from general to specific.	2,3	2
	11.2 There should be links to sections inside the same page/document to minimise scrolling.	3,4	2
	11.3 The Back button should refer to the page that the user was on before the current one; for example, in the Help System the Back button should not refer to the previous section of the of the Help System but rather to the page visited before the current one.	3,4	2
	11.4 In order to improve readability, the Course Menu should be wider, and the spaces between its different sections should be larger than the spaces between items of the same sections.	2	1
	11.5 There should be lines between the different windows in the two- or three window design.	2	1
	11.6 On the Course Menu, the Communicate option should be positioned last, to allow it space to grow its submenu as more information is subsequently added, such as new notices.	2	1
	11.7 The Breadcrumbs of the site come out clearly when the links within the page are used for navigation, but not when the Course Menu links are used.	2	1
	Category 3: Instructional design heuristics (Learner Focus)	**Eval**	***f***
13	**Learning objectives and outcome are clear to the learner**		
	13.1 Calendar information is not sufficient to assist the learner in determining what is to be done when.	3	1
	13.2 Course goals are not clear.	3	1

	13.3 Each link on the Home Page needs a brief description/indication underneath it of the information to be found by selecting it.	4	1
	13.4 The main course goals/objectives should be visible or immediately accessible from the Home Page.	4	1
14	**Collaborative learning**		
	14.1 Although facilities exist for learner-learner and learner-teacher interactions, there are no procedures in place to encourage their use.	3,4	2
18	**Feedback, guidance and assessment**		
	18.1 There is limited guidance to the learners as they perform tasks.	1,3,4	3
	18.2 The feedback provided via the system about learners' activities is limited and not obvious to the learners.	2,3,4	3
	18.3 Glossary is inadequate. More terms/phrases need to be defined.	2	1
	18.4 In Question 1 of the quiz/test, the word 'metadata' is shown as the correct answer, but 'meta data' and 'Metadata' are both marked wrong. However, learners were not informed that exact spelling is necessary or that the system is case-sensitive.	1	1
	18.5 The way in which content is provided to learners is sometimes misleading. For example, when the question "what are keys?" is asked, the question is not answered, but instead examples are given of the different keys.	1	1
	18.6 In order to guide learners, database-specific jargon should be hyper-linked to the Glossary or to a section where terms are explained later in the text. For example, in the sentence "The relational databases are based on *Entities*, *Attributes*, *Relationship*…", the italicised words should be hyper-linked to their meanings or definitions.	1	1
20	**Motivation, creativity and active learning**		
	20.1 There is no site content that encourages learners to compare, analyse or classify information so as to promote active learning or intuition.	2,4	2
	20.2 There are inadequate activities on the site to attract or engage learners.	3	1

Table 5.4 (a): No. of Problems Identified by Each Expert

Heuristic No.	1	2	3	4	Total Problems	Single expert
1	1	1	2	2	5	3
2	0	1	2	3	7	5
3	1	1	2	3	4	3
4	0	1	2	2	4	4
5	0	3	2	1	3	3
6	1	2	3	1	5	3
7	1	1	3	4	4	3
8	1	1	1	0	3	3
9	0	0	1	1	2	0
10	1	1	4	0	3	3
11	0	4	4	2	7	4
13	1	0	2	2	4	4
14	0	0	1	1	1	0
18	3	0	2	2	6	4
20	1	1	1	1	2	1
Total	**11**	**17**	**32**	**25**	**61**	**43**

Table 5.4 (b): No of Problems as Categories

Category	Heuristics	Evaluators				Total	%age
		1	**2**	**3**	**4**		
General Heuristic	1-10	6	10	22	17	55	66%
Website design Heuristics	11	0	4	4	2	10	12%
Learning and teaching heuristics	13, 14, 18, 20	5	3	6	6	18	22%
Total		10	16	32	25		

Table 5.3 and Table 5.4 show that more problems emerged from heuristics 2, 3, 6, 7, 11 and 18. These particular heuristics and the associated problems identified in BlackBoard™ are

briefly discussed below:

- For Heuristic 18, two of the problems were each identified by three experts. All four experts identified a problem in relation to Heuristic 18. This indicates that the system lacks feedback and guidance for learners.
- Similarly, all the experts identified a problem relating to Heuristic 6. These problems mainly arose as some labels or instructions were confusing or unclear.
- The fact that many problems were found with regard to Heuristics 3 and 11 indicated navigational and user control difficulties within the application.
- Four of the six problems in Heuristic 2 (2.1 to 2.4) were identified by the same evaluator (Evaluator 3), showing that this evaluator found labels or icons to not be meaningful. The other two problems in relation to Heuristic 2 (2.5 and 2.6) were identified by Evaluator 2 and are connected with the visual layout of the website.
- For Heuristic 7, the main problem, identified by three evaluators, was that the system could not be customised.
- Problem 6.1, all four expert evaluators identified confusing labels or instructions. This showed a lack of correspondence between actions and their results or between controls and their operations, namely problems relating to visibility. These problems occurred mainly because certain labels or instructions were confusing or unclear.

In Chapter 3, the heuristics in the expert evaluation were generated from theoretical foundations that, among others, advocate interactivity, visibility, feedback, customisation and flexibility in learning environments. These evaluation criteria have proved effective in identifying deficiencies in BlackBoard^{TM} by highlighting similar areas of concern to those raised in the learner-evaluation. These should be addressed in its future upgrades, as far as is

possible within the constraints of BlackBoard™.

Table 5.4 indicates that each evaluator identified several problems relating to one or two heuristics. For example, Evaluator 1 found more problems in Heuristic 18 (three out of 11). On the other hand, Evaluator 2 found more problems in Heuristic 11 (four out of 17), and Evaluator 4 found four out of 25 problems in heuristic 7. This difference in outcome shows that that evaluator had the tendency to focus on problems related to a particular evaluation criterion. However, Evaluator 3, whose findings are more evenly and widely spread across the heuristics, picked out the highest number of problems.

In Table 5.4, the last column holds the number of problems which were recognised by only one evaluator. The total for this column constitutes 70% of all the problems identified in this exercise, meaning that almost one third the problems (30%) were picked by more than one evaluator. This suggests that the level of agreement among the evaluators on the problems that exist was low. Table 5.4 also shows that this is mainly due to the fact that different experts tended to concentrate on different heuristics while performing their evaluations. Table 5.5 shows, for each evaluator, the heuristic for which they identified the highest number of problems. This information is extracted from Table 5.4.

Table 5.5: Heuristics with Highest Number of Problems

Evaluator	**Heuristics with highest number of problems**
1	No. 18
2	No. 5 and No. 11
3	No. 2 and No. 6
4	No. 3 and No. 7

Table 5.5 shows, for example, that the highest numbers of problems identified by Evaluator 2 were with respect to Heuristics 5 and 11 respectively. The data in Table 5.5 show that, with the exception of one heuristic (Heuristic 6) common to both Evaluator 2 and Evaluator 3, different evaluators identified the highest number of problems in the context of different heuristics. This indicates, as previously stated, that they tended to concentrate on different aspects.

5.2.5.2 Final List of Problems and Percentages Identified by Individual Evaluators

When the 61 problems identified by the expert evaluators (Table 5.4) were combined with the 55 identified by the learners, the final consolidated list comprised a total of 75 problems. This list is given in Appendix C (in the format used for the severity rating of the problems). Whilst these 75 problems cannot be considered to be the ultimate diagnosis of all problems that exist in the application, they can, as similar studies (Lindgaard, 2004) suggest, be assumed to be the most evident ones.

With this background, the percentage of total problems identified by each evaluator can now be calculated. Table 5.6 represents the number of problems identified by each evaluator, the percentage this comprises of the problems identified by experts only, and the percentages when the combined list of 75 problems is considered. It is interesting to note that, between them, the set of experts identified 77% of the problems on the final list. These percentages of the combined list are also shown in Figure 5.2. It is these percentages – in the last row – that are referred to in the discussions that follow, so that the results in this study are analysed in relation to those in similar studies.

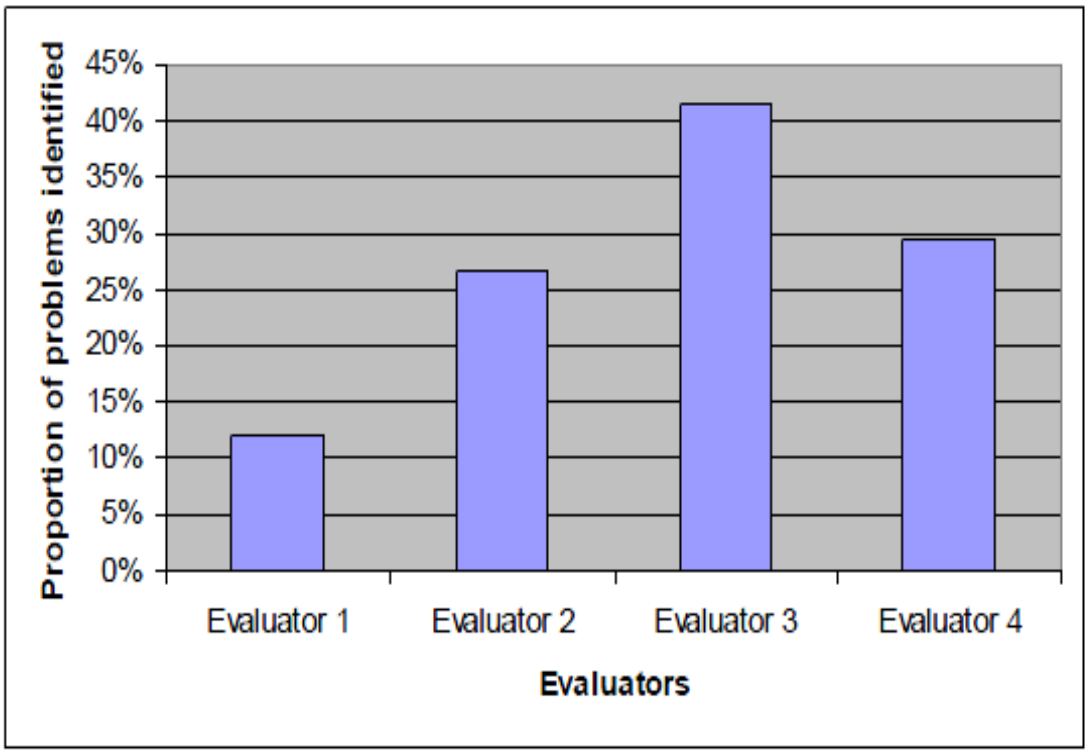

Figure 5.2: Proportion of Problems Identified by Each Evaluator

Table 5.6: Numbers and Percentages of Problems Identified by Evaluators

Evaluator	1	2	3	4	Total (experts only)	Total (combined)
Number of problems identified	10	16	32	25	61	75
% of problems identified by experts	16	26	52	40	100	
% of all (combined) problems	1	27	4	29	77	100

The percentages in Table 5.6 and Figure 5.2 range from 16% to 52%. In general, these percentages are in line with the findings of similar studies (Nielsen, 1994:44; Nielsen and Molich, 1990:255; Peng et al, 2004:46), which show that a single evaluator usually finds 20% to 50% of the problems in a system. It may be noted that Evaluator 1 identified fewer problems (16%) than did the others (26% to 52%). As previously indicated, this evaluator was the only one to perform the evaluation within the specified time period with no

assistance in clarification of issues or with anyone to act as a scribe. This evaluator took two hours to do the evaluation. The others took an average of one to one and a quarter hours, and did so in the presence of the researcher, who noted the problems while they evaluated. The fact that these three performed the evaluation in considerably less time than that taken by Evaluator 1 confirms the suggestion by Nielsen (1994:40) that this approach speeds up the evaluation process. The number and nature of the problems identified may be related to the evaluators' backgrounds (see Table 5.5). For example, Evaluator 1 found the lowest number of problems, possibly because of his background as an educationalist who has never studied or taught Human Computer Interaction (HCI) as a subject and who lacks experience of using heuristic evaluation as an evaluation methodology. This evaluator is considered to be a 'single expert', who in contrast to a 'double expert' is likely to identify fewer problems than one who has experience in both HCI and education. Evaluator 4, who has a similar background to that of Evaluator 1 in terms of formal training, identified far more problems than Evaluator 1. This could be attributed to the fact that, unlike Evaluator 1, Evaluator 4 had designed software for course management using BlackBoard $^{TM.}$ Furthermore, Evaluator 4 teaches Internet programming, making him a 'double expert'. Such teaching and design experience, and the feedback received from learners, has helped to identify problems in such applications. For example, one comment was "Many students have criticised systems designed using BlackBoard^{TM} for not being customisable".

Evaluator 2 has considerable experience in HCI and heuristic evaluation in particular. He/she had no formal education theory training despite being an educator (senior lecturer). Despite being classified as a 'single expert', he/she too identified a high number of problems.

As previously stated, in Section 5.3.2, Evaluator 3 had Master's degrees in both Information Systems and Education. As a lecturer in HCI at the postgraduate level, he can therefore be

considered a ‘double expert’. The maximum numbers of problems were identified by this evaluator. As stated in previous chapters, the highest amounts of usability problems were discovered by experts with both domain and HCI understanding. Nielsen and Phillips (1993) found that usability specialists are better at identifying usability problems, compared to their non-specialist colleagues. In addition to this, HE experts need specialist knowledge, skills and experience in domain and usability evaluation (Kantner and Rosenbaum, 1997).

Percentage of problems identified by a set of evaluators:

Examination of the number of problems identified by individual evaluators allows the mean number of problems identified by a given number of evaluators to be determined (Law and Hvannberg, 2002; Nielsen, 1994). This is shown in Table 5.7, which also shows these problems as a percentage of the 58 problems identified by the experts.

Table 5.7: Calculation of Average Number of Problems Expert Evaluators Identified

Problems identified by a set of experts	
Evaluator	**Number of problems identified**
1	10
2	16
3	32
4	25
Average	**21**
1 and 2 combined	26
1 and 3 combined	42
1 and 4 combined	35
2 and 3 combined	48
2 and 4 combined	41
3 and 4 combined	57
Average	**42**
1, 2 and 3 combined	58
1, 2 and 4 combined	51
2, 3 and 4 combined	73
1, 3 and 4 combined	72
Average for three experts	**64**
All four expert evaluators	**61**

The above table shows the mean number of problems identified by combinations of one, two and three evaluators respectively and how these figures were obtained. For example, the mean number of problems identified by a single evaluator was calculated by finding the mean of the number of problems identified by Evaluator 1 (10 problems), Evaluator 2 (16), Evaluator 3 (32) and Evaluator 4 (25), which gives an average of 21 – 35% of the 61 problems identified by the experts. These figures are shown in Table 5.7. Likewise, the average number of problems for the two evaluators was calculated by finding the mean number of problems identified by different combinations of two evaluators. For example, Evaluator 1 and Evaluator 2 together identified 26 problems. This is the number of problems identified by either of them or by both. The mean of these figures gives the average number of problems for two evaluators. This number and its percentage in relation to the 61 problems identified by the experts are shown in the table. Similarly, the average number of problems and corresponding percentages for the three evaluators can be determined. The next step was to use these figures to determine the average percentage of problems identified by a specific number of evaluators, with respect to the 75 problems in the combined list of problems (experts and learners) (see Table 5.8).

Table 5.8: Average Percentages of Problems Identified by Expert Evaluators

Evaluators	**1**	**2**	**3**	**4**
Average number of problems identified	21	41	63	75
% of 75 problems identified by experts and learners	28	48	64	77

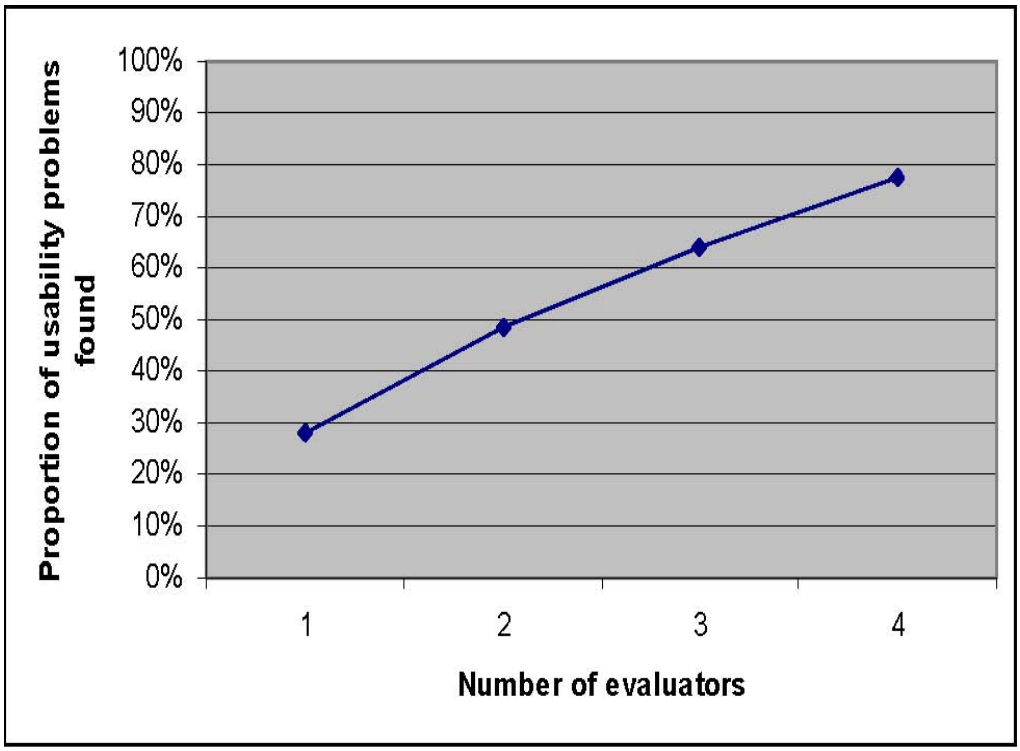

Figure 5.3: Proportion of Problems in System found by Various Evaluators

The data in Figure 5.3 show that one evaluator, on average, identified 28% of the problems. This confirms the results of a study by Molich and Nielsen (1990), which found that it is not possible to rely on a single person to perform a heuristic evaluation. The average of 28% is comparable to the results found in similar studies, where the values range from 29% (Nielsen, 1994) to 34% (Law and Hvannberg, 2002). Figure 5.3 shows that as the number of evaluators increases, so too does the proportion of problems identified. However, the rate of increase falls as the number of evaluators increases. The figure shows that 77% of the 75 problems were identified by four evaluators as stated in previous sections.

In order to compare the results of this study with similar studies, Figure 5.3 below was redrawn on the same axes as the figure in a study by Nielsen (1994). The integrated figure is presented here as Figure 5.4.

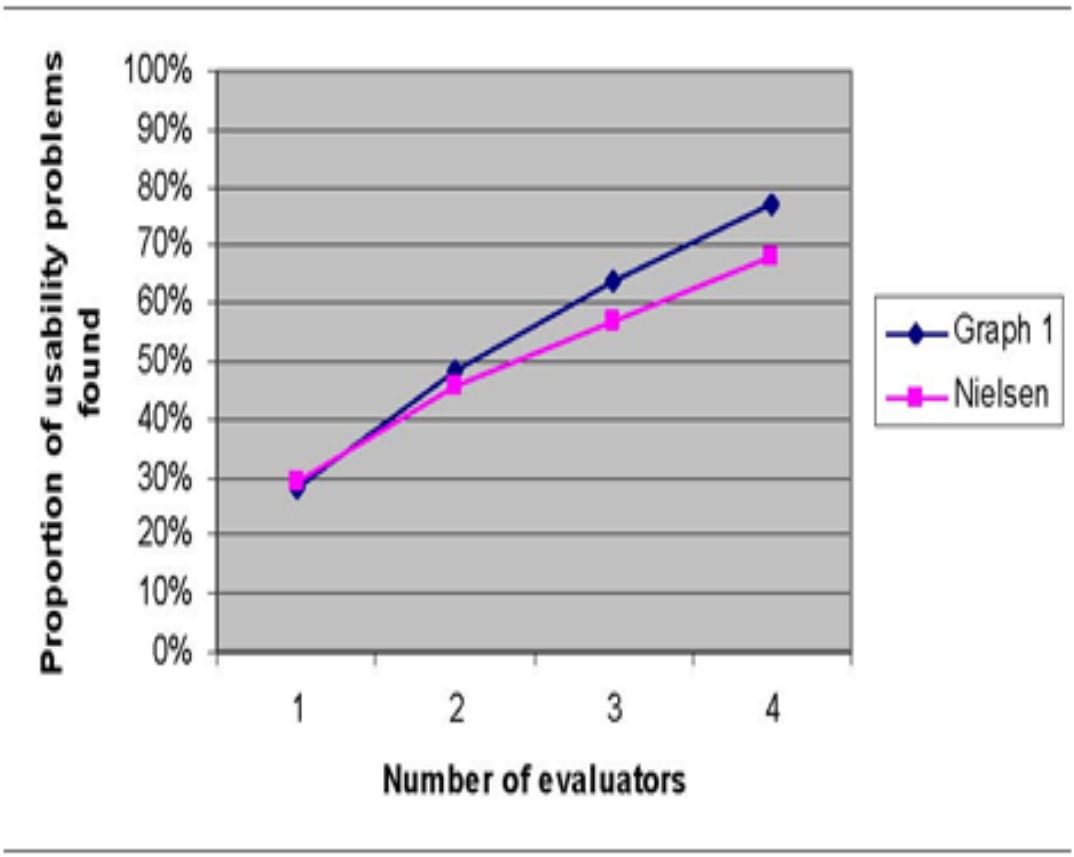

Figure 5.4: Current Case Study Compared with That of Nielsen (1994)

The graphs are named 'Graph 1' and 'Nielsen' respectively. The two are very similar in shape and correspond closely.

- Both start from almost the same point (29% for Nielsen's figure and 28% for this study for the case of a single evaluator).
- For two, three and four evaluators, the values for Graph 1 are 51%, 64% and 77% respectively. The corresponding values for Nielsen's Figure are 46%, 57% and 68%.
- As shown in Figure 5.4, the values in the figure for this case study, Graph 1, are slightly higher than that of Nielsen, except at the starting point. This means that the proportion of problems identified in this case study is higher than the proportion in the study by Nielsen. This is highly satisfactory and could be due to various factors. One possible

reason could be the diligence with which the expert evaluators in this study undertook their task and identified a high proportion of problems.

The fact that four evaluators identified 77% of the problems is a slight improvement on Nielsen's finding that three to five evaluators would identify about 75% of the problems.

More analysis of the HE results, together with results from the learner survey, is presented in the following section, in which the two sets of findings are compared.

5.3 Comparison of Survey and Heuristic Evaluation Results

In comparing the results of the learner survey and the heuristic evaluation, the list of 55 problems identified by learners excludes the eight problems that emerged from the criteria not presented to the experts (Heuristics 12, 15, 16, 17 and 19 – see Appendix B and Appendix C). As previously discussed, one of the reasons for this was to make the two sets of problems fully comparable.

Table 5.9 presents the number of problems identified by evaluation exercises, learners and experts for each criterion. A total of 75 problems were recognised. The learners identified 55 problems while the experts identified 58 problems. A total of 39 problems were identified by both groups. It may therefore be stated that 77% of all the problems were recognised by the experts and 73% by the learners. Although 61 students participated in the survey, they identified fewer problems than did the four experts. This is in line with Nielsen's statement that "usability problems in a system cannot be fully identified by the end users because of their less conceptual knowledge related to usability and computer principles" (Nielsen, 1994). However, the statement by Nielsen and Molich (1990) that even experts are not ideally

placed to identify usability problems cannot be ignored, as findings show that experts also only identified 77% of the problems.

Table 5.9 shows that 52% of all problems were identified by both students and expert evaluators. Moreover; the end-users recognised 67% (39 of 58) of the problems identified by the experts. However, 71% (55) of the problems were picked up by both evaluation techniques, namely heuristic and the learners' survey. As stated in the introduction, the main objective of this study is the widely recognised fact that a heuristic evaluation technique is economical, simple and rapid in comparison to other evaluation methods. However, it was observed in this research exercise that the heuristic evaluation took considerably less time and effort compared to the evaluation of the questionnaire survey, including materials preparation, carrying out the survey, and data analysis. For example, only four expert evaluators were used in HE compared with the 600 students involved in the survey evaluation. However, the four experts managed to identify more than three-quarters of the set of combined problems due to their experience and expertise, whereas the end users only recognised 70% of problems. These factors make HE a relatively easy to conduct and cost-effective method, as was the case in this case study comparing two different evaluation methods.

Table 5.9: Problems Identified by Learners Vis-à-vis Experts' Findings

Heuristic	Problems Found			
	By Questionnaire	By Heuristic Evaluation	By Both Methods	All
1	3	5	1	5
2	2	7	3	6
3	4	4	5	6
4	4	4	3	5
5	4	3	2	3
6	3	5	2	5
7	3	4	5	7
8	5	3	3	4
9	4	2	1	3
10	3	3	2	5
11	2	7	2	10
13	2	4	3	4
14	1	1	1	2
18	6	6	4	8
20	2	2	2	2
Totals				
General	**37**	**55**	**27**	**49**
Web Site	**5**	**10**	**2**	**10**
Educational	**13**	**18**	**10**	**16**

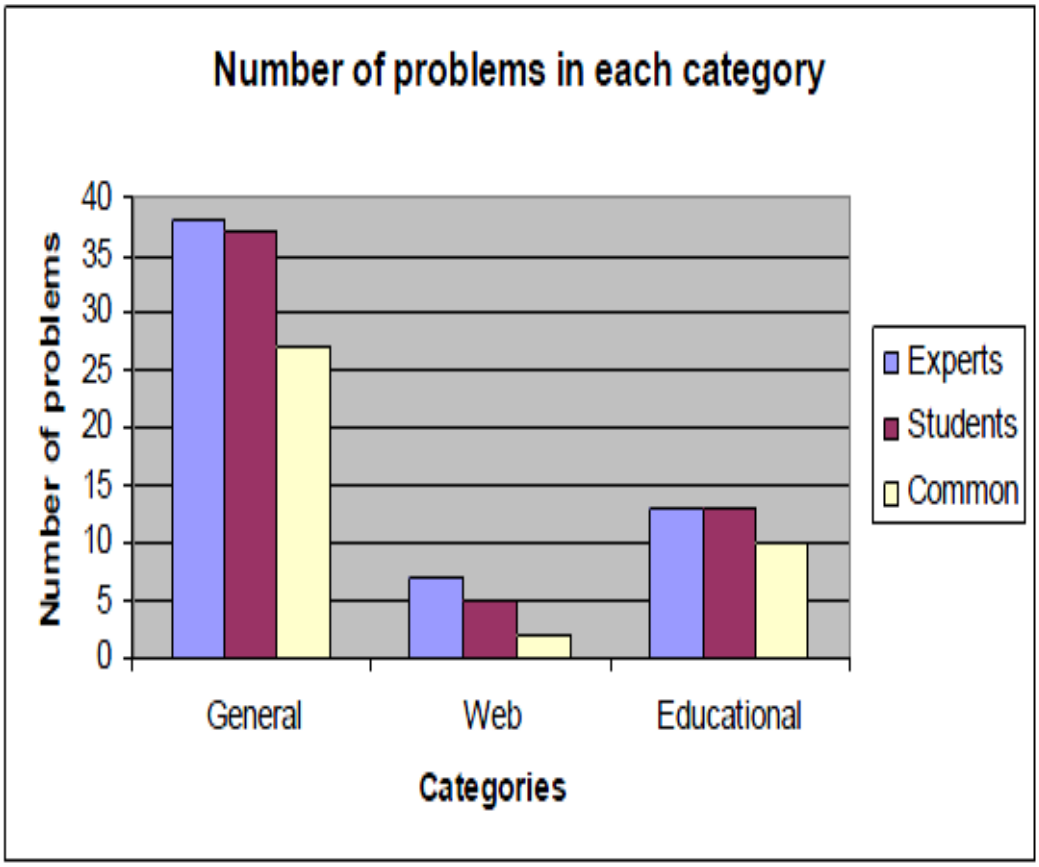

Figure 5.5: Comparison of No. of Problems Identified by Two Evaluations

Figure 5.5 shows that almost the same number of problems were identified in each category by experts and learners and that a number of problems were recognised by both experts and students in each category. There are subtotals of 49, 10 and 16 problems in the three different categories of problems, namely General, Web and Educational (see Table 5.9), respectively, corresponding to 65%, 13% and 22% of the total of 75 problems. This may be attributed to the fact that there were 10, one and five criteria to consider in the corresponding categories. The data thus indicate that more problems were identified in cases in which there were several criteria in a category and vice-versa.

Table 5.10: Percentages, within Each Category, of Problems Identified

	Experts	Students	Common
General	78%	76%	55%
Web	70%	50%	20%
Educational	81%	81%	63%

Table 5.10 shows the percentages, within each category, of problems identified by experts and learners. These results are presented in Figure 5.6.

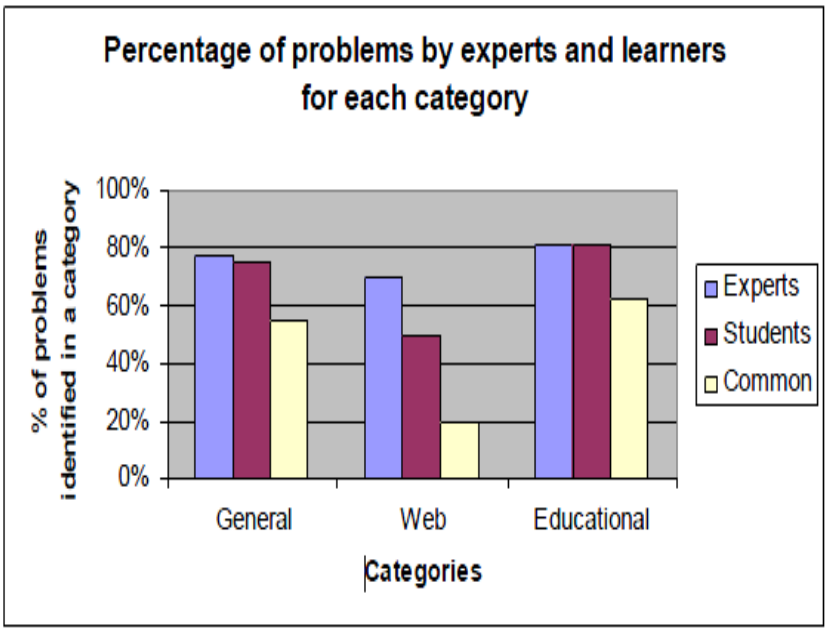

Figure 5.6: Percentages, within Each Category, of Problems Identified

Table 5.10 and Figure 5.6 show that that the percentages relate to the total number of problems in a category. For example, Table 5.9 shows that experts identified seven out of 10 problems in the Web category. Figure 5.6 shows that the experts and learners identified the highest, and identical, percentages of problems in the Educational category (both 81%) followed by the General category (78% and 76% respectively). The lowest percentages were in the Web category (70% for experts and 50% for learners), where the percentage of problems identified by experts was 20% higher than that identified by learners. Figure 5.6 also shows that the highest percentages of common problems was in the Educational category

(63%), followed by the General category (55%), whilst in the Web category only a small percentage (20%) of problems were picked by both the learners and experts. There was therefore considerable agreement on the problems relating to the educational and general category but not so in the web category. The most likely reason is that there was only one heuristic to consider for evaluation in the Web category compared to 10 and four in the General and Educational categories respectively.

Figure 5.7 presents the number of problems recognised by heuristic evaluation and the survey questionnaire for each criterion (see Table 5.9). It is clear from Figure 5.7 that the results of the two groups correspond closely. For example, where the learners found a high number of usability problems (five or more), such as for Heuristics 3, 7, 11 and 18 (Appendix B), the same applied for the evaluators. Examination of Appendix C shows that in 14 out of the 15 heuristics, the top two problems identified by the highest number of experts correspondingly had the highest number of students who identified the same problem under that criterion. This correspondence further emphasises the level of agreement between the learners and experts on the problems in the application.

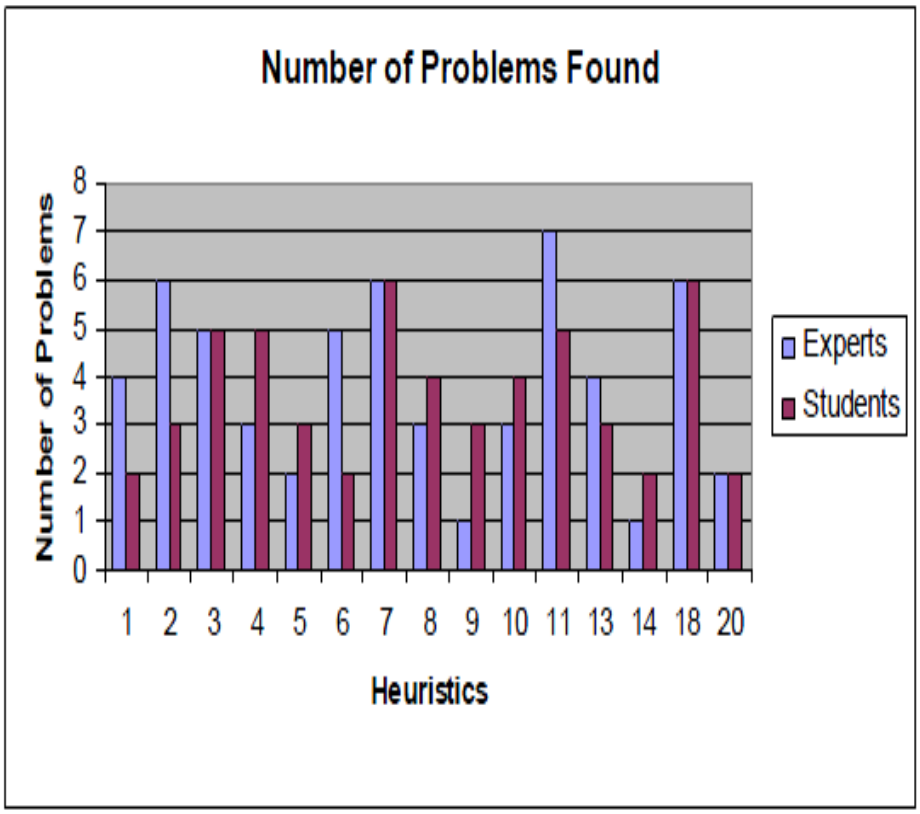

Figure 5.7: Usability Related Problems

Problems identified by experts and their severity rating

All 75 of the problems listed were graded on the basis of the severity of the problems, as:

- Cosmetic
- Minor
- Medium
- Major
- Catastrophic

on a five-point scale. Appendix C presents the rating scale, along with the 75 problems, and shows each expert's rating and the average rating of each problem. The mean was 3.0 whereas the SD was 0.8. This implies that the experts considered the majority of the problems to be 'medium problems', in that users could quickly adapt to them and make

satisfactory use of BlackBoard™.

It was also observed that the average scores for each individual expert evaluator (namely 3.1, 3.2, 2.9 and 2.8) were close to the overall mean score of 3.0. Although this alone does not show that there was general agreement on the severity grading of the different problems, a closer look at the appendix shows that this was indeed the case; all the expert evaluators allocated almost the same score to most of the problems. Appendix C also shows the severity grading data when only the first two problems for each criterion (see the criteria and the problems in Appendix C) were considered. The data in Appendix C shows that the mean of the averages of the ratings increased from 3.0 to 3.5. Since the ordering of the problems in Appendix C is presented in decreasing order according to the number of expert evaluators who identified a particular problem, the increase in the mean value indicates that problems identified by many expert evaluators were generally rated higher than those identified by fewer evaluators. However, this was not always the case. For example, whereas Problems 5.1 and 5.2 were identified by three and two different experts respectively (see Appendix C), the average rating of each of these two (2.8) was lower than that of Problems 5.4 and 5.5 (both with an average rating of 3.0), each of which was only identified by a single expert. This shows openness on the part of the experts to severely rate a problem that they themselves had not personally identified. This demonstrates credibility and lack of bias on the part of the expert participants in this case study.

Minor and major problems

As discussed in the literature review, the main aim of severity rating analysis is to decide on the genuineness and strength of problems related to the usability of WBLP. Such problems could be major or minor. As previously discussed, a five-point Likert scale was used to determine the severity of the problems. Appendix C, which contains data from the result of

the experts' rating, was used to categorise these problems as major or minor. In this study, the WBLP usability problems were divided into two classes. A 'Major Problem' is a problem which has a mean of four to five (Major to Catastrophic) and a 'Minor Problem' has a mean of one to two (Cosmetic to Minor). Table 5.11 and Figure 5.8 present the number of problems in the major and minor categories and their corresponding percentages.

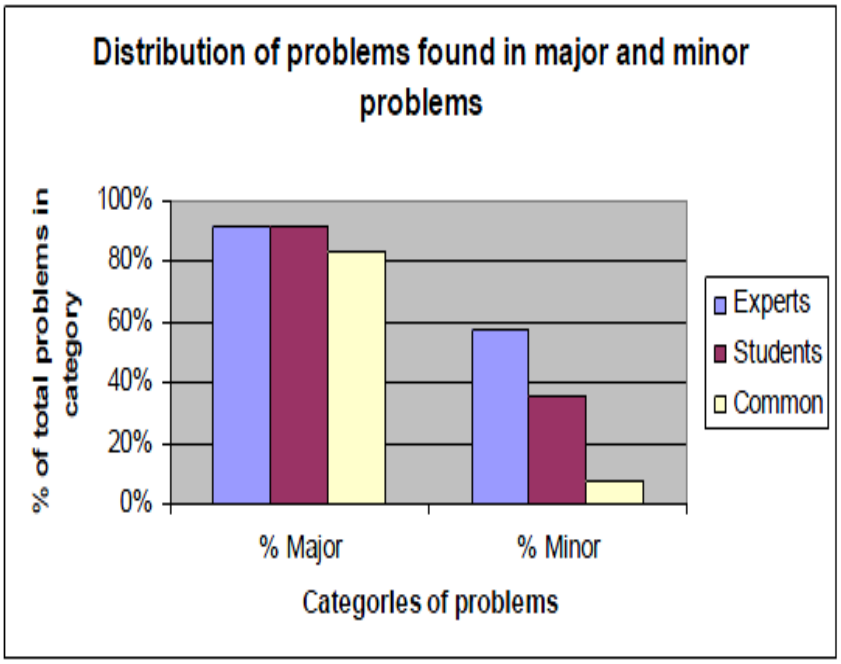

Figure 5.8: Percentage of Major and Minor Issues (Experts vs. Learners)

Table 5.11: No. and % of Problems Recognised by Experts and Students

	Expert evaluator	Learner	Common
Major problems identified by	11	11	10
% of Major problems identified by:	92%	92%	83%
Minor problems identified	8	5	1
% of Minor problems identified by:	57%	36%	7%

12 *major* and 14 *minor* problems were found. This indicates that this set eliminates 49 problems out of 75 with normal ratings of 2<_ but _ <5.

Major problems

Table 5.11 shows that out of 12 major problems, 11 (92%) were picked up by the expert evaluators using heuristic techniques. Learners identified 11 (92%), whereas 10 (83%) problems were identified by both of these groups. This shows that both expert evaluators and students recognised 92% of major problems. Both these groups believe that these problems occur in BlackBoard^{TM}. In fact, only one major problem identified by the experts was not identified by the learners.

Minor Problems

Table 5.11 and Figure 5.8 show that out of 14 minor problems, 57% were identified by the expert evaluators and 36% by the learners, whereas only 7% were identified by both of these groups. It is worth noting that in this category of problems only one problem was identified

by both the evaluation techniques. This means that one out of five problems was identified by learners and one out of eight was identified by the experts. These figures demonstrate that both evaluation techniques picked up only a small number of minor problems with a small agreement of only 7%.

Discussion

These results support those of similar studies (Nielsen, 1994:56; Law and Hvannberg, 2002:77) which found that it is easier to find major problems than minor problems. In this study, expert evaluators and students identified 92% of the major problems, whereas 57% of the minor problems were identified by experts and 36 percent were recognised by students. Nielsen (1994) stated that whilst it is easy to identify major usability problems, when all sets of problems are measured, the set of minor problems will exceed that of major problems, which was also the case in the present study. Without going into detail regarding the nature of major and minor problems identified, a few examples of characteristics of the problems in this case study are now addressed. The top three major problems concerned system navigation and error recovery issues. These are listed in Table 5.12 along with the number of experts and learners who identified them.

Table 5.12: Top Three Major Problems

Problem	**Number of experts**	**Number of students**	**Average severity**
Redo or Undo not available	2	16	4.8
The error messages given are not helpful, as they do not provide any instructions for recovery.	2	7	4.5
Apart from the buttons provided by the browser, there should be a Back/Previous and Forward/Next button within the application.	0	19	4.5

Table 5.12 shows that the first two problems can be classified as being catastrophic. If users have no way to return to the previous stable state in the a system and cannot get help on how to do so, they remain 'stuck' in the system. It is also important to note that at least two experts and a fairly high number of learners (16 and seven respectively) identified these two problems. This further confirms the view that major problems are easy to identify.

The third problem can be classified as a major problem using the classification in Table 5.6. Although users find it difficult to navigate the system without being able to use the Back/Previous and Forward/Next buttons, they can work around this problem by using the button on the browser to move backwards and forwards. It is interesting to note that whilst no expert actually identified this problem, they rated it highly in terms of its severity. This can probably be attributed to the fact that they have more experience than learners in using the Web, and consequently used the alternative button on the browser. Another notable inference, already noted in Section 5.4.3, is that the expert evaluators were not biased in the severity rating, since they rated a problem highly even when they had not recognised it themselves. Table 5.13 shows the three least serious (Cosmetic) problems identified in the application using the results of the severity rating.

Table 5.13: Three Most Minor Problems

Problem	**Number of experts**	**Number of students**	**Average severity**
There are no facilities for synchronous communication such as video conferencing.	0	1	1.3
There should be lines between the different windows in a two- or three-window design.	1	0	1.5
In order to improve readability, the Course Menu should be wider, and the spaces between its different sections should be larger than the spaces between items of the same sections.	1	0	1.7

The problems in the table can be classified as minor, according to Table 5.2, since none of them will affect the actual use of the system. The first problem, regarding the lack of video conferencing facilities, does not affect the use of BlackBoard™. This issue was raised by a single learner as one of the ways in which collaborative learning could be improved. Although the point is valid, the system could be used collaboratively without including such a facility. The last two problems in the table will clearly not affect the use of the system, although as they affect the visual layout of the windows and menus they could marginally reduce the speed at which certain tasks can be performed.

Analysis of Table 5.12 and Table 5.13 shows that a higher numbers of evaluators (experts and learners) identified the top three major problems when compared to the number that identified the three most minor problems. This supports the statement earlier in this section that it is easier to find major problems than minor ones.

This section has analysed and compared the results of the survey evaluation among learners and heuristic evaluation by experts. The final section of this chapter summarises the main findings.

5.4 Summary

The Arabic BlackBoard™, created from the original BlackBoard™ was evaluated by end users (learners) using survey methods. The analysis of the survey responses shows that the learners who participated recognised a set of 55 problems.

Arabic BlackBoard™ was subsequently heuristically evaluated by four expert evaluators.

Some of the evaluation criteria used in the study were derived from theoretical concepts based on learning theories such as constructivism. The evaluation criteria played a major role in identifying deficiencies in the Arabic version of BlackBoard™. This confirms the integrity of these criteria, and has a further benefit of identifying areas in the Arabic BlackBoard™ that should be addressed when it is upgraded or re-engineered in the future. A severity rating of identified problems proved to be a most helpful exercise that helped to differentiate between major and minor problems.

This chapter analysed the findings of the heuristic evaluation and compared and contrasted it with the findings of the end-user evaluation using the survey technique.

Chapter 6: Summary and Conclusions

Educational software requires evaluation, like any other software. While traditional software is typically evaluated to meet criteria such as efficiency and usability of the interface, educational software also needs to be evaluated in terms of how well it supports learners in their learning (Quintana, et. Al., 2003).

As stated previously, a variety of methods for usability evaluation exist. The major methods currently in use were discussed and compared in Chapter 3. Due to the complex nature of web-based learning platforms (WBLP) and their users (requirements plus efficacy), it is crucial to develop an efficient and effective method or set of methods to conduct usability testing with these platforms. This research is has attempted to find criterion and methods by which to evaluate the usability of a WBLP, by studying the effectiveness and efficiency of two widely used techniques, i.e., user evaluation and heuristic evaluation.

The aim of this study was to understand and evaluate the usability of web-based learning applications from the perspective of learners, and to compare and contrast their views with the findings of Heuristic evaluations of these platforms by professionals. The case study research was conducted using two methods, i.e., survey and HE, and a range of diverse evidence was collected and collated. This triangulation of the data helped the researcher to answer the research questions. For the evaluation with learners, a questionnaire survey technique was used; while for the heuristic evaluation by experts, a criterion-based evaluation, using Nielsen's (1992, 1994, 2002) criteria was conducted. After this, a consolidated set of problems was passed to experts who requested to collate a severity ratings

table. The target e-learning application has therefore been evaluated using two major UEMs, each employing sub-methods. This chapter describes the findings from the two techniques and analyses and compares these.

6.1 Why WBLP Usability Evaluation?

The researcher studied the construction and usability of web based learning platforms as they were perceived by the participant Saudi university students. The usability of a web based learning platform (WBLP) was defined by the manner in which the learners interact, navigate and find information on it (Goto and Cotler, 2002; Wood, 1998). Therefore, in a WBLP context, usability denoted students using the WBLP independently to accomplish tasks quickly and easily. WBLPs' usability is based on four suppositions: (i) Learners are the prime focus, (ii) WBLP is used to make learners more productive, (iii) learners are subject to time constraints and are trying to accomplish tasks within a specified timeframe, and (iv) learners are the best judge of usability, i.e., ease of use (Dumas and Redish, 1994).

This dissertation aimed to study the university students' perception of usability of WBLP, and to achieve this applied Nielsen's usability heuristics; these widely used evaluation guidelines are well respected for testing the usability of software applications. The tools were primarily used to gauge and measure the usability of commercial web sites. This research involved an attempt to study the applicability of Nielsen's proposed heuristics, to evaluate the usability of WBLP. Furthermore, how far the findings of heuristic evaluations fare and compare with learners' perceptions of usability.

The literature review supported the claim that there is a lack of research to develop strategies and guidelines to enhance WBLPs' usability. Furthermore, the review of literature lent

support to the fact that there is a need to study WBLPs' usability from the learners' standpoint. It is worth noting that concern with usability is vital to the process of learning and teaching, in view of the ever increasing demand and reliance on web based teaching, use of web based course management systems (CMS), and the presentation of teaching materials to students via web portals.

The U. S. Department of Education (2009) and Moos and Azevedo (2009) stated that with the advent of new web based tools (Web 2.0), and increasing sophistication in communication systems (i.e., speed of the internet, Omnipresence of the internet, etc.) the demand for online sources is ever increasing, especially in higher education. Yet, they also noted the lack of research focused on usability and effectives of web based courses. Hence, few guidelines and strategies are available to allow software designers and educators to take full advantage of the potential for web based communication technologies.

This lack of guidelines and strategies gives rise to the following problems:

1. Left many educators and software developers unsure of how to design effective and useful course materials and WBLP (Katz, 2008);
2. Wide range of content structures and interfaces (Oblinger and Hawkins, 2006);
3. Poorly designed and structured courses, course materials and difficulty interacting with WBLP interfaces (Duffy and Kirkley, 2004; Hall, Watkins and Eller, 2003).

Tallent-Runnells, et al. (2006) studied the role of course design and development in supporting learners' success and argued that appropriate and excellent course design and development requires further research, primarily focused on learners' perceptions.

In addition it should be remembered, that in a WBLP environment teachers and learners are separated by space and time, therefore, designing an online-course differs from designing a conventional course, requiring a thorough understanding of learner requirements, efficacy and perception. The interface of the application/portal is the only point of interaction and communication. Therefore, the material appearing in the window/on screen must be easy to follow, clear and usable, assisting learners to complete the required tasks and achieve their learning objectives.

6.2 Research Questions and Methodology

Usability evaluation is a major step in the development of any software. However, as argued by Kjeldskov, Skov and Stage (2004) in the process of the development of web based learning platforms the usability evaluation is often ignored as it is considered to be expensive, time consuming and difficult to conduct. This is also true in the case of the WBLP adopted in the Kingdom of Saudi Arabia, because the majority of platforms were initially developed in English and later merely translated into Arabic, ignoring the users' perception and requirements.

In software engineering different techniques are used to conduct usability evaluations; for example analytical, expert heuristic evaluation, observational, survey and experimental evaluations. However, due to the complex nature of WBLP and the various users' requirements it is important that easy to use, cost-effective, and yet efficient methods be established to identify and overcome usability problems of WBLP.

As mentioned previously, this research attempted to contribute to existing knowledge in the field of HCI (especially usability and usability evaluation methods) and e-Learning. This research project has been conducted to answer the following question:

What criteria and techniques are appropriate for the evaluation of usability of a web-based learning platform?

This question is answered by measuring the effectiveness and efficiency of user evaluation (user centric approach), and comparing and contrasting it with heuristic evaluation.

It is evident from the above discussion that this is a bidirectional study. Therefore, two research methods - a user survey using a structured questionnaire and a heuristic evaluation using a modified version of Nielsen's set of heuristics were employed - to collect the necessary data to answer the research question.

The data collected from these two techniques was statistically analysed using standard statistical techniques and methods (using SPSS^{TM}). Chapter's 4 and 5 summarised the findings of the data analysis, and the following sections will compare and contrast these findings to answer the research question.

6.3 Summary of Research Findings

In this research, the usability constructs were measured using a quantitative methodology by employing two tools. First, learners' perceptions of WBLP's usability were measured quantitatively by using a questionnaire. The questions in the questionnaire were mapped according to Nielsen (1994, 2000, 2002) and were based on Stewart, Hong and Strudler

(2004). After this step, four experts were employed to conduct a heuristic evaluation using Nielsen's (1994, 2000, 2002) heuristics.

The end users (learners) evaluate the Arabic BlackBoard™, created from the original BlackBoard™, using survey methods. These were in the form of questionnaires administered to participants and a focus group interview. Prior to conducting the questionnaire survey, a pilot study was carried out with a small group of learners. This was found to be very useful, as the feedback from the pilot study identified shortcomings that would have affected the evaluation process negatively, had they not been resolved. Likewise, the focus group interview enriched the findings, clarifying certain issues raised by the learners in response to the questionnaire and identifying problems in the application that had not been identified in response to the questionnaire. After consolidation, the set of problems identified by learners numbered 55.

BlackBoard™ was then heuristically evaluated by four expert evaluators. After consolidation, the set of problems identified by the experts comprised 58 problems. When the experts' and learners' problems were integrated, the final set of problems numbered 75. The percentage of problems identified by the aggregated group of experts as a factor of this final set was 77%, a very satisfactory achievement from a group of only four experts. The input from the expert evaluators varied in terms of the number of problems they identified. The percentage of problems found by each individual ranged from 12% to 41% of the consolidated set of problems, with an average of 28%. This shows that one cannot rely on a single expert to perform an evaluation of a system, as pointed out by Nielsen and Molich (1990). The literature suggests that three to five expert evaluators should be used, depending on the complexity of the system to be evaluated and on the knowledge and experience of the

evaluators in the domain area, i.e., subject matter expert/s, and HCI, i.e., usability experts/s. In general, those evaluators with experience, or knowledge of HCI discovered more problems than those without HCI expertise, showing that previous exposure to usability evaluations is beneficial in the application of heuristic evaluation.

In this case study, there was a tendency for each expert to concentrate on problems associated with certain evaluation criteria at the expense of others. The result was that more problems were identified with respect to these criteria. When the criteria that different experts emphasised differed, the various heuristic evaluations were complementary, with the result that few problems were identified by more than one evaluator.

It can be difficult for evaluators, who are not learners themselves, to apply criteria related specifically to learning. Criteria intended to determine whether learners were able to learn using the system, or whether they had a sense of ownership over BlackBoard^{TM}, were therefore excluded from the heuristics measured by the experts. However, learners using these criteria identified certain problems that were vital in terms of learning. This supports the suggestion by Kantner and Rosenbaum (1997) and Lindgaard (2004), that, ideally, heuristic evaluations should be supplemented by feedback from end users, using methods such as user interviews and surveys.

One of the issues that the researcher of this study realised, both during the evaluation by experts and the evaluation by learners, is that evaluators should be allowed ample time to perform their evaluations. This is because they work backwards and forwards, when checking an application, to determine what the problem is, and to establish clarity regarding a problem they have already encountered. More time is required to describe information and/or record

it. During the observation of the evaluations by the researcher, this process represented a challenge to both groups of evaluators. The challenge became even greater when the evaluator had to determine which heuristic/s was/were violated by a particular problem.

Although, as stated above, issues related to cost and time were beyond the scope of this study, this research exercise demonstrated that heuristic evaluation requires less time and effort when compared with the processes of questionnaire based survey evaluation. This supports the findings of (Karoulis and Pombortsis, 2003; Blandford et al, 2004; Lindgaard, 2004) that the heuristic evaluation technique is efficient, inexpensive and easy to conduct, when compared to other usability evaluation methods.

Some of the evaluation criteria used in the study were derived from theoretical concepts based on learning theories such as constructivism. The target system of the study, BlackBoard™, was not developed in reference to these concepts, mainly because of its development environment, and so does not readily support them. However, these evaluation criteria played a major role in identifying deficiencies in BlackBoard™. This confirms the integrity of these criteria, and has the further benefit of identifying areas within BlackBoard™ that can be addressed when it is upgraded or re-engineered in the future.

Severity ratings were used to determine which problems were and were not so critical. Therefore, the exercise of severity rating of problems identified in the target WBLP was found to be valuable.

The learners who participated in the survey identified 71% of problems, i.e., a slightly lower proportion of the total problems, than using Nielsen's HE technique, which identified 79% of

problems. This confirms Nielsen's (2002) observation that heuristic evaluation by experts is better than that by end users for identifying website usability problems. When the set of major problems was considered, the proportion of problems identified by both groups rose to 93%. This was done by extracting and analysing data relating to critical problems only. The increase in proportion identified shows it is easier for both learner and experts to identify major problems than minor ones.

It was further observed that the heuristic evaluation detected 72%, i.e., more than 2/3 of the usability problems spotted by the learners. Meanwhile, i.e., the end-users, identified only 60% of the problems identified by the experts. The percentage of user-identified problems, which were also picked up by the experts jumped to 91% when only major problems were considered. This proportion fell to 20% for minor problems. It was also found that, in general, for the heuristics, where experts identified a high number of problems, the learners did the same and vice-versa.

It can be concluded, from the above discussion, that the findings of the heuristic evaluation based on Nielsen (1994) matches well with those of the questionnaire evaluation, i.e., the perceptions of end-users. However, the results of the heuristic evaluation were found to be better than those from the survey. It is worth noting that a heuristic evaluation was conducted by only four experts, while 600 learners participated in the survey, although the heuristic technique identified 60 problems compared to the 53 problems identified by the survey technique. Furthermore, the experts using a heuristic evaluation technique identified 79% of all problems, while learners using questionnaire based surveys identified 71% of problems. At the beginning of Section 1.6, it was stated that one aim of this research was to determine whether heuristic evaluation, when applied to web-based e-learning applications, was

sufficient to identify usability problems (where 'sufficient' is taken to mean adequate identification of problems that users themselves point out). In this research exercise, it was observed that the experts using heuristic technique identified 71% of the usability issues identified by the survey participants. However, experts identified 91% of the critical problems that had been picked by the end-users. These facts indicate that heuristic evaluation is a highly effective usability evaluation method, as well as being relatively easy to conduct, and inexpensive (Ardito, et. al., 2006).

Certain evaluation criteria were presented to the learners but not to the expert evaluators (since they were only relevant to learners). However, even when applying the same set of criteria, learners identified some problems that the experts did not, which showed that the end-user survey results did contribute value to the evaluation. Therefore, while heuristic evaluation is good at identifying usability problems in web-based e-learning applications, particularly major problems, it can be enhanced by supplementary user-based evaluation methods. Despite this, the author of this work recommends heuristic evaluation as the most suitable method for a usability evaluation of web-based e-learning applications in cases where only one method can be applied.

In summary, this research has contributed to the existing literature in the field of HCI and education, as it provides a set of guidelines to evaluate the usability of WBLP and strategies for the design and development of WBLP based upon the findings of two different evaluation methods and a quantitative analysis of the data obtained. This research has also attempted to relate the design requirements of WBLP with commercial web based applications by relating design principles to Nielsen's (1992, 2000, 2002).

One of the main research questions in this research related to how learners perceive the usability of WBLP. One of the findings of this study was that student's perceptions of usability are in line with Nielsen's (1994, 2000, 2002), and that Nielsen's Heuristic framework can be employed to evaluate the usability of WBLP.

The above conclusion does not deny the fact that the end-user, i.e., learner, or teacher, not the developer, is the best judge and evaluator of a WBLPs' usability and effectiveness. Hence, it is important to study and understand learners' perceptions of WBLPs' usability to enhance their learning experience and achievements, so that WBLP can be designed and developed to meet learners' requirements and support the learning process.

6.4 Epilogue

The analysis of questionnaires and learners comments revealed that those learners who participated in the research found it difficult to locate the required content within the WBLP in use at King Saud University.

The comments of the learners revealed that the language and phrases used to label and tag links was lacked clarity, Moreover, and that they found it difficult to foresee outcomes without clicking on links. Furthermore, the organisation of course materials and consistency in language use were considered of key importance. Therefore, effort must be made to develop a controlled vocabulary for WBLPs so that learners can readily become familiarised with these concepts. Therefore, further research is required to identify learners' expectations in terms of the language and phrases used to label buttons and links, and to identify what clues (pop-ups) would help learners find what information by clicking on a link. This

standardisation of vocabulary can further facilitate learners when moving from one institution to another (i.e., one platform to another).

Ever increasing demand for online and distance learning has given rise to the need for further research to understand how teachers think about the effectiveness and usability of WBLP. Thus, further research is recommended.

In order to further understanding of the usability construct from an end-user perspective (i.e., the learner), lab based usability testing could be conducted. This could be carried out following a survey to self-report computer self-efficacy. This research exercise could be based on the Computer User Self-efficacy Scale (CUSE), as developed by Eachus and Cassidy (2006). Furthermore, time/error data (that is to measure time taken to accomplish a required task, errors made during the process, and the final outcome, i.e., success or failure) could be collected during usability testing sessions. This would provide qualitative data and help in the comprehension and development of a cause and effect model to gauge the usability of WBLP.

6.5 Conclusions

In the industry there have been several techniques to evaluate usability, such as analytical, inspection methods such as expert heuristic evaluation, surveys by questionnaires and interviews, observational and experimental methods. However, the choice of method for a usability evaluation is subject to cost and effectiveness when identifying users' issues. A heuristic evaluation (HE) technique is widely used to evaluate the usability of software. In the case of learning platforms, the selection of suitable usability evaluation techniques is especially important, because unless a system is readily usable, learning becomes obstructed

and students spend more time learning how to use the system than learning from it. This research employed two usability evaluation techniques in a complementary manner; i.e., heuristic evaluation complementing user surveys to evaluate WBLP.

Evaluation of usability in HCI is a process involving the gathering of information regarding the potential usability of software, in order to improve its interface, and/or assess its usability, by identifying problems and suggesting improvements. This form of evaluation should ideally be performed during development phases. In the industry several techniques have been commonly used to evaluate usability issues, such as observation and testing, user surveys, and heuristic evaluation; any of these techniques could easily be adapted to identify problems in WBLP. Nielsen developed heuristic evaluation, which is a usability inspection technique.

A heuristic evaluation technique is cost effective, easy to conduct, time efficient, and can result in major improvements; this is why such evaluation techniques are the most widely-used usability evaluation techniques for software interfaces. When evaluating usability of a WBLP, surveys can probe learner-oriented usability problems, which are not always identified by heuristic evaluation. In this research, a questionnaire based on closed-ended questions was used to cover this possibility. The questions were based on the criterions or set of heuristics identified following an extensive literature review.

As mentioned above heuristics/ evaluation criteria for WBLP should address interfaces and HCI usability aspects as well as pedagogical issues, for the purpose of evaluating the Arabic version of BlackBoard in use at King Saud University, Riyadh. The evaluations were conducted in a socially-responsible, ethical and professional manner, protecting participants' rights and meeting DMU's ethical criterion.

Although heuristic evaluation technique's mainly focus on reporting the existence of a usability problem rather on solving problems, in most cases the solution is implicit. It was observed that if the problems identified by the experts during a heuristic evaluation of BlackBoard are fixed, this would improve it from both usability and learning perspectives.

This research has therefore reached the following conclusions:

i. The evaluation framework for categories, criteria, and sub-criteria synthesised for is a flexible instrument that can be applied to identify usability-and pedagogical problems on any WBLP.

ii. This framework could easily be customised to other applications and to a variety of usability methods.

iii. The framework can be used as a design aid for WBLP. Although it is not possible to mould this framework to fit every WBLP, the guidelines in the framework can be contextualised and adapted as required.

iv. This research is being undertaken to complement existing debate in the field of Comparative Usability Evaluation (CUE), and could be used as a framework to further study the comparative effectiveness of different usability measurement techniques.

v. *Secondary benefit:* Evaluation of the Arabic version of the BlackBoard application is in itself of value. Although it was generally rated positively, problems were identified that can be addressed.

In the future, what usability evaluation techniques are most effective to evaluate the usability of WBLP will be further studied. The research concluded that Nielsen's proposed heuristic

evaluation technique is more effective for addressing website usability and pedagogy related problems, as a method in the context of WBLP. Although the heuristic evaluation technique identified a large number of major problems it is recommended overall that the technique be supplemented with end-user surveys or usability laboratory testing.

In order to further understanding of the usability construct from an end-user perspective (i.e., the learner), laboratory based usability testing should be conducted. This could be carried out following a survey to self-report computer self-efficacy. Furthermore, time/error data (that is to measure time taken to accomplish a required task, errors made during the process, and the final outcome, i.e., success or failure) should be collected during usability testing sessions. This would provide qualitative data and help in the comprehension and development of a cause and effect model to gauge the usability of WBLP.

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Appendices

Appendix A: Questionnaire Rating Summary Results

Statement	Strongly agree (Likert 1)		Agree (2)		Maybe (3)		Disagree (4)		Strongly disagree (5)		Average rating
	F	***%***	***F***	***%***	***f***	***%***	***f***	***%***	***f***	***%***	
1.1	11	19	41	69	5	8	2	3	0	0	**2.1**
1.2	17	28	33	55	10	17	0	0	0	0	**1.9**
1.3	5	8	32	53	13	22	10	17	0	0	**2.5**
1.4	8	13	36	60	9	15	7	12	0	0	**2.3**
1.5	11	19	27	47	9	16	10	18	0	0	**2.3**
2.1	13	21	35	57	5	8	8	13	0	0	**2.1**
2.2	6	10	38	63	10	17	6	10	0	0	**2.3**
2.3	7	11	30	49	14	23	8	13	2	3	**2.5**
2.4	5	8	19	31	20	33	15	25	2	3	**2.8**
2.5	12	20	21	34	15	25	11	18	2	3	**2.5**
2.6	11	18	36	59	10	16	4	7	0	0	**2.1**
3.1	12	20	37	61	8	13	4	7	0	0	**2.1**
3.2	3	5	42	69	11	18	5	8	0	0	**2.3**
3.3	14	24	21	36	5	8	17	29	2	3	**2.5**
3.4	7	12	14	24	11	19	22	37	5	8	**3.1**
4.1	14	23	28	47	12	20	5	8	1	2	**2.2**
4.2	5	8	38	62	12	20	6	10	0	0	**2.3**
4.3	3	5	31	51	21	34	6	10	0	0	**2.5**
4.4	4	7	31	53	14	24	10	17	0	0	**2.5**
4.5	15	25	29	48	5	8	10	16	2	3	**2.3**
4.6	12	20	34	56	9	15	6	10	0	0	**2.1**
4.7	16	27	27	45	11	18	6	10	0	0	**2.1**
4.8	14	23	36	60	6	10	3	5	1	2	**2.0**
4.9	15	25	33	55	7	12	4	7	1	2	**2.1**
4.10	19	32	31	53	6	10	1	2	2	3	**1.9**
5.1	13	22	36	60	9	15	2	3	0	0	**2.0**
5.2	11	18	29	48	10	16	8	13	3	5	**2.4**
5.3	25	42	26	43	6	10	3	5	0	0	**1.8**
5.4	17	29	22	37	13	22	7	12	0	0	**2.2**
5.5	17	29	29	49	5	8	7	12	1	2	**2.1**
6.1	15	25	30	50	9	15	6	10	0	0	**2.1**

6.2	9	15	38	64	9	15	2	3	1	2	**2.1**

6.3	9	16	42	72	6	10	1	2	0	0	**2.0**
6.4	10	17	37	63	9	15	3	5	0	0	**2.1**
6.5	5	9	25	43	16	28	11	19	1	2	**2.6**
7.1	13	22	22	37	13	22	9	15	2	3	**2.4**
7.2	9	16	19	33	16	28	13	22	1	2	**2.6**
7.3	8	14	24	42	18	32	7	12	0	0	**2.4**
7.4	4	7	16	28	17	29	18	31	3	5	**3.0**
7.5	5	8	16	27	14	23	22	37	3	5	**3.0**
8.1	10	16	39	64	10	16	1	2	1	2	**2.1**
8.2	15	25	37	61	5	8	3	5	1	2	**2.0**
8.3	7	11	34	56	17	28	3	5	0	0	**2.3**
8.4	5	8	31	53	17	29	6	10	0	0	**2.4**
8.5	11	18	43	70	7	11	0	0	0	0	**1.9**
9.1	16	27	29	48	11	18	4	7	0	0	**2.1**
9.2	11	19	28	47	16	27	4	7	0	0	**2.2**
9.3	3	5	20	36	16	29	16	29	1	2	**2.9**
9.4	4	7	16	28	23	40	13	22	2	3	**2.9**
9.5	7	12	11	19	29	49	9	15	3	5	**2.8**
9.6	11	18	14	23	11	18	20	33	4	7	**2.9**
10.1	0	0	3	43	2	29	1	14	1	14	**3.0**
10.2	0	0	4	57	1	14	2	29	0	0	**2.7**
10.3	0	0	2	29	2	29	3	43	0	0	**3.1**
10.4	1	14	5	71	0	0	1	14	0	0	**2.1**
11.1	20	33	27	45	6	10	7	12	0	0	**2.0**
11.2	10	17	25	42	11	18	10	17	4	7	**2.6**
11.3	16	27	37	62	4	7	3	5	0	0	**1.9**
11.4	12	21	24	43	12	21	6	11	2	4	**2.3**
11.5	12	21	19	33	10	18	11	19	5	9	**2.6**
11.6	12	21	34	59	11	19	1	2	0	0	**2.0**
11.7	9	16	25	45	15	27	7	13	0	0	**2.4**
11.8	11	19	35	59	7	12	5	8	1	2	**2.2**
12.1	8	14	36	62	7	12	7	12	0	0	**2.2**
12.2	14	24	40	68	5	8	0	0	0	0	**1.8**
12.3	13	22	38	64	5	8	3	5	0	0	**2.0**
12.4	4	7	24	41	19	33	11	19	0	0	**2.6**
12.5	32	54	22	37	4	7	1	2	0	0	**1.6**
12.6	16	27	24	41	14	24	4	7	1	2	**2.2**
13.1	9	16	29	50	9	16	11	19	0	0	**2.4**

13.2	13	22	28	48	6	10	11	19	0	0	**2.3**
13.3	24	41	31	53	3	5	1	2	0	0	**1.7**
13.4	14	25	20	35	10	18	9	16	4	7	**2.5**
13.5	12	21	18	32	14	25	10	18	3	5	**2.5**
14.1	18	31	33	56	4	7	3	5	1	2	**1.9**
14.2	17	28	29	48	12	20	2	3	1	2	**2.0**
14.3	24	39	31	51	1	2	4	7	1	2	**1.8**
14.4	25	41	28	46	4	7	4	7	0	0	**1.8**
14.5	5	8	22	37	11	19	15	25	6	10	**2.8**
14.6	13	22	35	59	10	17	1	2	0	0	**2.0**
14.7	17	29	25	42	15	25	2	3	0	0	**2.0**
15.1	14	23	36	60	6	10	3	5	1	2	**2.0**
15.2	16	27	31	53	9	15	3	5	0	0	**2.0**
15.3	9	15	28	47	16	27	6	10	1	2	**2.4**
15.4	4	7	22	37	17	28	15	25	2	3	**2.8**
15.5	10	17	27	47	13	22	6	10	2	3	**2.4**
16.1	9	15	34	57	15	25	2	3	0	0	**2.2**
16.2	2	3	39	65	15	25	4	7	0	0	**2.4**
16.3	9	15	36	60	10	17	4	7	1	2	**2.2**
16.4	20	33	31	52	4	7	5	8	0	0	**1.9**
16.5	16	27	25	42	13	22	6	10	0	0	**2.2**
17.1	17	28	28	47	12	20	3	5	0	0	**2.0**
17.2	36	59	23	38	2	3	0	0	0	0	**1.4**
17.3	24	40	27	45	6	10	3	5	0	0	**1.8**
18.1	14	23	35	57	9	15	3	5	0	0	**2.0**
18.2	24	39	29	48	6	10	2	3	0	0	**1.8**
18.3	19	32	37	62	3	5	1	2	0	0	**1.8**
19.1	12	20	43	73	4	7	0	0	0	0	**1.9**
19.2	6	10	44	75	8	14	1	2	0	0	**2.1**
19.3	7	12	23	39	23	39	6	10	0	0	**2.5**
19.4	7	12	29	50	15	26	7	12	0	0	**2.4**
20.1	14	24	38	64	5	8	2	3	0	0	**1.9**
20.2	11	18	33	55	14	23	2	3	0	0	**2.1**
20.3	13	22	32	54	12	20	2	3	0	0	**2.1**
20.4	17	28	32	53	8	13	3	5	0	0	**2.0**
20.5	13	22	30	50	14	23	3	5	0	0	**2.1**
20.6	11	19	31	53	12	20	5	8	0	0	**2.2**
20.7	28	47	25	42	1	2	6	10	0	0	**1.8**
20.8	30	50	23	38	3	5	4	7	0	0	**1.7**
20.9	29	48	25	42	2	3	3	5	1	2	**1.7**
Mean											**2.3**

Standard deviation											**0.4**
Summary Section											
a	23	38	32	52	5	8	1	2	0	0	**1.7**
b	14	23	31	51	7	11	8	13	1	2	**2.2**
c	12	20	42	69	6	10	1	2	0	0	**1.9**
d	20	33	38	62	3	5	0	0	0	0	**1.7**
e	12	20	36	59	10	16	3	5	0	0	**2.1**
f	14	23	37	61	8	13	2	3	0	0	**2.0**
g	6	10	3	5	52	85					
h	13	21	43	70	3	5	2	3	0	0	**1.9**

Appendix B: Set of Problems Identified by Learners

	Problem	
	Category 1: General interface design heuristics	***F***
1	**Visibility of system status**	
	1.1 When doing a quiz/test, if an answer has already been saved and then if one changes his/her mind and selects another answer and clicks the Save Answer button, there should be feedback by the system to confirm that the later answer is the one accepted.	1
	1.2 The time allocated to do a quiz/test should be known before, instead of after the user clicks on the button to start the test.	1
2	**Match between the system and the real world i.e., match between designer model and user model**	
	2.1 Symbols are not meaningful.	8
	2.2 Some terminologies are unfamiliar.	5
	2.3 Calendar should be called a Diary	1
3	**User control and freedom**	
	3.1 There are no facilities for Undo and Redo.	16
	3.2 The system is slow to respond.	13
	3.3 There is no system exit button.	12
	3.4 When doing a quiz/test, if the test is submitted before the time expires, one should have a chance to change answers within the time limit.	7
	3.5 It is not easy to print site content.	1
	3.6 There is no 'Print version' of the notes in the Table of Contents.	1
4	**Consistency and adherence to standards**	
	4.1 Same symbols/icons represent different things.	7
	4.2 Background colour is white on some pages and blue on others	6

	4.3 In order to be consistent, the format for the self test should be the same as that of the quiz/test.	2
	4.4 All pages should have a title, but the Introduction page does not.	1
	4.5 On the Course Material page, the size and layout of the 'Databases' icon should be consistent with the other icons by not having a different size and shape.	1
5	**Error prevention, specifically prevention of peripheral usability-related errors**	
	5.1 The system does not always give error messages to prevent errors from occurring.	3
	5.2 When doing a quiz/test, the system should inform the user immediately he/she tries to move away from a question, that the answer selected is not saved. Instead, the user is informed at the end of the quiz/test.	3
	5.3 Whatever is entered into the system is accepted. There are no ways to avoid erroneous/meaningless entries.	2
6	**Recognition rather than recall**	
	6.1 Instructions on how to perform some tasks are not visible.	1
	6.2 On the View Results page for multiple choice questions for quizzes/tests, the row in which the correct answer is located should be bold so that it is easily recognisable.	1
	6.3 There is no obvious relationship between controls and their actions.	1
	6.4 Some links, BlackBoard™ default links, such as Resume Course, are difficult to recognise since they are labelled in small fonts.	1
7	**Flexibility and efficiency of use**	
	7.1 It is not easy to navigate the system using the keyboard only.	7
	7.2 The system cannot be customised.	5
	7.3 There are no shortcuts provided.	4
	7.4 The system is not flexible "you do what is exactly required and leave it that way"	3
	7.5 The system does not cater for novice users.	2

	7.6 It is not easy to use the Help System. For example, the structure of the Help System is confusing.	1
8	**Authenticity and minimalism in design**	
	8.1 Notices on the Notice Board should show the dates when they were posted.	10
	8.2 When starting a quiz /test, there is too much info in one window.	2
	8.3 The use of a three-window design for the Table of Contents makes it difficult to read the content.	1
	8.4 Instead of saving answers one-by-one, there should be one Save Answers button for the entire quiz/test, to minimise time loss.	1
9	**Recognition, diagnosis, and recovery from errors**	
	9.1 The error messages given are not helpful, for they do not provide any instructions to fix errors.	7
	9.2 If a typed command (data) results in an error message, one has got to retype the entire command instead of repairing the faulty part only.	3
	9.3 When the wrong password is entered for a quiz/test, the error message should be in a text box instead of appearing on the screen where it is entered.	1
10	**Help and documentation**	
	10.1 It is not easy to search for information on the site.	3
	10.2 The Help System is not appropriate for the user, since it refers to issues more relevant to the designer than to the learner.	2
	10.3 There is no FAQ section.	1
	10.4 There is no section on how to use the site.	1
	Category 2: Website-specific design (educational websites) Heuristics	***f***
11	**Simplicity of site navigation, organisation and structure**	
	11.1 There is no Forward/Next button.	10
	11.2 There is no Back button so it is difficult to link back to the previous page.	8

	11.3 On the Home page, the options should be arranged in a more natural order.	2
	11.4 The Course menu should show where the user is.	1
	11.5 Visited links do not show this by colour.	1
	11.6 There should be links to sections inside the same page to minimise scrolling.	1
	11.7 The colours of the links are not consistent with Web conventions, i.e., non-visited links are not blue and visited ones are not green or purple.	1
	11.8 The link to the library under Useful Links should link to the relevant materials in the library, but not to the library's search section.	1
	11.9 There should be Forward and Back buttons within the site apart from those on the browser.	1
	Category 3: Learner-centred instructional design heuristics	***f***
13	**Clarity of goals, objectives and outcomes**	
	13.1 Calendar information is not sufficient.	6
	13.2 Course goals are not clear.	3
	13.3 Links on main page should be accompanied by brief explanations of what is found in the sections to which they are linked.	2
14	**Collaborative learning**	
	14.1 Although facilities exist for learner-learner and learner-teacher interactions, there are no procedures in place to encourage their use.	3
	14.2 There are no facilities for synchronous communication such as video conferencing.	1
18	**Feedback, guidance and assessment**	
	18.1 Glossary is not sufficient. More terms/phrases need to be defined.	3
	18.2 Each unit must have its self test.	2

	18.3 In Question 1 of the quiz/test done, the word 'metadata' is shown as the correct answer, but 'Metadata' is marked wrong whereas learners were not informed that the system is case sensitive.	2
	18.4 The feedback provided via the system about the learners' activities (such as tests and assignments) is limited.	2
	18.5 The guidance provided via the system about the learners' activities is limited. For example, diagrams and pictures should be used to illustrate learning concepts.	2
	18.6 Class lecture slides/notes, and quiz/test and assignment solutions should be available on the site.	3
	18.7 Diagrams and pictures should be used to illustrate learning concepts.	2
	18.8 There should be links to previous years' learning material.	1
20	**Motivation, creativity and active learning**	
	20.1 There are inadequate activities to attract learners to the site.	3
	20.2 More content is required to encourage learners to compare, analyse or classify information so as to promote active	2

Appendix C: Heuristic Evaluation Documents

Heuristics for Expert Evaluators

Evaluation of the e-learning Platform

Heuristic evaluation criteria

	Category 1: General interface design heuristics
1	**Visibility of system status** • The website keeps the user informed about what is going on through constructive, appropriate and timely feedback. • The system responds to actions initiated by the user. There are no surprise actions by the site or tedious sequences of data entries.
2	**Match between the system and the real world i.e., match between designer model and user model** • Language usage such as terms, phrases, symbols, and concepts, is similar to that used by the users in their day-to-day environment. • The metaphor usage corresponds to that of real-world objects or concepts. For example, understandable and meaningful symbolic representations are used to ensure that the symbols, icons and names used are intuitive within the context of the performed task.
3	**User control and freedom** • Users control the system. • Users can exit the system at any time even when they have made mistakes. • There are facilities for Undo and Redo.
4	**Consistency and adherence to standards** • The same concepts, words, situations, or actions refer to the same thing. • Common platform standards are followed.

5	**Error prevention, specifically prevention of peripheral usability-related errors** • The system is designed such that the users cannot easily make serious errors.
6	**Recognition rather than recall** • Objects to be manipulated, options for selection, and actions to be taken are visible. • The user does not need to recall information from one part of a dialogue to another. • Instructions on how to use the system are visible or easily retrievable whenever appropriate.
7	**Flexibility and efficiency of use** • The site caters for different levels of users, from novice to experts. • Shortcuts or accelerators, unseen by the novice users, are provided to speed up interaction and task completion by frequent users. • The system is flexible enough to enable users to adjust settings to suit themselves, i.e., customise the system.
8	**Authenticity and minimalism in design** • Site dialogues do not contain irrelevant or rarely needed information, which could distract users as they perform tasks.
9	**Recognition, diagnosis, and recovery from errors** • Error messages are expressed in plain language. • Error messages indicate precisely what the problem is and give quick, simple, constructive, specific instructions for recovery. • If a typed command results in an error, the user does not have to retype the entire command, but rather repair only the faulty part.

10	**Help and documentation** • The site has a help facility and other documentation to support the user's needs. • The information in these documents is easy to search, focused on the user's task and lists concrete steps to be carried out to accomplish a task.
Category 2: Website-specific design (educational websites) heuristics	
11	**Simplicity of site navigation, organisation and structure** • The site has a simple navigational structure. • Users should know where they are and have options of where to go next, i.e., they should be aware of what has been completed and what is still to be done. • The navigational options are limited so as not to overwhelm the user. • Related information is placed together. • Information is organised hierarchically, starting with general information then specific. • Common browser standards are followed.
Category 3: Learner-centred instructional design heuristics	
13	**Clarity of goals, objectives and outcomes** • There are clear goals, objectives and outcomes for learning encounters. • The reason for inclusion of each page or document on the site is clear.
14	**Collaborative learning** • Facilities and activities are available that encourage learner-learner and learner-teacher interactions. • There are facilities for both asynchronous and synchronous communication, such as e-mail, discussion forums and chat rooms.

18	**Feedback, guidance and assessment** • Apart from the interface-feedback by the system, as described in Criterion 1, learners give and receive prompt and frequent feedback about their activities and the knowledge being constructed. • Learners are guided as they perform tasks. • Quantitative feedback, for example, in terms of grading learners' activities, is given so that learners are aware of their level of performance.
20	• The site has features that motivate learners, and promotes creativity by engaging learners. For example, the activities in the application are situated in practice and will interest and engage learners. • To promote active learning, learners are encouraged to compare, analyse or classify information, or make deductions from it. • In order to attract and retain learners, the application engages them by its content and interaction.

Set of Problems Identified by Expert Evaluators

	Problem	Eval
	Category 1: General interface design heuristics	
1	**System status**	
	1.1 When doing a quiz/test, if an answer has already been saved and then if one changes his/her mind and selects another answer and clicks the Save Answer button, there should be feedback by the system to confirm that the later answer is the one accepted.	3
	1.2 When submitting a quiz/test, the following message is given in a dialog box "All questions have been answered and all answers have been saved. Do you want to proceed?" with an OK and Cancel button. In this case the cancel option is confusing since it not clear whether it refers to the cancellation of this step or of the whole quiz/test.	3
	1.3 When starting a quiz/test, it is surprising that though the only button on this page is Begin Quiz, when the enter key is used, the system displays the same page, still with the Begin Quiz button, with the exception of the textbox and the instructions for entering the password.	2
	1.4 In rare circumstances, when some of the links on the Course Menu (site index) are clicked on, the message "Not been configured to run with framesets" appears and the Course Menu disappears. This is a surprise action.	4
2	**The System represents real world i.e., designer approach vs learner models**	
	2.1 When notes are taken for the first time, the button for saving them should not be labelled 'Update'.	3
	2.2 'My progress' option should not refer to the number of times different pages have been visited but rather to marks/grades gained or proportion of work covered.	3
	2.3 When doing online assessment, the term 'Test' rather than 'Quiz' should be used since learners are not familiar with the later.	4
	2.4 Under Discussions, the status of a topic could be 'Public, Unlocked'. These terms are not familiar to learners.	3
	2.5 In the discussion forum, the use of 'Title' and 'Topic' is confusing.	3
	2.6 The Calendar object should be called a Diary.	4

	2.7 The options, such as 'Content module table of contents', given in the dropdown list on the Search page should match with those on the Course Menu options.	3
	2.8 Symbols such as the icons used on the Home Page are not meaningful.	3
	2.9 The terminology, such as 'Content module' and 'Content page', used by the Help System is unfamiliar to users (learners).	3
	2.10 On the Communicate page, the options should be arranged in alphabetic order i.e., Discussion, Mail and Notice Board, instead of Discussion, Notice Board and Mail, as is the case now.	2
	2.11 The visual layout of the Course Menu should be more natural in that items at the same site level have the same alignment. For example, those on the Home Page (level 1) should have the same alignment.	2
3	**User control and freedom**	
	3.1 There are no facilities for Undo and Redo.	2,3
	3.2 There is no system exit button.	4
	3.3 There is no way to exit the Help System to the main system, apart from closing the Help window.	4
	3.4 Sometimes the system is slow to respond.	4
	3.5 It is not easy to print the Learner Guide and there is no 'Print version' of the notes found in the hyperlinks in the Table of Contents.	1,2,3
4	**Adherence to standards and Design Consistency**	
	4.1 Same symbols/icons represent different things. For example, on the Home Page the icon for Student Resources is the same as that for Assessment.	4
	4.2 On the Course Material page, the size and layout of the 'Databases' icon should be consistent with the other icons by not having a different size and shape.	3
	4.3 In the Learner Guide the spaces between sections should be consistent. Some should not be single and others double.	3
	4.4 In order to be consistent, the format for the self test should be the same as that of the quiz/test. For example, a mark/grade should be allocated as is done with a quiz/test.	2,3,4
5	**Prevention of Errors**	

	5.1 In some cases, there are no ways to avoid erroneous/meaningless entries. For example, in Discussions, whatever is entered as a title or message is accepted.	3
	5.2 The system does not give error messages to prevent errors from occurring.	3
6	**Recall instead of Recognise**	
	6.1 When starting a quiz/test, after entering the password, there should be an Enter button next to the textbox for the password instead of the Begin Quiz button which is a number of line spaces down from the textbox.	2
	6.2 When there is a space in a fill-in-the-answer type of question in a quiz/test, it is not clear whether to insert the answer in that space or in the text box given after the question.	3
	6.3 When performing a quiz/test, the error message, for example, when time has elapsed refers to 'Submit quiz' but the button used to submit the quiz is labelled Finish.	2
	6.4 On the View Results page for quizzes/tests, 'Attempt: 1/1' is confusing since the '1/1' could be mistaken for a score.	3
	6.5 On the Statistics page for quizzes/tests, it is not easy to recognise that the check box on the left must be checked before the statistics for	4
	6.6 On the Statistics page for quizzes/tests, it is not easy to know when to use the options 'Summary Statistics' or 'Item Statistics'.	4
	6.7 In the Take Notes section, when the View All option is selected, it is difficult to know which notes relate to which section since for each section only the words 'Objectives' and 'Overview' are listed without showing the name of the main section they belong to.	2,3
	6.8 It is not easy to recognise that by clicking on the Course Menu arrow the Course Menu window disappears or reappears.	1
	6.9 On the Course Menu, the Home Page link should be bold so that it clearly stands out from the rest.	2
	6.10 On the View Results page for multiple choice questions for quizzes/tests, the row in which the correct answer is located should be bold so that it is easily recognisable.	3
7	**Efficiency of use and Flexibility**	
	7.1 There are no shortcuts provided.	3,4

	7.2 The system cannot be customised. For example, whereas the three-window design in the Table of Contents can be customised to a two-window one, by clicking on the arrow on the left of Course Menu, it is not possible to customise it to a single window.	1,3,4
	7.3 The system is not flexible in its use.	4
	7.4 The system does not cater for different levels of users.	4
	7.5 When entering date/time values, in order to speed up data entry, the default values should be '00' instead of '--'. For example, if the user needs to enter the time as 13h00 in the calendar, he/she should not be forced to select the '00' to replace the '--'.	2
	7.6 The Discussions facility is not easy to use.	3
	7.7 It is difficult to perform tasks on the Calendar. For example, after adding an entry to the Calendar, it is not clear how to go back to the main system.	4
	7.8 It is not easy to use the Help System.	4
8	**Authenticity and minimalism in design**	
	8.1 Notices on the Notice Board should show the dates when they were posted.	3
	8.2 The use of a three-window design for the Table of Contents makes it difficult to read the content.	1
	8.3 When starting a quiz /test, there should be one window with instructions on how to do the test followed by another one for entering the password. This would be preferable to clustering all the information on one window.	2
9	**Diagnosis, Error Recognition and Recovery**	
	9.2 The error messages given are not helpful, for they do not provide any instructions for recovery.	3,4
10	**Documentation and online Help**	
	10.1 The Help System is not appropriate for the user, since it refers to issues that are more relevant to the course designer (such as	3
	10.2 It is not easy to search for information on the site.	2

	10.3 There is no obvious help given to show how to reduce the three-window design to a two- or one-window design.	1
Category 2: WBLP specific design heuristics		
11	**Content Organisation, site navigation and structure**	
	11.1 The Course Material page should only have the content modules – Databases and Project Management. The Syllabus (Learner Guide) should not be on this page.	3
	11.2 There should be links to the different sections of the learner Guide to minimise scrolling and the Table of Contents should not only have links to its main sections, but also to its subsections.	3,4
	11.3 In the Table of Contents, for example, that of the Databases module, the Previous Page button should refer to the page that the user was on before the current one, but not to the previous section of the Table of Contents.	3
	11.4 In the Help window, the Back button should refer to the page that the user was on before the current one, but not to the previous section the Help System.	4
	11.5 Site content is not arranged hierarchically, from general to specific.	2
	11.6 In order to improve on the readability of the Course Menu, there should be bigger spaces between its different sections than between items of the same sections.	2
	11.7 On the Course Menu, the Communicate option should be positioned last, so that there is space for it to grow its submenu as more information is subsequently added, for example, new notices.	2
	11.8 The Breadcrumbs of the site come out clearly when the links within the page are used for navigation, but do not come out when the Course Menu links are used.	2
	11.9 On the Course Menu, Term Test 2 Scope link should not be aligned with the links on the Home Page since it is not on the Home Page.	2
	11.10 There should be lines between the different windows in the two- or three-window design.	2
	11.11 The Course Menu should be wider than it is to enhance its readability.	2
Category 3: Instructional design heuristics		
13	**Learning objectives and Outcome is clear to the learner**	

	13.1 Course goals are not clear.	3
	13.2 The main course goals/objectives should be visible or immediately accessible on the Home Page.	4
	13.3 Each link on the Home Page needs a brief description/indication, underneath it, of the information to be found by selecting it.	4
	13.4 Calendar information is not sufficient to assist the learner in determining what is to be done when.	3
14	**Collaborative learning**	
	14.1 Although facilities exist for learner-learner and learner-teacher interactions, there are no procedures in place to encourage their use.	3,4
18	**Feedback, guidance and assessment**	
	18.1 The feedback and the guidance provided via the system about the learners' activities (such as tests and assignments) are limited.	3,4
	18.2 Feedback should be more obvious to the user.	2
	18.3 There is limited guidance to the learners as they perform tasks, for example, apart from the explanation "The logical structure is visualized as a matrix composed of intersecting rows, one for each entity, and columns, one for each attribute" , a graphical illustration of this relationship should be provided.	1,3,4
	18.4 Diagrams and pictures should be used to illustrate learning concepts.	1
	18.5 The way content is provided to learners is sometimes misleading, for example, when the question "what are keys?" is asked; the question is not answered but instead, examples of the different keys are given.	1
	18.6 In order to guide learners, database specific jargon should be hyper-linked to the Glossary or to a section where they are explained later in the text. For example, in the sentence "The relational database makes use of *controlled redundancy* to maintain *integrity* while linking related tables", the italicised words should be hyper-linked to their meaning.	1
	18.7 In Question 1 of the quiz/test done during the evaluation, the word 'metadata' is shown as the correct answer but 'Metadata' is marked wrong. However, learners were not informed that the system is case sensitive	1
	18.8 Glossary is inadequate. More terms/phrases need to be defined.	2

20	**Motivation, Active thinking and Creativity**	
	20.1 There is no site content that encourages learners to compare, analyse or classify information so as to promote active learning	2,4
	20.2 There are inadequate activities on the site to attract or engage learners.	3

Appendix D: Severity Rating Form and Results

Severity Rating Form

Heuristic evaluation: Severity rating of problems Scale to use

Description	Score
Cosmetic problem: will not affect the use of the system. Fix it if possible.	1
Minor problem: users can easily work around the problem. Fixing this should be given a low priority.	2
Medium problem: users are likely to encounter this problem but will quickly adapt to it. Fixing this should be given medium priority.	3
Major problem: users will find this problem difficult but may be able to find workarounds. It is important to fix this problem. Fixing it should be given a high priority.	4
Catastrophic problem: users will be unable to do their work because of this problem. Fixing it is mandatory.	5
Not Applicable: I don't consider this to be a problem	N

Use the given scale to indicate the severity of each of the problems in the table that follows. Insert the numbers (1-5) or N alongside the problem in the **Sc**(Score) column to show your rating. In some cases, the statement in the 'Problem' column is not actually a problem. Rather, it is a proposal to rectify a problem or it is a suggested change (e.g. as in 2.1). In such cases please rate the underlying problem. For example, if you strongly agree with the proposal, then enter a score of 5. The **Ex** and **St** columns give weightings according to how many experts and students, respectively, identified the problem. The problems for each criteria are grouped in descending order, according to the number of experts who identified the problem.

	Problem			
	Category 1: General interface design heuristics			
1	**Visibility of system status**	**Ex**	**St**	**Sc**
	1.1 When doing a quiz/test, if an answer has already been saved and then if one changes his/her mind and selects another answer and clicks the Save Answer button, there should be feedback by the system to confirm that the later answer is the one accepted.	1	1	
	1.2 When submitting a quiz/test, the following message is given in a dialog box "All questions have been answered and all answers have been saved. Do you want to proceed?". It is accompanied by an OK and a Cancel button. In this case the cancel option is confusing, since it is not clear whether it refers to the cancellation of this step or of the whole quiz/test.	1	0	
	1.3 When starting a quiz/test, the only button on this page is Begin Quiz. It is surprising that, when the Enter key is used, the system displays the same page, still with the Begin Quiz button, with the exception of the textbox and the instructions for entering the password.	1	0	
	1.4 In rare circumstances, when some of the links on the Course Menu (site index) are clicked, the message "BlackBoard™ has not been configured to run with framesets" appears and the Course Menu disappears. This is a surprise action.	1	0	
	1.5 The time allocated to do a quiz/test should be known before, instead of after the user clicks on the button to	0	1	
2	**Match between the system and the real world i.e., match between designer model and user model**	**Ex**	**St**	**Sc**
	2.1 Some labels/names should be changed if they are to be meaningful. For example, when notes are taken for the first time, the button for saving them should not be labelled 'Update', and the Calendar object should be called a Diary.	2	1	
	2.2 Symbols such as the icons used on the Home Page are not meaningful.	1	8	

	2.3 Some terminologies are unfamiliar; for example, under Discussions, the status of a topic could be 'Public, Unlocked'. Learners (users) do not	1	5	
	page', used by the Help System are unfamiliar to users.			
	2.4 The options, such as 'Content module table of contents', given in the dropdown list on the Search page should match those on the Course Menu options.	1	0	
	2.5 On the Communicate page, the options should be arranged in alphabetic order i.e., Discussion, Mail and Notice Board, instead of Discussion, Notice Board and Mail, as is the case now.	1	0	
	2.6 The visual layout of the Course Menu should be more natural in that items at the same site level should have the same alignment. For example, those on the Home Page (level 1) should have the same alignment.	1	0	
3	**User control and freedom**	Ex	St	Sc
	3.1 It is not easy to print site content, such as the Learner Guide and Content Modules. For example, there is no 'Print version' of the notes found in the hyperlinks in the Table of Contents.	3	2	
	3.2 There are no facilities for Undo and Redo.	2	16	
	3.3 Sometimes the system is slow to respond.	1	13	
	3.4 There is no system exit button.	1	12	
	3.5 There is no way to exit the Help System to the main system, apart from closing the Help window.	1	0	

	3.6 When doing a quiz/test, if the test is submitted before the time expires, one should have a chance to change answers within the time limit.	0	7	
4	**Consistency and adherence to standards**	Ex	St	Sc
	4.1 In order to be consistent, the format for the self test should be the same as that of the quiz/test. For example, a mark/grade should be allocated as is done with a quiz/test.	3	2	
	4.2 Same symbols/icons represent different things. For example, on the Home Page the icon for Student Resources is the same as that for Assessment.	1	7	
	4.3 There should be consistency in the spacing and size of items. For example, in the Learner Guide the spaces between some sections are single while other are double.	1	1	
	4.4 Background colour is white on some pages and blue on others.	0	6	
	4.5 All pages should have a title, but the Introduction does not.	0	1	
5	**Error prevention, specifically prevention of peripheral usability-related errors**	Ex	St	Sc
	5.1 The system does not give error messages to prevent errors from occurring.	1	3	
	5.2 In some cases, there are no ways to avoid erroneous/meaningless entries. For example, in Discussions, whatever is entered as a title or	1	2	
	5.3 When doing a quiz/test, the system should inform the user immediately he/she tries to move away from a question, that the answer selected is not saved. Instead, the user is informed at the end of the quiz/test.	0	3	

6	**Recognition rather than recall**	Ex	St	Sc
	6.1 It is sometimes difficult to recognise the relationship between different sections, between actions and their results or between controls and their actions. For example, in the Take Notes section, when the View All option is selected, it is difficult to know which notes relate to which section, and it is not easy to recognise that by clicking on the arrow next to the 'Course Menu' label the Course Menu window disappears or reappears.	4	1	
	6.2 Instructions on how to perform tasks should be visible; for example, they should be bold and/or in large font sizes.	2	3	
	6.3 When starting a quiz/test, after entering the password, there should be an Enter button next to the textbox for the password, instead of the Begin Quiz button which is several line spaces down from the textbox.	1	0	
	6.4 When there is a space in a fill-in-the-answer question in a quiz/test, it is not clear whether to insert the answer in that space or in the text box after the question.	1	0	
	6.5 On the View Results page for quizzes/tests, 'Attempt: 1/1' is confusing since the '1/1' could be mistaken for a score.	1	0	
7	Flexibility and efficiency of use	Ex	St	Sc
	7.1 The system cannot be customised.	3	5	
	7.2 There are no shortcuts provided.	2	4	
	7.3 It is not easy to perform tasks using some of the facilities such as the Calendar, Discussions and Help System.	2	1	

	7.4 The system is not flexible in its use.	1	3	
	7.5 The system does not cater for different levels of users.	1	2	
	7.6 When entering date/time values, in order to speed up data entry, the default values should be '00' instead of '--'. For example, if the user needs to enter the time as 13h00 in the Calendar, he/she should not be forced to select the '00' to replace the '--'.	1	0	
	7.7 It is not easy to navigate the system using the keyboard only.	0	7	
8	**Authenticity and minimalism in design**	Ex	St	Sc
	8.1 Notices on the Notice Board should show the dates when they were posted.	1	10	
	8.2 When starting a quiz /test, there should be one window with instructions on how to do the test followed by another window for entering the password. This would be preferable to clustering all the information on one window.	1	2	
	8.3 The use of a three-window design for the Table of Contents makes it difficult to read the content.	1	1	
	8.4 Instead of saving answers one-by-one, there should be one Save Answers button for the entire quiz/test, to minimise time loss.	0	1	
9	**Recognition, diagnosis, and recovery from errors**	Ex	St	Sc
	9.1 The error messages given are not helpful, for they do not provide any instructions to fix errors.	2	7	

	9.2 If a typed command (data) results in an error message, one has got to retype the entire command instead of repairing the faulty part.	0	3	
	9.3 When the wrong password is entered for a quiz/test, the error message should be in a text box instead of appearing on the screen where it is entered.	0	1	
10	**Help and documentation**	Ex	St	Sc
	10.1 It is not easy to search for information on the site.	1	3	
	10.2 The Help System is not appropriate for the user, since it refers to issues more relevant to the course designer (or educator) than to the learner.	1	2	
	10.3 There is no obvious help given to show how to reduce the three-window design to a two- or one-window design.	1	0	
	10.4 There is no FAQ section.	0	1	
	10.5 There is no section on how to use the site.	0	1	
	Category 2: Website-specific design (educational websites) heuristics	Ex	St	Sc
11	**Simplicity of site navigation, organisation and structure**			
	11.1 Site content is not arranged hierarchically, from general to specific.	2	2	

	11.2 There should be links to sections inside the same page/document to minimise scrolling.	2	1	
	11.3 The Back button should refer to the page that the user was on before the current one; for example, in the Help System the Back button should not refer to the previous section of the of the Help System but rather to the one visited before the current one.	2	0	
	11.4 In order to improve readability, the Course Menu should be wider, and the spaces between its different sections should be larger than the spaces between items of the same sections	1	0	
	11.5 There should be lines between the different windows in the two- or three- window design.	1	0	
	11.6 On the Course Menu, the Communicate option should be positioned last, so that there is space for it to grow its submenu as more	1	0	
	11.7 The Breadcrumbs of the site come out clearly when the links within the page are used for navigation, but do not come out when the Course Menu links are used.	1	0	
	11.8 Apart from the buttons provided by the browser, there should be a Back/Previous and Forward/Next button within the application.	0	19	
	11.9 There should be colour differences between the visited, non-visited and current site links.	0	3	
	11.10 The link to the library under Useful Links should link to the relevant study materials in the library, but not to the library's search section.	0	1	
	Category 3: Learner-centred instructional design heuristics	Ex	St	Sc
13	**Clarity of goals, objectives and outcomes**			

	13.1 Calendar information is not sufficient to assist the learner in determining what is to be done when.	1	6	
	13.2 Course goals are not clear.	1	3	
	13.3 Each link on the Home Page needs a brief description/indication, underneath it, of the information to be found by selecting it.	1	2	
	13.4 The main course goals/objectives should be visible or immediately accessible from the Home Page.	1	0	
14	**Collaborative learning**	Ex	St	Sc
	14.1 Though facilities for learner-learner and learner-teacher interactions exist, there are no procedures in place to encourage their use.	2	3	
	14.2 There are no facilities for synchronous communication such as video conferencing.	0	1	
18	**Feedback, guidance and assessment**	Ex	St	Sc
	18.1 There is limited guidance to the learners as they perform tasks. For example, the explanation "The logical structure is visualized as a matrix composed of intersecting rows, one for each entity, and columns, one for each attribute", should be supplemented with a graphical illustration (diagrams/pictures) of this relationship.	3	4	
	18.2 The feedback provided via the system about the learners' activities is limited and not obvious to the learners.	3	2	
	18.3 Glossary is inadequate. More terms/phrases need to be defined.	1	3	

	18.4 In Question 1 of the quiz/test the word ‘metadata’ is shown as the correct answer, but ‘mettadata’ and ‘Metadata’ are both marked wrong. However, learners were not informed that exact spelling is necessary or that the system is case sensitive.	1	2	
	18.5 The way content is provided to learners is sometimes misleading, for example, when the question “what are keys?” is asked; the question is not answered but instead, examples are given of the different keys.	1	0	
	18.6 In order to guide learners, database-specific jargon should be hyper-linked to the Glossary or to a section where terms are explained later in the text. For example, in the sentence “The relational database makes use of controlled redundancy to maintain integrity while linking related tables”, the italicised words should be hyper-linked to their meanings or definitions.	1	0	
	18.7 Class lecture slides/notes, and quiz/test and assignment solutions should be available on the site.	0	3	
	18.8 There should be links to previous year’s learning material.	0	1	
20	**Motivation, creativity and active learning**	Ex	St	Sc
	20.1 There is no site content that encourages learners to compare, analyse or classify information so as to promote active learning or intuition.	2	2	
	20.2 There are inadequate activities on the site to attract or engage learners.	1	3	

Severity Rating of First Two Problems of each Criterion

Criterio	Problem	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Average
1	**1.1**	4	4	3	3	**3.5**
	1.2	3	2	3	4	**3.0**
2	**2.1**	4	2	2	4	**3.0**
	2.2	4	4	4	4	**4.0**
3	**3.1**	5	1	4	4	**3.5**
	3.2	5	5	5	4	**4.8**
4	**4.1**	3	5	4	3	**3.8**
	4.2	4	5	4	4	**4.3**
5	**5.1**	3	5	5		**4.3**
	5.2	3	4	4	2	**3.3**
6	**6.1**	4	3	4	4	**3.8**
	6.2	3	2	3	3	**2.8**
7	**7.1**	3	1	4	3	**2.8**
	7.2	3	1	4	3	**2.8**
8	**8.1**	5	5	1	4	**3.8**
	8.2	4	2	1	2	**2.3**
9	**9.1**	4	5	5	4	**4.5**
	9.2	4	3	4	3	**3.5**
10	**10.1**	4	4	3	3	**3.5**
	10.2	4	4	4	4	**4.0**
11	**11.1**	2	5	3	3	**3.3**
	11.2	3	3	3	3	**3.0**
13	**13.1**	4	5	3	4	**4.0**
	13.2	3	5	4	4	**4.0**
14	**14.1**	4	3	3	4	**3.5**
	14.2	1	1	1	2	**1.3**
18	**18.1**	3	2	4	4	**3.3**
	18.2	3	4	4	4	**3.8**
20	**20.1**	4	4	3	3	**3.5**
	20.2	4	3	3	4	**3.5**
Mean		**3.6**	**3.4**	**3.4**	**3.4**	**3.5**
Standard deviation		**0.9**	**1.4**	**1.1**	**0.7**	**0.7**

Phases of the Heuristics Evaluation

Phases

1. Read all the documents provided. They include the following:
   i. Phases: use Expert*Eval-Phases* document (this document)
   ii. System and user profiles: use *SystemandUserProfile* document
   iii. Procedure: use *Eval-Procedure* document
   iv. Consent form: use Expert*Eval-Consent* document
   v. Heuristic evaluation criteria: use Expert*Eval-Heuristics* document

2. Familiarise yourself with the evaluation criteria (heuristics) that you will use. A brief description of each heuristic is given in the table. Note that the word 'user' refers to a learner and 'system' to the website. The skipped numbers in the table refer to criteria that are specifically for evaluation of content or that deal with issues which can only be answered by the individual learner, but not by you the expert.

3. Please set apart about 2 hours to perform the evaluation. Make sure you have Internet access during that time.

4. Perform the actual evaluation. Use *Eval-Procedure* document provided.

5. E-mail the report to me at xxx@yyy.com.

6. Sign the consent form and email.

7. After this initial exercise, a document with a list of the problems identified by all the experts will be sent to you in order to rate the severity of each problem. Rate them and e-mail it back to me.

Thank you very much for participating in this evaluation exercise.

System and User Profile

System and user profile

System and its use

King Saud University bought and implemented BlackBoard™. The university decided to follow a phased implementation and at initial stage the system was made available to mathematics and Computer Science undergraduate students and faculty members. Next phase the system is implemented in the faculty of science and now the system is embedded across the University for teaching at undergraduate and graduate level.

Users

At the time of this research there were about 800 learners registered to use the platform.

Each of these learners has done at least one subject in programming, database design and basic PC hardware and software. They are comfortable with using Microsoft Windows™ (up to 2010) operating system and Microsoft Office™ (Word™, Excel™, PowerPoint™ and Access™ – up to 2007) package. They are also comfortable with using web-based systems, using Internet Explorer™, and e-mail. The learners can be classified as expert computer users and, as such, no training was given to them on how to use the BlackBoard™. However, some instructions were given to them prior to using the system. The learners use the system on campus, since about 40% of them are campus residences and the rest do not have computers at home, and only use computers when on campus. The workstations are accessible to learners even during non-lecture times. The system is accessible on and off-campus at any time of the day.

Procedure for Heuristic Evaluation

Procedure

1. Go to the King Saud University learning platform site (http://yyy.com) and log in as a student. You will be provided with the user name and ID.

2. Take about 15 minutes browsing the site to familiarise yourself with the system.

3. User Tasks: perform the activities listed to get a feel for the use of the system. Your evaluation will be based on these two activities and some other parts of the system.

a. *Content*: read the section on 'The Relational database model' under Course Material 4 Databases 4 Table of Contents. Read both the *Objectives* and *Overview*.
b. *Quiz*: do the quiz named Quiz 2C1 under Assessment 4 Tests and Quizzes. You will be provided with the password for the quiz. Save the answer for each question and submit your answers before the time expires. Click on View Scores to see the score. Click the 1 under Attempts to see the details.

4. List any violations of the heuristics that you identify in the system, i.e., problems that occur (*Ignore other sections in the Table of Contents for Databases and details of any quizzes/tests other than Quiz 2C1, which you have done. However, include any other problems in the other parts of the system*). Please be specific in describing the problem by explaining why it is a problem with respect to the heuristic(s) violated. Each problem should be written out separately. The number in the first column of the table of the heuristics may be used to refer to a particular criterion. You are free to visit any section of the site to identify and describe a problem. Just to make it clear, please evaluate any site component except those inside the content and quizzes/tests that you have been advised to ignore. Concentrate on the user tasks in 3 above other parts of the system.

5. Write a report about the problems. Indicate how long it took you to familiarise yourself with the system, and to do the evaluation itself. At the end of the report you may include comments on how you found the evaluation process. For example, problems you found in the system, but that could not be related to any of the heuristics, heuristics that were not clear, overlapping heuristics, setup of the whole expert evaluation exercise, how the evaluation could have been improved, etc.

6. E-mail the report to me at xxx@yyy.com

Thank you very much for participating in this evaluation exercise.

How to perform the evaluation

As you go through the steps, look out for any problems with the system that may make it difficult to use or make it difficult for you to learn. If you encounter such problems, they will be the kind of issues you will describe in the questionnaire when completing the open block sections at the end. Please do not rush over these parts – your contributions in these sections are very important.

Step 1: When you login to the system, take a few minutes to familiarise yourself with the system if you have forgotten some of its features. Browse the system.

Step 2: Read the section on "The Relational database model" under Course Material 4 Databases 4 Table of Contents. Read both the objectives and overview. This is done in preparation for a quiz you are going to do that will need this information as well as your general knowledge on databases.

Step 3: Do the quiz named Quiz 2C. You will be given the password for the quiz. This and the last step are to remind ourselves of some of the ways we have used the system before.

Step 4: Sign the Student consent form which is attached to this document.

Step 5: Do the system evaluation using the questionnaire. Apart from the problems you may have observed in Step 1 to 3, please feel free to include any other problems you have encountered with this system before. However be specific. As you do the evaluation, you can check back on certain sections of the system, including "The Relational database model" and Quiz 2C to identify problems.

Step 6: Hand the evaluation back to me, as well as this document with the attached consent form.

All information provided by you is treated as being confidential and will only be used for research purposes. If you are interested in the results of this evaluation please include an e-mail address at the end of the questionnaire.
Thank you very much for participating in this evaluation exercise.
Faisal Alghadi (xxx@yyy.com)

Consent Form

Expert evaluation

Consent form

I working as at _____in the department of _____state that I have not been put under any pressure to participate in this evaluation exercise as an expert evaluator, and have willingly involved myself in it.

I realise that the findings of the evaluation will be used for research purposes and that the findings will be published.

Signed _____date_____