Shendi University

Faculty of Post-Graduate Studies & Scientific Research

Toward A Novel Framework for Evaluating the Usability of Web-Based Learning Applications

A thesis submitted to requirement in fulfillment of the degree of M.Sc. in Computer Science

Mohamed Siddig Hassan AbdElgadir

B.Sc. (Statistics and Computer)

Faculty of Science and Technology

Shendi University (2007)

Supervisor:

Dr. Ahmed Salah-Eldeen AbdAllah

March 2015

Dedication

To any one help me „„

Acknowledgement

Firstly, I would like to thank Allah for his continued support me. I would like to take this opportunity to thank my supervisor Dr. Ahmed Salah-Eldeen AbdAllah , I must first thank my best friend Prof. Tagelsir Hassan for supporting me. I would like to thank any people who support me …

Abstract

This study aimed to develop a framework for evaluating the usability of Web-Based Learning Applications (WBLAs). The framework was selected considering relevant previous studies in usability field and web-applications. The methodology used in this study consists of three steps: (1) framework development, (2) usability testing to validate and refine the framework stages and to determine the metrics of usability as factors and criteria and weights for their, and (3) draw a conclusion and make some recommendations.

The selected framework has nine stages Specify usability evaluation goals; a determine of web-learning applications aspects to evaluate; select usability metrics; select evaluation method/s; select tasks; testing design, capture usability data, analyze and interpret usability data; and present usability results.

The result of this study a selected framework of the usability evaluation of WBLAs is needed in order to help ensure good usability. While this framework will have the obvious benefit of making the WBLAs easier and more pleasurable to use, consideration of usability in the application design will also have a significant impact in reducing lifecycle cost, and it has the benefits of (1) improved user experience and productivity, (2) a higher probability of system success, and (3) lowered system lifecycle costs for all stages of application developing.

The study recommended to more metrics and using blended usability evaluation techniques in to find cover problems of usability for web-based learning application in the future.

مستخلص الدراسة

هدفت هذه الدراسة إلى تحديد اطار لتقييم سهولة الاستخدام في تطبيقات التعلم التي تعتمد على الويب ، وتحديد المعايير التي تعكس الملامح الرئيسية لسهولة الاستخدام في هذه التطبيقات .

وقد تم تصميم منهجية هذه الدراسة كدراسة حالة من ثلاثة مراحل. مرحلة تحديد اطار العمل وذلك بتحديد الاطار بدراسة كافة الدراسات السابعة في المجال الخاص بسهولة الاستخدام ، مرحلة اختبار اطار العمل وتحديد الخصائص والعوامل المؤثرة على سهولة الاستخدام في تطبيقات التعلم المعتمدة على الويب، المرحلة الأخيرة هي الوصول إلى عوامل رئيسية المؤثرة على اطار العمل وعرض نتائج سهولة الاستخدام.

وقد وجدت الدراسة أن العوامل والمعايير المحددة في إطار وضعت مهمة لتقييم قابلية الاستخدام في هذا الإطار هو قادرة على تحديد مزايا وعيوب نظام إدارة التعلم المعتمدة على الويب. وينبغي أن تكفل الدراسات المستقبلية أن أكبر حجم العينة المستخدمة وتنوعت أنواع المستخدم، والمعايير التي وضعتها الإطار يمكن أن تكون أفضل اختبار على عدة نظم إدارة التعلم التي تدعم معيار آخر. يمكن أن تركز المزيد من التحقيقات حول كيفية مفروضا على الوزن لكل من الأبعاد الستة بحيث يمكن تحسين الإطار وتطورت إلى أداة تقييم قابلة للتكيف وفعالة مناسبة لتقييم قابلية الاستخدام النظام من مجموعة من نظم إدارة التعلم في بيئات التعلم. واوصت الدراسة باجراء بحصر المزيد من العوامل التي تؤثر في سهولة الاستخدام لتطبيقات التعلم التي تعتمد على الويب، ايضاً استخدام خليط من تقنيات تقييم سهولة الاستخدام لتطبيقات التعلم المعتمدة على الويب.

List of Contents

List of Tables

Table of Figures

List of Abbreviations

HE	**:**	**Heuristic Evaluation**
LMS	**:**	**Learning Management System**
Moodle	**:**	**Modular Object-Oriented Dynamic Learning Environment**
UE	**:**	**Usability Evaluation**
UEM	**:**	**Usability Evaluation Method**
UET	**:**	**Usability Evaluation Technique**
WBL	**:**	**Web-Based Learning**
WBLA	**:**	**Web-Based Learning Application**

Chapter One

Introduction

1.1 Motivations of this study

Developing web-based technologies, which support the individual's personal web-based applications, are gaining immense appreciation and adaptation over worldwide. Among them, user types, communication servers, high-intelligent search engines application and electronic services are focal areas for studying in this time, and future time. The rapid growth in development and implementation of e-service applications like e-commerce or e-business, e-health and e-government … etc. has gone hand-in-hand with a growing demand for e-services. Similarly, increase in the diversity of learners, technological expansion and radical changes in learning tasks, present significant challenges and render the possibility of defining the context of use of e-learning applications more complex than ever (Zaharias, 2006).

Evaluating the usability of web-based learning applications is not a trivial task. A boost in the diversity of learners, technological advancements, and major changes in learning tasks (learner interaction with a learning/training environment is often a one-time event) present significant challenges and render the prospect of defining the context of use of web learning applications more complex than ever before. Identifying whom the users are and what the tasks are in an web-based learning context impose extra difficulties. In the case of web-based learning design the main task for the user is to learn, which is rather implicit and abstract in nature. (Zaharias & et. al, 2006). Usability features not only allow people to efficiently manipulate the interactive applications, but also be appropriate them for the intended learning task (Squires & Preece., 1996). Moreover, Squires and Preece (1996) urges that the researcher have not considered enough the implication of usability features of an learning application in order to achieve educational goals.

The usability evaluation of web-based learning application's requires specific measures for learning activities, and addresses not only Human Computer Interaction (HCI) factors such as the effectiveness of interfaces and the quality of usability and interaction but also the aspects of learning from educational settings

(Ssemugabi & Villiers, 2007). Any evaluation should also consider the sequential and longitudinal characteristics of long-term activities such as information sharing, scheduling, role taking, synchronization, and allocation of resources (Neale, Carroll, & Rosson, 2004). Therefore a framework for assessing usability evaluation of WBLA should consist of the criteria which represent the key features of web-learning application usability defined above and be capable of identifying the issues or problems of a web-learning application‘s usability.

There was a gab in the studies on side of developing a framework, that would cover the key features of usability evaluation of web-based learning application usability and would be suitable for evaluating the usability of these applications for useful learning settings. The previously developed usability evaluation frameworks did not include comprehensive criteria for evaluating a usability, particularly for evaluating the usability aspects supporting the learning activities such as asynchronous or synchronous communication, monitoring, collaboration, and user management. Further research was necessary to address this. With this in mind, the researcher decided to take on the challenge and make a contribution towards identifying and developing an effective framework for usability evaluation of WBLAs. In this research, some WBLAs was selected and to test the validated of the developed framework and its usability was tested and evaluated by using the developed framework.

1.2 Objectives of this study

The aim of this study is to identify a framework for usability evaluation of web-based learning applications.

The sub-objectives of this study are:

1. To identify the important criteria for evaluating usability of WBLA in a learning environment.

1.3Expected Outcomes

The Expected outcomes from this study are:

- Help to increase the productivity of developers and end users
- improve the chances of system success
- increase the utility of a WBLAs
- help ensure end user needs are met
- lower life cycle costs, and
- Improve satisfaction levels for all people who work with the system.
- They can adapt the set of criteria synthesized in this study to conducting usability evaluation for any developer of WBLAs with quickly and low cost.
- For WBLA already developed and operational, the set of criteria could contribute to those used to assess such sites for their usability, with a view to improving them.

1.3Methodology of this study

This study is a quantitative in the area of developing a framework for usability evaluation of web-based learning application and had adopted experiment case study as its study methodology. It's aimed to identify and selected a framework for evaluation the usability of web-based learning application, and planned firstly, to define the main factors and criteria that effected in the usability to build a framework based. Secondly, to employ the proposed factors and criteria to evaluate more web-based learning application‘s usability in a real learning environments. Lastly to develop a short list or heuristics or guidelines for evaluating the usability of web-based learning application.

The methodology of this this study including three main steps are:

Step 1: Selected a usability evaluation framework for evaluating the usability usability of WBLAs with all stages and steps and discussion each of steps.

Step 2: Conducting a usability testing to validate and refined the developed framework, descried in step1.

Step 3: Present the Results of testing and draw conclusions, to make some recommendations on what should be improved in future study in of web-based learning applications.

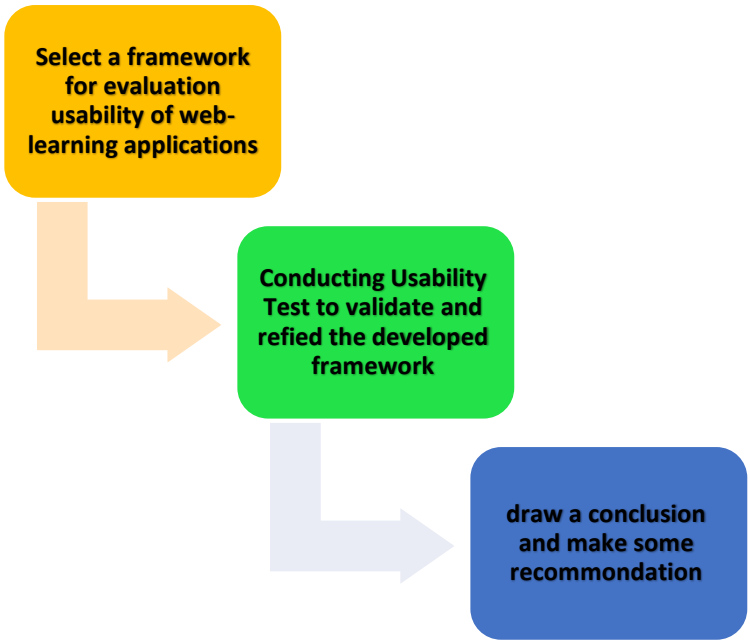


Figure 1.1: The Study Methodology

1.4Structure of this study

Chapter 2: Background: contains a literature review and basic concepts about usability and e-learning, web-learning application. In addition, present a previous related studies on usability evaluation, gives a details of problem scope and discuss more of concepts like web-application with benefits and applications types, e-learning are discussed, web-based learning application, discussed the usability as general and related topics like usability of web-based learning application, finally present the usability evaluation methods and techniques.

Chapter 3: Selected Framework: This chapter provides an explanation about the stages of development of a developed framework of usability evaluation for WBLAs.

Chapter 4: Conducting Setting and Testing Result for Selected Framework: this chapter present the applied setting of a selected usability evaluation framework in real context to validate and refined the framework stages. Finally, present the results of the test and showing the problems of usability criteria on the WBLAs under test.

Chapter 5: Conclusion & Recommendations: this chapter present a result summary of the study and draw conclusions and some recommendations for future studies.

Chapter Two

Background

2.1 Literature Review

2.1.1 Web-Based Application

The web-based applications are more frequently becoming a part of our daily lives, and its presence in education is unmistakable. Web-based application seem to dominate the attention of educators and students. The interest in this new instructional medium is indeed commanding.

Definition of Web-Based Applications:

With traditional desktop applications, you run copies of software programs on each computer you own. The systems, documents and applications you create are stored on the computer you which they created. Although information and documents can be accessed from other computers on the network, they can be accessed by computers outside the network. Rather than web-based applications, that software programs you aren't run from your personal computer, but are rather stored on servers accessed via network or via internet. If your computer crashes, the software stills available for other to use (Miller M. , 2009). Same goes for the documents or any data contents you created, they are stored on a collection of servers accessed via internal network or internet. Anyone with permission can't only access the data, information and documents, but can also edit and collaborate on those documents or information in real time.

According to Doboly (2010) web-based application is a type of software that is hosted on a server and can be accessed remotely through an Internet browser, usually by a human. The server is responsible for receiving requests from users, processing these requests, and then returning information to the user.

According to Smith (2011), a web-based application is an Internet based application, an application that is delivered over the internet. This usually takes the form of a browser based front end, some middleware implementing business logic and a back end database all working in concert. The application could be a piece of business

logic, an internet shopping site or anything like that. The application is the whole bunch of stuff that makes the website work (Smith, 2011).

Types of web-based application:

There are two types of web applications (Alverno, 2012)

- Client application (presentation-oriented) - Client side web application executes at client-side (on browser) & all the resources of application pages loads at clients side.
- Server application (Server oriented) - Server side web application executes at central computer server in which page life cycle goes on at server end.

2.1.2: E-learning?

Web-based technologies, which support the individual's many types of web-based applications, are gaining immense appreciation and adaptation worldwide. Among them, user profile like discussion forums, blogs, social media applications, communication servers, high-tech intelligent search systems and e-services are important areas for future work. Rapid growth in designing, development and implementation of e-service systems like e-health, e-government and e-commerce or e-business etc. has gone hand-in-hand with a growing demand for e-services. Similarly, increase in the diversity of learners, technological expansion and radical changes in learning tasks, present significant challenges and render the possibility of defining the context of use of e-learning applications more complex than ever (Zaharias, 2006).

Definitions of e-learning

e-Learning means electronic learning that utilizes electronic communication for teaching and learning designed to be applied from a distance. eLearning can be as effective as the conventional in-class face-to-face teaching and learning, if the techniques are appropriate for the teaching goals with a well-organized student–teacher interaction(Hope, et al., 2006;Oztekin, et al., 2013) (Hope & Guiton, 2006). Electronic learning (or e-learning) is a kind of technology supported education/learning (TSL)

where the medium of instruction is through computer technology, particularly involving digital technologies. E-learning has been defined by Nichols as "pedagogy empowered by digital technology (Nichols, 2008).

The basic purpose of e-learning applications is to deliver knowledge, share information and help learners in their learning activities in an effective and efficient way by involving advanced electronic technologies (Qureshi & Irfan, 2009) . E-learning is a form of teaching and learning that includes instruction delivered via all electronic media including the Internet, intranets, extranets, satellite broadcasts, video, audio tape, interactive TV, and CD-ROM (Govindasamy, 2002). E-learning refers to the use of electronic media and information and communication technologies in education. E-learning is broadly inclusive of all forms of educational technology in learning and teaching and it is inclusive of, and is broadly synonymous with multimedia learning, technology enhanced learning , computer-based instruction , computer-based training, computer-assisted instruction or computer-aided instruction , internet-based training , web-based training, online education, virtual education, virtual learning environments (which are also called learning platforms), m-learning, and digital educational collaboration. These alternative names emphasize a particular aspect, component or delivery method. E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite TV, CD-ROM, and computer-based learning, as well as local intranet/extranet and web-based learning. Information and communication systems, whether free-standing or based on either local networks or the Internet in networked learning, underlay many e-learning processes (Tavangarian D., 2004).

E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or may be instructor-led, synchronous learning. E-learning is suited to distance learning and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term blended learning is commonly used. It is commonly thought that new technologies make a big difference in education. Many proponents of e-learning believe that everyone must be equipped with basic knowledge of technology, as well as use it as a vehicle for reaching educational goals.

The objectives of e-learning are to facilitate and assist people by delivering appropriate contents and services to fulfill user needs. The increase in demand of learning instantly from anywhere has resulted in e-learning systems on the web with the aim to provide effective and efficient learning platforms which create an environment for knowledge acquirement, predominantly in distance learning. Now the question that arises here is how the performance of an e-learning system can be judged, especially concerning user interaction with the interface of that system (Qureshi & Irfan, 2009).

According to Govindasamy (2002), value of e-learning in the context of web-based application , does not lie in its ability to train just anyone, anytime, anywhere, but in training the right people to gain the right skills or knowledge, at the right time.

E-learning is the use of information and computer technologies to create learning experiences (Horton, 2006).

2.1.3: Web-based learning:

Web-based learning encompasses all educational interventions that make use of the internet (or a local intranet). There are currently three broad classifications or configurations within web-based learning (WBL): tutorials, online discussion groups, and virtual learning. The distinctions between these configurations are often blurred, and in fact a given WBL intervention might use a combination of two or three, but the implication for teaching warrant a conceptual, albeit at times arbitrary, separation. Online tutorials are similar to face-to-face lectures. They generally consist of information structured by the teacher in a way that will (hopefully) facilitate learning. Tutorials are often enhanced by features such as multimedia (sound, pictures, movies, and animations), links to online resources (full-text journal articles or related websites) and other areas within the course, and self-assessment tools. Effective online tutorials often also make use of patient cases. Online discussion is similar to the face-to-face small group session. As with any small group, there may be an element of didactic teaching from the instructor (eg a brief tutorial) but the heart of the teaching lies in group discussion. Teachers take on the role of facilitators – defining the scope of the discussion, monitoring and guiding the discussion as needed, and providing or helping

students to find additional resources. Communication among group members can be asynchronous (delay between sending a message and receiving the response) or synchronous (live). Virtual learning are computer-based simulations of laboratory procedures. Depending on the scenario students might query the computerized 'laboratory' to obtain a all procedure, request information about the findings of tests or examinations (Cook, 2007).

Definition of web-based learning:

We find many ways to determine the meanings of technical terms, but more terms for new concepts are often derived intuitively from related concepts. E-learning and Web-based learning are examples of recent concepts. Other times, concepts are derived by shading their meanings with aggregated adjectives. For example online learning or distance learning obtain their meanings this way, as Web-based learning.

According to cook,2007. Web-based learning encompasses all educational interventions that make use of the internet (or a local intranet). Web-based learning: is associated with learning materials delivered in a Web browser, including when the materials are packaged on CD-ROM or other media and it is associated with content readily accessible on a computer. The content may be on the Web or the Internet, or simply installed on a CD-ROM or the computer hard disk. Distance learning: involves interaction at a distance between instructor and learners, and enables timely instructor reaction to learners. Simply posting or broadcasting learning materials to learners is not distance learning. Instructors must be involved in receiving feedback from learners. For each of these concepts, the discriminating feature must be the primary characteristic of the learning activity (Tsai & Machado, 2004).

The World Wide Web (WWW) is changing the way academic teach and learn and developing innovative ways to meet the needs of users (Tobin & Kesselman, 1999). Development of computer and Internet technologies has dramatically increased the ways of teaching and learning. Among these new approaches, online Web-based education has become a promising field. While increasing enrollment is certainly desirable from an administrative perspective, there is a growing concern about program quality.

Trainers and learners are using the Web for a variety of reasons and the extent and scope of the usage differs significantly. A majority of current Web-based learning environments have evolved from face-to-face teaching. The course content usually takes the form of HTML with hyperlinks to related information within and beyond the immediate course. An added feature is often a communicative element enabling interactions between learners and the teacher (Oliver & Herrington, 2000). According Crossman (1997), the World Wide Web is an instructional technology that permits the display of information in any medium, on any subject, in any order, at any time, i.e. asynchronous learning, independent of place This is not possible with traditional contact teaching, where learners and educators go to a particular place, at a particular time, for a particular class on a particular topic. That means, the Internet, and the Web, in particular, have changed the way in which people relate to time and space. (Crossman, 1997). That means the Web is not only used to enhance teaching and learning in the traditional face to face environment, but also supports distance learning and teaching by enabling learners to communicate both synchronously and asynchronously (Vrasidas & McIsaac, 2000). Synchronous communication in web-based learning occurs where learner or trainer are carry on 'live' or immediate conversation via text, audio, or video, like virtual classroom. It assumes that the learner or trainers are logged onto the computer network system simultaneously. Chat rooms and whiteboards use this form of communication. Asynchronous communication in web-based learning, on the other hand, occurs where a learner posts a message for another learner or group of learner to respond or their own convenience. The basic principle of asynchronous communication in web-based learning is that the receiver of the message need not be logged onto the system at the time the message is sent. Examples are electronic mails and online discussion forums, which are common features of online learning or virtual environments (Firdyiwek, 1999).

According Shneiderman, *et al* (1998) the importance of web-based learning, stems from the fact that it supports several pedagogical approaches such as:

- **Distance education** : Learners need not be in the classroom in order to study, and can participate synchronously or asynchronously with fellow learners or the instructor;

- **Active learning and inquiry-based education**: Learners can solve issues interactively with varying levels of human and computer guidance;
- **Collaborative and cooperative learning**: Collaboration in the form of teamwork results in knowledge acquisition by team members; and
- **Individual and self-paced instruction**: Learners can learn on their own at their own pace with the assistance of e-learning applications.

In finally, the extensive use of the Internet, its use for both synchronous and asynchronous communication, and its support for varying learning theories and its approaches has made web-based learning an attractive and important mechanism for learning and teaching. Designers of web-based learning environments should guard against using the Web merely for delivery of content. They should make the most of on the features of interactivity and individualization to support active learning. Web-based instruction offers learners unparalleled access to instructional resources, far surpassing the reach of the traditional classroom. It also makes possible learning experiences that are open, flexible, and distributed, providing opportunities for engaging, interactive, and efficient instruction (Khan, 2001).

2.1.4 Web-Based Learning Application:

The main features of the term “Web-based learning application,” which is defined by Liu, *et al* (2005) as "instructional content or activity delivered through the Web that teaches a focused concept, meets specific learning objectives, provides a learner-centered context, and is an individual and reusable piece". Accordingly, web-learning application can be defined as a technology with four major features:

(a) It is delivered through the Web;

(b) It teaches content that meets specific learning objectives aligned with the curriculum;

(c) It is designed on the basis of a learning theory and pedagogical strategy;

(d) It contains reusable elements. Figure 2.1 shown that ,

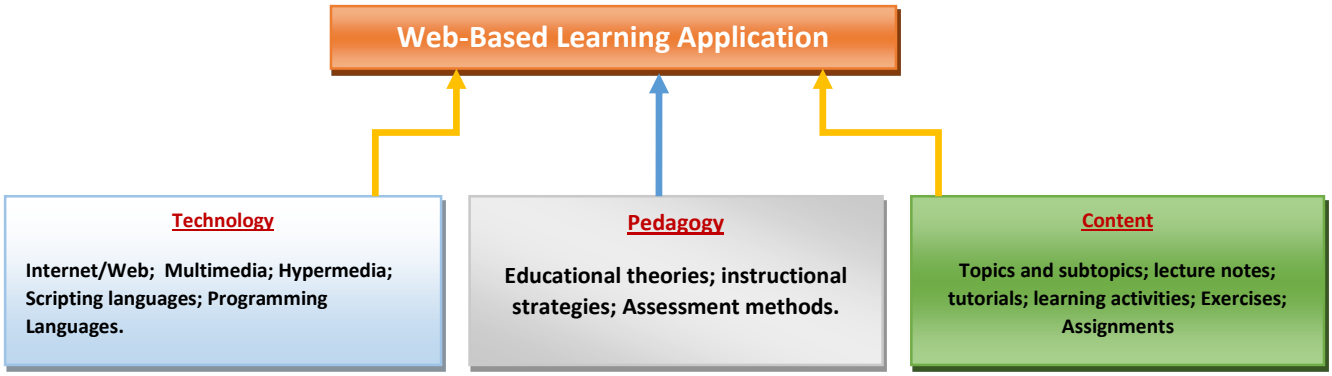


Figure 2.1 WEB-BASED LEARNING CONTENT

From a pedagogical point of view, web-based learning is embedded within a pedagogical procedure or learning theory, such as instructvism, behaviorism, cognitivism, constructivism, and collaborative learning or a combination of them (Martinidale, Cates, & Qian, 2005). Hence, they are associated with pedagogical values that potentially affect teaching and learning processes. In addition, they can be used in a context, where the teaching and learning of the subject matter takes place via a combination of classroom and Web-based learning.

From a content point of view, web-based learning application includes study material and lessons, task-based activities and exercises, examples, and eventually assessment procedures. Web-Based learning can also be created to support different topics of a given subject, as well as instructional material in a number of subject areas at all levels of education.

2.1.5 Usability:

Usability is a term, which refers to the interaction of users with a software application and generally acknowledged as a factor of system quality representing the answer to many frustrating interactions with technology. It describes the quality of products and systems from the point of view of humans who use them. On the other hand, It is often measured in terms of how easy it is to learn and use the application or system, and whether user is satisfied with these application or system or not.

2.1.5.1 Ergonomics

Ergonomics (or human factors) is traditionally the study of the physical characteristics of the interaction: how the controls are designed, the physical environment in which the interaction takes place, and the layout and physical qualities of the screen. A primary focus is on user performance and how the interface enhances or detracts from this. In seeking to evaluate these aspects of the interaction, ergonomics will certainly also touch upon human psychology and system constraints. It is a large and established field, which is closely related to but distinct from human computer interaction (HCI), and full coverage would demand a book in its own right. Here we consider a few of the issues addressed by ergonomics as an introduction to the field. We will briefly look at the arrangement of controls and displays, the physical environment, health issues and the use of color. These are by no means exhaustive and are intended only to give an indication of the types of issues and problems addressed by ergonomics (Dix, Finlay, Abowd, & Beale, Human-Computer Interaction., 1998).

2.1.5.2 Definition of Usability

According to Shackel (1991) usability was formerly defined as: "*the capacity in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios*".

The previous definition has lead to the more modern definitions of usability, as described in the next paragraph; they do not necessarily conflict with the former, but explicitly state that 'user satisfaction' should be taken into consideration and the issue of giving 'specified training and user support' left out. However, the more recent definitions are still in harmony with the usability framework as it stood. The next paragraph gives some of the more recent definitions of usability.

According to Miller (2005) usability has been defined by some as: "the extent to which an application is learnable and allows users to accomplish specified goals efficiently, effectively, and with a high degree of satisfaction. An additional component

that should be added to this definition is usefulness; that is, a highly usable application will not be embraced by users if it fails to contain content that is relevant and meaningful to them". (Miller, 2005).

Table 2.1 illustrate different standards of defining the term Usability

Table 2.1 Usability definitions according to ISO and IEEE standards

"The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions" (ISO/IEC 9126-1, 2000).
"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." (ISO9241-11, 1998)
"The ease with which a user can learn to operate, prepares inputs for, and interprets outputs of a system or component. (IEEE Std.610.12-1990)"

In these definitions shown in table 2.1, *effectiveness* means "the accuracy and completeness with which users achieve specified goals", *efficiency* is "the resources expended in relation to the accuracy and completeness with which users achieve goals", and *satisfaction* is described as "the comfort and acceptability of use".

Nielsen (1993) focused on usability as a sub part of system acceptability and made its own way about usability. The wider term "system accessibility", explains the system credibility through its acceptance by the stakeholders and their satisfaction level regarding needs and requirements. The figure describes his definition which is still valid and widely accepted in the computer science field.

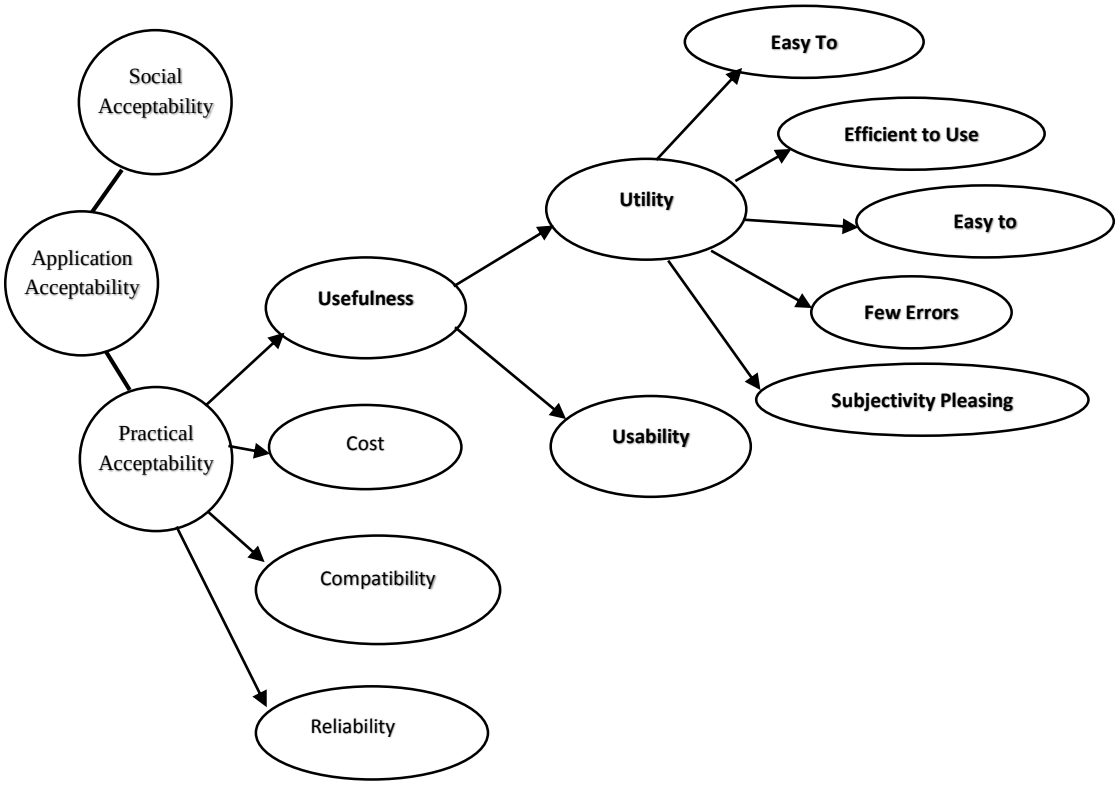


Figure 2.2 Usability and application acceptability

Usability problems therefore refer to aspects that make the application ineffective, inefficient, and difficult to learn and to use.

According to the Nielsen's definition, usability refers to (Preece, et al., 2002):

- *Learnability*: the ease of learning the functionality and the behavior of the system.
- *Efficiency*: means how a system supported user in doing their tasks.
- *Effectiveness*: is an overall goal concerning how good a system is for doing what it is supposed to do and safety is about protecting users from dangerous conditions and undesirable situations
- *Memorability*: the ease of remembering the system functionality, so that the casual user can return to the system after a period of non-use, without needing to learn again how to use it.

- *Few errors*: the capability of the system to feature a low error rate, to support users making few errors during the use of the system, and in case they make errors, to help them to easy recover.
- *User's satisfaction*: the measure in which the user finds the system pleasant to use.
- *Utility*: concerns to what extent a system provides the right functionality for doing what the users want to do whereas learnability of a system concerns how easy it is to learn to use a system.

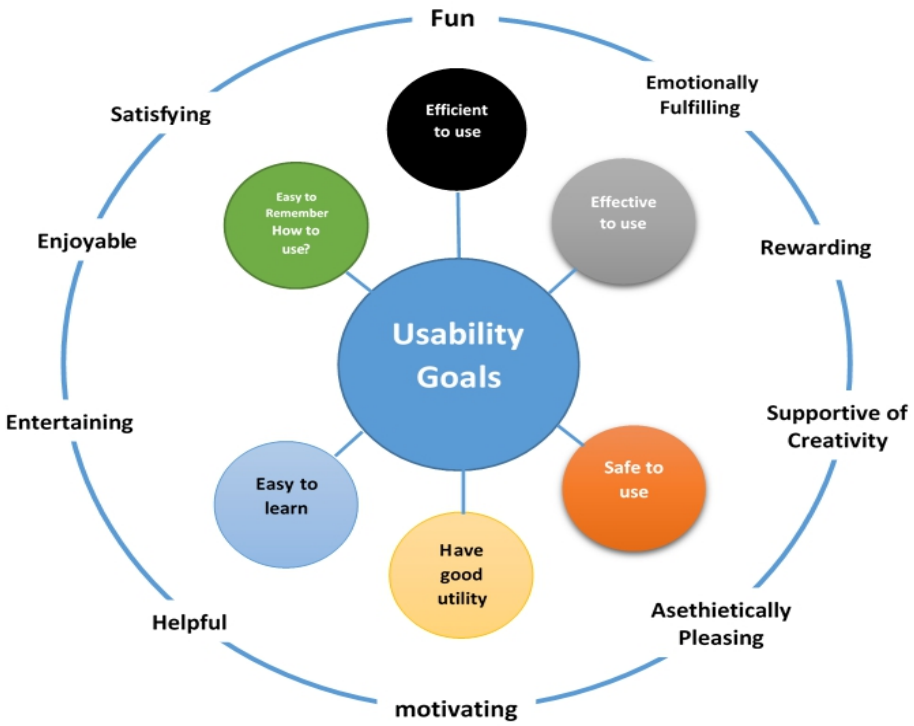


Figure 2.3 Differentiating Usability via Users Goals

Usability is important in the development of e-learning applications. If they are not easily usable, the learner will spend too much time trying to understand system functionality rather than engaging with the content (Costabile, et al., 2005) .

Usability plays a significant role towards the success of e-learning applications as well. If an e-learning system is not usable enough, it obstructs student's learning: the learners would not spend more time learning how to use the software rather than learning the contents (Wong, et al., 2003).

2.1.5.3 Usability of web-learning applications

Usability plays necessary role for the success of web learning applications. If an web-learning application is not usable, the learner is forced to spend much more time trying to understand software functionality, rather than understanding the learning content (Wong et al.., 2003). Moreover, if the application interface is complicated, slow and unpleasant, people feel frustrated are likely to walk away and forget about using it.

Usability of pedagogical applications is key feature in the pedagogy domain. According to Granic and Glavinic (2002), lack of an appropriate usable and user-cantered interface design of different computerized educational systems decreases the interface's effectiveness and efficiency. This underlines the importance of the main goal of this study which is to evaluate the usability of the interface of a widely used web-based learning application.

Increased maturity in learning approaches has increased the importance of and challenges for usability design in the domain of learning. In an web-learning environment, the traditional task and work-related usability seem to have limited value while at the same time the need to approach the learner experience in a more appropriate holistic way becomes stronger (Zaharias, 2004). This challenge requires a focus on the affective aspects of learning (O'Regan, 2003; Picard et al., 2001). To evaluate the usability of system and to determine usability problems, it is important to select appropriate usability evaluation method/methods (Fitzpatrick, 1999; Ssemugabi, 2006.) by considering efficiency, time, cost-effectiveness, ease of application, and evaluators (Gray & Salzman, 1998; Parlangeli et al., 1999). One of the goals of any learning application is to avoid any distraction in order to keep all the content fresh in the learner's minds as they accommodate new and foreign concepts. In the specific case of e-learning, the challenge is to create an interactive application that doesn't confuse learners. It is often noticed that an e-learning application is a mere electronic transposition of traditional material, presented through rigid interaction schemes and awkward interfaces. When learners criticize the web based training or express a preference for classroom based instruction, it is often not the training, but rather the confusing menus, unclear buttons, or illogical links that scare them off (Ardito et al., 2005). According to Melis et al. & Weber (2003) the design of an web-learning

application which is more usable, basically involve two aspects. The first aspect is technical usability and the second is pedagogical usability. Technical usability involves methods for ensuring a trouble-free interaction with the system, while pedagogical usability aims at supporting the learning process. Both aspects of usability are intertwined and tap the user's cognitive resources. The main goal should be minimizing the cognitive load resulting from interaction with the system in order to provide a resourceful learning environment. (Melis et al. & Weber 2003)

2.1.6 Usability Evaluation

2.1.6.1 Definition of Usability Evaluation:

The term evaluation generally refers to the process of gathering data about the usability of a design or product by a specified group of users for a particular activity within a specified environment or work context (Squires & & Preece, 1999).

"A usability evaluation method is a systematic procedure for recording data relating to end-user interaction with a software product or system" (Fitzpatrick, 1999). After the data has been recorded, it can be analyzed and evaluated in order to determine the level of usability of the system or product.

From the definitions according to ISO-4211 for usability as "the extent to which the product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." This definition was specified an attributes of usability with five point: learnability, efficiency, memorability, errors, and user satisfaction (Scholtz, 2004). Efficiency is concerned with the ease of learning and use of a system. Effectiveness deals with the ability of a system to perform tasks comprehensively and accurately. Satisfaction refers to the ability of a system to successfully complete tasks (Genise, 2002).

The Evaluation should not be considered as a single phase in the design or assessment of a system but, ideally, be conducted throughout the systems development life cycle, because there are a number of methodologies and frameworks that support the design of usable interactive systems, there is a need to assess the design and test the systems to ensure that they actually behave as expected and meet the requirements of the user (Dix, et al., 2004).

Usability evaluation is concerned with gathering information about the usability or potential usability of a system in order either to improve its interface or to assess it. The aim is to determine the effectiveness or potential effectiveness of an interface in use or to provide a means of suggesting improvements to it (Preece, 1993). Dix, *et al* (2004) suppose the main goals of usability evaluation are:

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

Evaluation thus involves the user, the tasks, and ease of use of the system.

Evaluating Web applications in particular consists in verifying if the application design allows users (learner) to easily retrieve and browse contents, and invoke available services and operations. This therefore implies not only having appropriate contents and services available into the application, but also making them easily reachable by users through appropriate hypertexts. Depending on the phase in which evaluation is performed, it is possible to distinguish between formative evaluation, which takes place during design, and summative evaluation, which takes place after the product has been developed, or even when any prototype version is ready. During the early design stages the goal of the formative evaluation is to check the design team understanding of the users' requirements, and to test design choices quickly and informally, thus providing feedback to the design activities. Later on, the summative evaluation can support the detection of users' difficulties, and the improvement and the upgrading of the product. Within these two broad categories, there are different methods that can be used at different stages of the product development. The most commonly adopted are user testing, where the real users are studied, and usability inspection, which is conducted by specialists. Recently, Web usage analysis has also emerged as a method for studying user behaviors through the computation of access statistics and the reconstruction of user navigation on the basis of Web access logs. The rest of this section is devoted to illustrate the main features of these three classes of evaluation methods, also highlighting their advantages and drawbacks.

2.1.6.2 Usability Evaluation Methods:

Various usability evaluation methods can be found. Gellner and Forbrig (2003) defined two types usability evaluation methods - inspection and testing (see Figure 2.4) while Zhang (2008) added one more type and divided usability evaluation methods into three types: testing, inspection, and inquiry. Inquiry methods include interview, usability evaluation questionnaire, field observation, and so on.

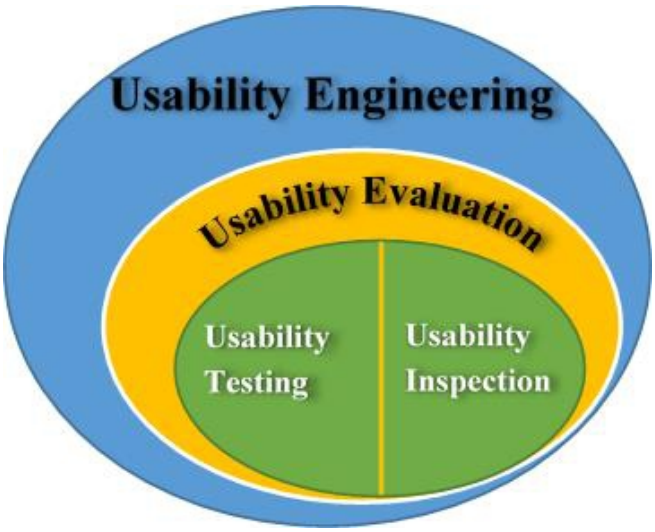


Fig. 2.4: layers of usability terms

According to the type of data collected, usability evaluation methods can be qualitative or quantitative whereas usability evaluation methods can be formative or summative based on the stage of the lifecycle of an application or product at which a usability evaluation was carried out. Scholtz,(2004) divided usability evaluation method into two types, formative evaluations are used to obtain information used in design and conducted during the design and construction phase. In contrast, summative evaluations are usability evaluations that document the effectiveness, efficiency, and user satisfaction of a product at the end of the development cycle, and conducted after the application has reached the end user. On the other hand, the usability evaluation methods divided into two types depending on who performs the evaluation, the first type User-based methods or direct methods named empirical evaluation methods, and the second type indirect methods named usability inspection methods. User-based methods or Empirical evaluations mainly consist of user testing. The evaluations are

accomplished by identifying representative users, representative tasks, and developing a procedure for capturing the problems on a tested application (Nogueira & Garcia, 2003; Scholtz J. , 2004) while Expert-based methods, Usability inspection are an efficient formative evaluations method and can be applied even on system prototypes or design specifications up to the almost ready-to-ship product (Karoulis & Pombortsis, 2003; Scholtz J. , 2004). Only expert evaluators inspect the application and provide judgments based on their knowledge and experience (Molich & Dumas, 2008; Zhang, 2008). The experts can be software developers, usability engineers, and other professionals who are deeply familiar with the concepts of usability in design. The popular inspection methods are Cognitive Walkthroughs, Feature Inspection, Heuristic Evaluation, Pluralistic Walkthrough, Perspective-based Inspection (Zhang, 2008).

Analytical Usability Evaluation Methods:

As mentioned, experts perform analytical methods and the category mainly contains of three evaluation methods: "design guidelines", "formal-analytical techniques" and "inspection methods" (Blecken et. al., 2010). These methods can in turn be performed or used in different ways, inspection methods can for example be either heuristic evaluation or cognitive walkthrough. In order to give an overview of these evaluation methods a description is required for each of them.

Design guidelines:

Contain instructions that should be followed in order to develop a user-friendly interface. These methods are in turn divided into five categories: design rules, ergonomic algorithms, style guide, standards and collection of guidelines (Vanderdonckt, 1999). Each group of design guidelines have its own characterization; Design rules contains concise instructions in such way that no further interpretation is needed; Ergonomic algorithms collect design requirements in a rigid manner that describes how the design process has to be carried out under certain conditions;

Style guides:

Contains rules and standards in order to provide a model graphical user interface design, the actual content is then later inserted. Standards, for example ISO 9241 are defined by national or international organizations to generalize design of interfaces.

Finally, Collections of guidelines offers a number of different guidelines for different types of user interfaces (Blecken et. al., 2010).

Formal-analytical techniques:

Are also done by usability experts and the techniques can be divided into two subgroups. The first, task analytical methods focuses on the task within the system. These tasks are broken down into small sub-tasks in order to distinguish potential problems in each one of them. The outcome of this method is data on execution times or sequences. GOMS (Goals, Operators, Methods, and Selection Rules) are one such technique and it provides time intervals in which a user should need in order to solve a task. This time includes both cognitive and physical actions. This can be helpful if there are two designs to choose from as it would be easy to compare them and see what design is most efficient. The second formal-analytical technique is "expert guidelines", which instead of focusing on the tasks focuses on the ergonomics of the software. It could be said that expert guidelines are a set of questions and statements for the design of software (Blecken et. al., 2010).

Inspection methods:

Which can also be divided into two sub-categories, design principles such as heuristic evaluation design task analysis such as cognitive- walkthrough.

Heuristic evaluation:

The usability experts put themselves in the position of the user and evaluate the interface independently. When this is done the evaluations can be merged to an overall assessment of the system. The evaluation is done according to the usability heuristics, among them the ten basic heuristics defined by Nielsen (Nielsen 1993). These heuristics have been further developed and can be adopted differently depending on what type of system being developed (Blecken et. al., 2010).

Cognitive walkthrough:

Are more focused on tasks the users are to perform. It's a review process, where experts evaluate the design using criteria appropriate to the design issues (Wharton et. al, 1994).

Empirical usability evaluation methods

Empirical usability evaluation methods were done by the intended end-user and can consist of Usability Tests. These methods can be carried out either on a prototype

of the application or on a deployed application. Usability Test can be in several forms including video feedback or screen recording, log files & input protocols, thinking aloud protocol and attention-tracking (mouse tracking) & eye-tracking. The objective of these methods is to identify real problems users encounter when using the application by analyzing the data and take result from these tests, conclusions can be made concerning the problems and what actions that needs to be taken in order to solve these issues (Blecken et. al., 2010). This process can be described as collecting empirical data while users are observed when interacting with the system and performing typical tasks (Rubin & Chisnell, 2008). usability test is a convenient process as it enables the identification and explanation of errors in the interface. Usability tests should, however, not exclude tests made by experts, rather complement them (Rubin & Chisnell, 2008; Blecken et.al., 2010).

Many studies named the empirical evaluation methods as user-testing methods. User testing has a long history and gained popularity in the early 1980s (Dumas & Fox, 2008; (Downey, 2007; Molich & Dumas, 2008). It is widely used in usability evaluation (Nakamichi, Shima, Sakai, & Matsumoto, 2006). User testing it is " a process that employs people as participants who are representative of the target audience to evaluate the degree to which a product meets specific usability criteria " (Rubin & Chisnell, 2008). During user testing, participants work on typical tasks using the application (or the prototype) and are observed; the evaluators use the result to see how the application supports the users to do their tasks (Zhang Z. , 2007) and to evaluate the degree to which a application /product meets specific usability criteria (Rubin & Chisnell, 2008). It can often uncover very specific areas needing improvement (ForakerDesign, 2005).

Table (2.3) shows that usability testing (user testing) method has different techniques, such as Coaching Method, Co-discovery Learning, Question-asking Protocol, Remote Testing, Think Aloud Protocol, User Observation, and so on (Ivory & Hearst, 2001; Zhang Z. , 2007; Zhang, 2008).

Table 2.3 Usability Testing Techniques

(Ivory & Hearst, 2001; Zhang Z. , 2007; Zhang, 2008)

Usability Testing technique	Description
Thinking-Aloud Protocol	user talks during test
Question-Asking Protocol	tester asks user questions
Shadowing Method	expert explains user actions to tester
Coaching Method	user can ask an expert questions
Teaching Method	expert user teaches novice user
Co-discovery Learning	two users collaborate
Performance Measurement	tester records usage data during test
Log File Analysis	tester analyzes usage data
Retrospective Testing	tester reviews videotape with user
Remote Testing	tester and user are not collocated during test
User observation	Observe watches and listens carefully to users as they work with a product or a system

2.2 Previous Studies

In this section, summarize earlier studies that evaluated the usability of web based learning application using different types of usability method. In fact, nearly all the studies that evaluated the usability of web-based learning application or educational website employed either user-based (i.e. user testing) or evaluator-based (i.e. heuristic evaluation) usability evaluation methods.

The usability evaluation investigated by Tarafdar and Zhang (2005) explored the influence of six web learning application design issues on the usability of websites using different criteria related to information content, ease of navigation, download speed, customization and personalization, security, and availability and accessibility. The investigation was carried out by two web users only who evaluated a total of 200 websites using the six design factors. These sites were selected from five different domains: portals and search engines, retail, entertainment, news and information, and financial services (40 sites in each industry). Interestingly, the results showed that the four design factors that influenced website usability were: information content, ease of navigation, download speed, and availability and accessibility. However, the results showed that security and customization did not influence a website's usability.

Kostaras and Xenos (2006) employed the heuristic evaluation method to evaluate the usability of the website of the Hellenic Open University. The usability assessment was conducted by five evaluators; two of these were usability specialists while the other three were experienced in heuristics evaluation. The heuristics used were the set of ten usability heuristics suggested by Nielsen. The results revealed that the heuristic evaluation method was an effective and useful method which identified various usability problems most of which were not previously detected.

The study conducted by Pearson *et al.* (2007) investigated the relative importance of five design criteria in the evaluation of the usability of a commerce web-based learning application from the viewpoint of 178 web users. The objective of their research was to shed light on the criteria that influence successful web design, and to determine if gender has an impact on the relative importance of these usability criteria. The criteria related to navigation, download speed, personalization and customization,

ease of use, and accessibility. The results showed that these five criteria were significant predictors of website usability from the point of view of website users. Ease of use and navigation were the most important criteria in determining website usability, while personalization and customization were the least important. It was also found that males and females viewed these web usability criteria differently. The two usability criteria, navigation and ease of use, were found to have significant differences based on gender. Females placed greater emphasis on both of these web usability criteria than did males.

Similarly, usability evaluation of the new version of Hellenic Open University conducted by Papadopoulos and Xenos (2008) using a heuristic evaluation by employing Nielsen's ten usability rules and performance measurement (user testing). The evaluation was performed by experts and regular users (students of the HOU). The result revealed that the combination of the two evaluation methods identified several usability problems that had not been traced in the website's development phase and revealed users' lack of satisfaction with the website.

An empirical study of university websites that was done by Astani and Elhindi (2008), focused on the effectiveness factor of higher education institutions' web application to assess the effectiveness of the university websites, by selected the top 50 universities in the U.S., using U.S. News & World Report's ratings. The raters evaluated the top 50 university websites based on the characteristics that have been identified by Tarafdar and Zhang's method, the websites were evaluated against the list of characteristics and each item was rated based on a 5-point Likert Scale. Each evaluator used the same computer for evaluating the websites to guard against differences for infrastructure reasons and identified successful websites characteristics as: information content, navigation usability, customization, download speed, and security. The website evaluation was done independently by each rater and completed over the course of three weeks. In addition, the study considered the mean values of the two sets of ratings for each website as values of the evaluations for each item in the questionnaire. The result of the study show that the an important characteristic of a website is content. However, they need to improve in updating their information and presenting it in a layout that will make it easier for users to locate the information of

interest. Also, they have been careful about the download speed since the results indicate that pages can be downloaded at a good speed. However, the universities need to improve in the areas of navigation, usability, customization, and security. The websites' navigational components were rated average for consistency of links, having redundant links for easier navigation, and arrangement of links that would be easy to understand. The usability components of these website, that is the attractiveness, getting the user excited about the website, ease of use, and having attractive layout were rated average also. In addition, the websites need to offer better-customized information. The security of the university websites also needs improvement.

An evaluation of the usability of academic websites in the Spanish-Speaking Context of Use (SSCU) were conducted by Gonzalez et al. (2008) also using heuristic evaluation and cognitive walkthrough methods. A specialized application was developed based on heuristic evaluation techniques to support the usability evaluation of Spanish-Speaking Context of Use (SSCU); this was used to evaluate the usability of 69 academic websites. The study defined heuristics consisted of twenty-five questions related to four types: design, content, navigation and search. The evaluation team which carried out the usability evaluation comprised two usability experts and two advanced students with solid knowledge of heuristic evaluation. The results showed the feasibility of applying both the specialized software tool and the particular cognitive walkthroughs while evaluating academic websites.

Lencastre and Chaves (2008) employed a questionnaire method to ask students in the evaluation of the usability of an educational website, used by post-graduate students at Minho University. The evaluation was conducted by asking five students from the educational material (Masters course) to reply to a questionnaire. This consisted of 49 questions divided into seven categories: visual clarity, navigation, content, control, feedback, errors, and consistency. The questionnaire was designed to gather data about students' reactions to and perceptions of the educational website. The result revealed the questionnaire method is the best method for scale the satisfaction of users with the website.

Mustafa et.al, (2008) employed a questionnaire method specifically to evaluate the usability of web-learning applications which was also aimed directly to the final

users (students), and employed two online automatic tools (html toolbox and web page analyze) to measure the internal attributes of the websites which could not be perceived by users, The questionnaire was developed and designed based on 23 usability criteria divided into five categories: content, organization and readability; navigation and links; user interface design; performance and effectiveness; and educational information. The results showed that the overall usability level of the studied websites was acceptable. However, there were some weaknesses in some aspects of the design, interface and performance. The usability category content, organization and readability exhibited the highest evaluation value, followed by the category of navigation and links; both were rated "good" according to the scale that was used. The other three categories (i.e. educational information, user interface design, and performance and effectiveness) were rated "moderate".

The method was developed by Zaharias et, al. (2009) using the questionnaire-based for usability evaluation for e-learning applications. This method was developed according to an established methodology in HCI research and relied upon a conceptual framework that combines Web and instructional design parameters and associates them with the most prominent affective learning dimension, which is intrinsic motivation to learn. The latter is proposed as a new usability measure that is considered more appropriate to evaluate e-learning designs. Two large empirical studies were conducted in order to evaluate usability of e-learning courses offered in corporate environments. The results provide valuable evidence for reliability and validity of the method, thus providing evidence that usability practitioners can use it with confidence when evaluating the design of e-learning applications.

Furthermore, the study of Toit and Bothma (2010) investigated the usability of the website of an academic marketing department in the University of South Africa using the heuristic evaluation method conducted by two expert evaluators. The usability guidelines which were used in the evaluation were modified from an earlier research study and consisted of five categories: content; organization and readability; navigation and links; user interface design; performance and effectiveness; and educational information.

Jaber M.A. and et.al, (2014) measured the usability level of three university web-based application from the perspective of 351 students, using a questionnaire based on research model of measuring web-application usability based on factors of Content, Organization and Readability, Navigation and Links, User Interface Design, Performance and Effectiveness. The result identified the strengths and weaknesses associated with each websites. Therefore this model can serve as guideline for evaluating website usability in order to know if a particular web-based learning applications has meet the need of its intended users and also assist the web designers in building more usable web-applications.

The investigation study conducted by Layla Hasan (2014) study the relative importance of specific design criteria developed for the purpose of the study, in the evaluation of the usability of educational websites from the point view of students; it then evaluated the usability of nine educational websites based on students' preferences. The results showed that content and navigation were the first and second preferred design categories to be considered while evaluating the usability of educational websites, while the organization/architecture was the least important category. In addition, the results showed that there was a statistically significant difference between males and females regarding only one category: the content. Females considered this to be the most important category while males considered it as the second most important. By contrast, the results showed that there were no statistically significant differences between the students of the two selected faculties (the Faculty of Information Technology and Science, and the Faculty of Economics and Administrative Sciences) concerning the relative importance of the developed criteria based on their majors/specializations. In general, the results showed that the majority of the students were satisfied with the usability of the Jordanian university websites. Specifically, the results showed the students were satisfied with the content and navigation (ease of use) of the tested websites, but dissatisfied with the design of the websites.

Chapter Three

The Developing Framework

One of the main objectives of this study is to develop an effective framework for evaluating the usability of web-based learning applications, from the reviewing a previous studies of (Dix et al. 1998; Molich et al. 1998; Molich et al. 1999; Nielsen 1993;Nielsen 1993; Shneiderman 1998), this study developed a framework looks at the various dimensions of the interaction of different types of users of the web-learning applications. Each dimension represents a particular aspect of the web-learning application relative to usability. The figure (3.1) below shows the usability dimensions of the framework. Each of the dimensions was discussed below.

Figure 3.1: Developed Framework for Usability Evaluation

Table 3.1: Developed Framework for Usability Evaluation.

1. Specify usability evaluation goals.
2. Determine Web-learning applications aspects to evaluate.
3. Select usability metrics (main factors and criteria).
4. Select evaluation method/s.
5. Select tasks.
6. Testing Design.
7. Capture Usability Data.
8. Analyze and interpret Usability Data.
9. Present results.

- **Specify Usability Evaluation Goals**

  Usability evaluation is applicable at all stages of an application-developing life cycle (e.g., design, implementation, and re-design). At these various stages, different usability evaluation goals are relevant. Below is a list of typical usability evaluation goals.

  - Specify application interface requirements
  - Evaluate design alternatives
  - Identify specific usability problems
  - Improve application interface problems

  The evaluator must clearly specify the goals of the usability evaluation at the outset of the study. These goals influence other aspects of user interface assessment, such as the user interface components to evaluate and appropriate evaluation methods.

- **Determine Web-based learning Application Aspects to Evaluate**

  Some application interfaces can be extremely large and complex and an evaluation of all aspects may not be economically feasible. Hence, the evaluator

must determine specific application interface aspects to evaluate. These aspects must be consistent with the goals of the usability evaluation.

- **Select Usability Metrics**

  Usability metrics are a crucial component of the usability evaluation. The goal in selecting these metrics is to choose a minimal number of metrics that reveal the maximum amount of usability detail for the web-based learning application under study. ISO Standard 9241 (International Standards Organization 1999) recommends using effectiveness, efficiency, and satisfaction measures as described below:

  - Effectiveness is the accuracy and completeness with which users achieve specified goals. Example metrics include: percentage of goals achieved, functions learned, and errors corrected successfully.
  - Efficiency assesses the resources expended in relation to the accuracy and completeness with which users achieve goals. Example metrics include: the time to complete a task, learning time, and time spent correcting errors.
  - Satisfaction reflects users' freedom from discomfort and positive attitudes about use of an interface. Example metrics include: ratings for satisfaction, ease of learning, and error handling.

  Metrics discussed above are quantitative in nature. Non-quantitative metrics could include, for example, specific heuristic violations identified during a usability inspection.

- **Select Evaluation Method(s)**

  Choosing one or more usability evaluation methods is an important step of the usability evaluation process. There are five classes of usability evaluation methods: usability testing, inspection, inquiry, analytical modeling, and simulation. An inspection entails an evaluator using a set of criteria to identify potential usability problems in an interface, while testing involves an evaluator observing participants interacting with an interface (i.e., completing tasks) to determine usability problems. Similar to usability testing, inquiry methods entail

gathering subjective input (e.g., preferences) from participants, typically through interviews, surveys, questionnaires, or focus groups. Analytical modeling and simulation are engineering approaches to usability evaluation that enable evaluators to predict usability with user and interface models. Usability evaluation methods differ along many dimensions, such as resource requirements, costs, results, and applicability (i.e., at what stages of the interface development process). There is a wide range of methods that one could employ at all stages of system development, which actually complicates choosing an appropriate method. usability evaluation methods uncover different types of usability problems; therefore, it is often recommended for evaluators to use multiple assessment methods (Jeries et al. 1991; Molich et al. 1998; Molich et al. 1999; Nielsen 1993). For example, during a usability test, participants may also complete questionnaires to provide subjective input; thus, enabling evaluators to gather quantitative and qualitative data.

- **Select Tasks**

Tasks are the most crucial part of the usability evaluation (Dix et al. 1998; Nielsen 1993; Shneiderman 1998). They must be appropriate for the web-based application aspects under study, the target users, and the evaluation method. Other constraints may affect the selection of tasks, such as cost and time limits during usability testing sessions, for instance.

- **Testing Design**

After completing the previously activities, the evaluator may need to design testing for collecting usability data. In particular, the evaluator needs to decide on the number of participants (evaluators and users), the evaluation procedure (this is largely dictated by the usability evaluation method) as well as on the environment and system setup. The nature of experiments or testing depends on the evaluation method. Experiments may entail completing tasks in a controlled manner (usability testing); responding to specific questions (inquiry); or comparing alternative designs (analytical modeling and simulation). It is also recommended that the

evaluator conduct pilot runs during this phase (Nielsen 1993), especially if user involvement is required.

- **Capture Usability Data**

During this phase, the evaluator employs the usability evaluation method to record previously specified usability metrics. For some methods, such as usability testing and inspection, the evaluator may also record specific usability problems encountered during evaluation.

- **Analyze and Interpret Data**

The primary goal of usability data analysis is to summarize the results in a manner that informs interpretation. This summarization may entail statistical techniques based on the goals of the usability evaluation. It may also entail creating a list of specific usability problems found along with their severity.

Actually interpreting the results of the study is a key part of the evaluation. It entails using the analysis of usability data to draw conclusions as dictated by the evaluation goals. For example, it may mean concluding that one design is better than another or whether usability requirements have been met.

- **Present Results**

The final step of the usability evaluation process is to communicate the results and interpretation of these results to the stakeholders. Ideally, the evaluator presents the results such that they can be easily understood (e.g., using graphs and providing severity ratings) and acted upon.

Chapter Four

Conducting Setting and Testing the Developed Framework

This section contains the conducting steps of the framework was selected in the previous chapter.

4.1 Usability Evaluation Goals:

The goal of this evaluation study was to determine if web-based learning applications in the study could be usable or not, if the users could be complete the steps and task easy.

4.2 Selection of web-based learning applications

In order to select forty web-based learning application, one of the major international ranking web-application was used; this was the Alexa (alexa.com). All learning web-applications like universities and colleges for academic and other web-learning applications over worldwide are ranked by Alexa by using the many characteristics like popularity of their web-based learning applications. The list of web-based learning applications grouping into four groups sorted by their web ranking, as provided by Alexa for the year of 2014, was used to select the sample for this study. These forty websites, which had the highest ranking, were then picked out, as shown in (table 4.5). This number was chosen to keep the study at a manageable size for the researcher.

4.3 Identify Usability Metrics (Factors and Criteria)

The framework was adopted in this study consists of six main factors and twenty criteria (Figure 4.1). Each factor has its own some criteria, which were carefully selected according to the review of previous, related studies (table 4.1).

Each factors criteria of each learning web-based application was examined to identify problems with each web-application. These problems were classified, and similar problems were grouped together to identify common areas of usability problems on each web-application. These were examined to identify common areas of usability problems across the web-based learning applications. Consequently, six common factors of usability problems were identified, which suggested identifying 20 problem criteria. The six main factors related to: effectiveness, efficiency, satisfaction, control and management, ubiquity, error tolerance. The list of factors and its criteria of each was explained in the table (3.1).

Table (4.1): the Usability Metrics (factors and criteria)

factor	Criteria	Description
Effectiveness	Visibility	The application should always keep user informed about what is going on, through the appropriate feedback within responsible time.
	organization	An application should always use simple navigation menu and logical structure and no deep architecture;
	Navigation	An application should always support users to clearway to navigate, because the user often chose application functions by mistake and will need a clearly way to leave unwanted state without having go through an extended dialogue, effective internal search; working links; no broken links; no orphan pages and the simple navigation function in menu and support undo, redo, forward, backward … etc

factor	Criteria	Description
	Completeness	A web learning application should take user in easy interaction with it and help to complete all learning objective.
Efficiency	Speed	Quick downloading of web-learning applications.
	Consistency	The web learning application should have to wonder whether different words, situations and action the same thing.
	flexibility	The web learning application should always support different foreign languages and communication support and contact.
Control & management	User management	Web learning application should have the utility to allow users to administrate and manage team members in the application because a team consists of different roles.

factor	Criteria	Description
	Awareness	The web learning application should always support the awareness, which is use for coordinating between users with others in collaborative learning tasks where direct communication is not always necessary, Awareness also refers to indirect forms of communication even while involved in a direct conversation.
	User control	Users should be free to select and sequence tasks (when appropriate), rather than having the web learning application do this for them.
	File/content management	The web learning application should always support stored file or content and retrieve it when it requested by the user and tracked online whenever needed in future.
	Automated Notification,	The web learning application should support automated notification to support the learning for users by informing users of the dates lectures and dates of exams and other functions to private learning and that all means available by e-mail to the user, which is automatically or showing notifications directly on the application interface.
	Content protection/ Security	.Web learning application should have support the protection of content or file in the learning tasks and through the provision of content and file protection tools in the application of illegal access by hackers
Error tolerance	Error prevention	The web learning application should be ensures that an application has the capability of preventing errors, or helping with recovery from those errors that do occur.
ubiquity	Support different user	The web learning application should be support the different types of users, experts users and novices user

factor	Criteria	Description
satisfaction	Learnability	Learnability will affect how much need for users memorizing a application, determine if they are able to understand the application intuitively and to quickly find out what they should.
	Memorability	Means that is a measure of how easy a web learning application is to remember after a substantial time-lapse between visits.
	Simplicity	The web learning application should need to minimize the number of steps involved in learning process, to use symbols and terminology that make the web-learning interface as obvious as possible and to make it difficult to make mistakes.
	functionality	A web-learning application must be useful to its targeted users, must be capable of helping these users complete their tasks or achieve their goals.
	Aesthetic Design	the web learning application is attractive, appealing, and has professional first impression

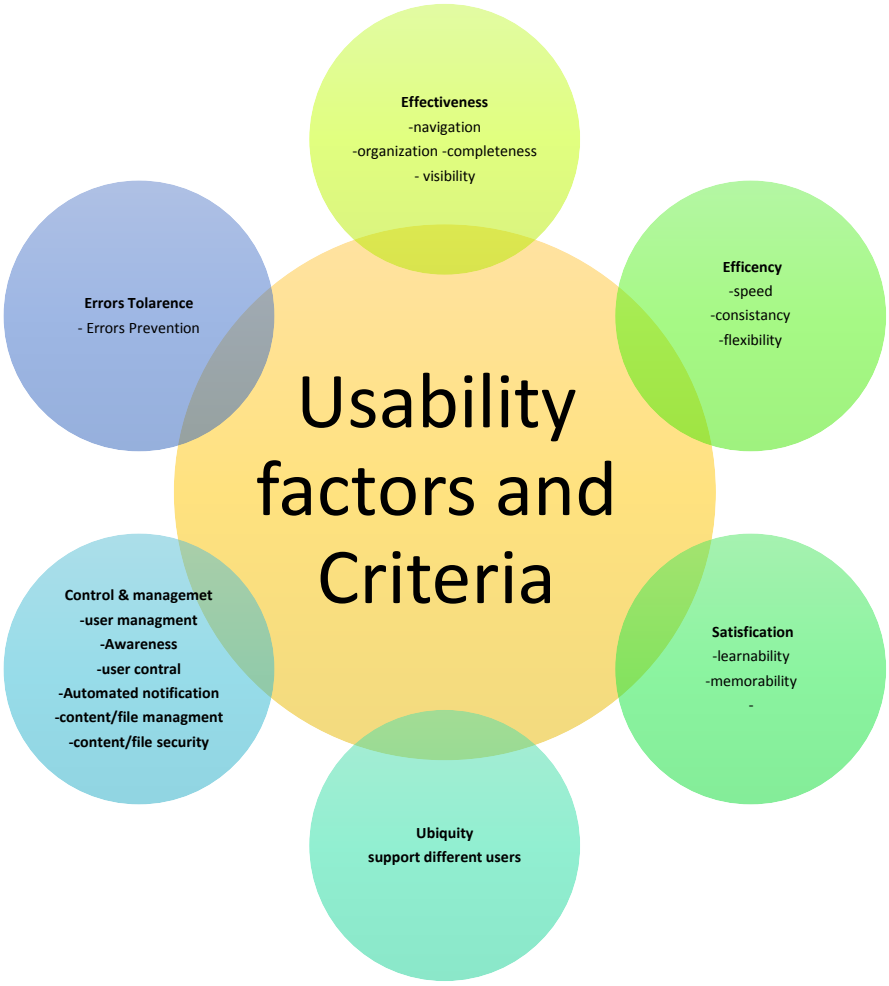


Figure 4.1: The Usability factors and criteria

4.4 Selection of usability evaluation method

In order to evaluate the usability of the selected web-based learning applications, the researcher using mixing method with user testing technique and scenario based framework, to developed usability conclusion and make a recommondation. The usability guidelines was developed includes a set of comprehensive factors, specific to web-based learning applications and used as criteria in the usability evaluation for this types of applications.

4.5 Tasks Selection

In order to execute the usability test, four tasks was selected and described below:

1. Sign up for an account,
2. Login into account in system,
3. Join a course, and, finally,
4. Submit the text file into an online assignment.

These four tasks covered the main features of the web-based learning application.

4.6 The Usability Test

The usability test was conducted with 20 sessions, each session in the usability test; the researcher was tested one of the main factors within a one of criteria to identify the usability level or problems to this criteria and applied into each set of 40 web-based learning applications. Each session was conducted independently from others the rest of the sessions, which means that the entire major factors have been tested independently from the rest of the factors. After ending the sessions, the researcher register and analyze the usability point scale for the criteria and factors.

4.7 Data collection

In this study, the researcher using Likert 5- scale contains five options are available to ratting the usability for each criteria and factors, the options and corresponding merits were shown in table (4.2). To do the assessment for usability for each factor and its criteria of each web-learning application, The researcher distribute 100 points across the six major factors and distribute the point assign to each factor across corresponding the criteria see (table 4.3). Then calculate the data from the direct assessment within each session when evaluate the usability of each criteria for one factor and finally register data of the overall usability form for each web-based learning applications.

4.8 Data Analyze

After completing the collection of quantitative usability data has from each session, the research analyzed the data for one criteria of the one of main factors by using software tool, Statistical Package for Social Sciences (SPSS), by defined this variable and equation shown below to analyze the usability data and :

The Usability rating point for the criteria, *x*, was defined as:

$$x = \left[\frac{\sum(\ points\ of\ each\ craiteria\ for\ web\ learning\ applications)}{number\ of\ web\ learning\ applications}\right]$$

The usability rating point for the factor, *x*, was defined as:

$$x = \left[\frac{\sum(rating\ point\ for\ each\ criteria\ in\ the\ factor)}{total\ number\ of\ critera\ in\ the\ factor}\right]$$

In order to determine the usability level of all web-based learning applications, the usability index was identified in this study and calculated from all usability factors. The usability index, *x*, was defined as:

$$x = \left[\frac{\sum(rating\ point\ for\ each\ factor)}{total\ number\ of\ factors}\right]$$

The usability index and corresponding usability levels, shown in (table 4.4)

Table (4.2) Options for rating the usability factors' criteria and the corresponding of usability point

Rating Options	Bad	Poor	Moderate	Good	Excellent
Usability Criteria Point (weight)	1	2	3	4	5

Table(4.3): The Relative Importance Points (weights) of each Criteria and Factors

factor	Criteria	Weight	Total weight of factor
Effectiveness	**Completeness**	**5**	**20**
	Navigation	**5**	
	Organization	**5**	
	Visibility (Feedback)	**5**	
Efficiency	**Speed**	**5**	**15**
	Consistency	**5**	
	Flexibility	**5**	
Control & Management	**User Management**	**5**	**30**
	Awareness	**5**	
	User control	**5**	
	File/Content Management	**5**	
	Automated Notification	**5**	
	File/Content Protection /Security	**5**	
Error Tolerance	**Error Prevention**	**5**	**5**
Ubiquity	**Support different users**	**5**	**5**
Satisfaction	**Functionality**	**5**	**25**
	Learnability	**5**	
	Memorability	**5**	
	Simplicity	**5**	
	Atheistic Design	**5**	
		Total weight	**100**

Table (4.4) usability rating point and corresponding usability index

Usability Rating Points (*x*)	Usability Index	Discerption
0.0-1.0	Failure	**Not response feature**- keep application has bad usability and may imperative to more fix before released application
1.0-2.0	Major	**not important feature**- keep application has poor usability may fixing it with high priority
2.0-3.0	Minor	**Little important feature**- keep application has moderate usability and need more fixing.
3.0-4.0	Cosmetic	**Important feature**- keep application has good usability ,but need more fixing
4.0-5.0	Positive	**Very important feature**- keep application has excellent usability with no problem at all

Table (4.5): Groups of Web-Based Learning Applications that Ranked by Alexa

Group 1 University web-learning applications	Group 2 Academy web-learning applications	Group 3 Free learning web-learning applications	Group 4 Commercial learning web-app.
Stanford University http://online.stanford.edu/ Global rank: 1,230	Microsoft IT Academy http://www.microsoft.com/en-us/education/training-and-events/it-academy/default.aspx#fbid=otPA7RsVKrH Global Rank: 42	LYNDA http://www.lynda.com/ Global Rank: 1,098	Udemy https://www.udemy.com/ ranking rate: 905
Harvard University http://www.extension.harvard.edu/open-learning-initiative Global rank: 1,421	http://ocw.mit.edu/courses/ MASACHUSETTS institute of technology-MITOPENCOURSEWARE Global rank: 1,149	Coursera https://www.coursera.org/ Global rank: 1,209	Udacity https://www.udacity.com Global rank: 5,570
Carnegie Mellon University - Open Learning Initiative https://oli.cmu.edu/jcourse/webui/syllabus Global rank: 4,695	https://www.khanacademy.org/ Khan Academy Global rank: 2,837	edX https://www.edx.org/ Global rank: 3,923	K12 http://k12.com Global rank: 8,772
University of California http://ocw.uci.edu Global Ranking: 8,092	Saylor Academy http://www.saylor.org/ Global Rank: 43,234	Open Yale Courses http://oyc.yale.edu/ Global Rank: 4,707	E-learning Center http://www.e-learningcenter.com/ Global rank: 888,713
Utah state University http://ocw.usu.edu/ Global Rank: 27,931	RWAQ Academy http://www.rwaq.org/ Global rank: 38,390	WIZIQ http://www.WIZIQ.com/ Global Rank: 7,859	Kendal Collage http://www.kendal.ac.uk Global Rank: 3,729,729
Reading University http://www.reading.ac.uk Global rank: 47,502	http://academicearth.org/education/ Earth Academic Global rank: 99,484	ALISON http://alison.com Global rank: 10,858	
Open University http://www.open.edu/openlearn/education Global rank: 79,315	ALDARAYN Academy http://www.aldarayn.com/ Global rank: 182,584	TUFTS http://ocw.tufts.edu Global Rank: 14,078	
United Nation University http://ocw.unu.edu/ocw/Courses_listing Global Rank: 99,465	Master Class Management http://www.masterclassmanagement.com Global Rank: 375,950	future learn https://www.futurelearn.com Global rank: 20,969	

Group 1	Group 2	Group 3	Group 4
Sudan University of science and technology http://cms.sustech.edu Global Rank: 126,966	Tag Academy http://www.tajac.org/ Global Rank: 2,180,969	Open2Study https://www.open2study.com Global rank: 46,184	
Sudan Open University http://ous.edu.sd/ Global Rank: 145,932	ENV3D http://Env3d.org/ Global rank: 2,737,059	GED for Free http://www.gedforfree.com/ Global rank: 527,038	
CAPILANO University http://ocw.capilanou.ca Global Rank: 149,061	Beat Beauty Academy http://www.baetbeauty.com/ Global Rank: 20,017,410	Way-Builder: Free-ED http://www.waybuilder.net/free-ed/ Global rank: 900,975	
Gresham Collage http://www.gresham.ac.uk/ Global Rank: 790,275	GCF FREE LEARN ACADEMY http://gcfleaenfree.org/ Global rank: 14,619		

4.9 Result of Usability Test

This section contains the results of the usability test for determined the important factors and its criteria, and scale the overall usability

4.9.1 The overall usability results

According to the indexing of usability and their corresponding of usability level in (table 4.4). The results showed that the most important factors for the usability of learning web-based application from the viewpoint of user between all groups of web-based learning application under test, the satisfaction factor as it has a highest usability indexing as in positive level shown in (table 4.4), Compared to the control and management factor ,it has a lowest usability indexing as in cosmetic level.

Figure 4.2 shows the usability rating point of each group. The results indicated that group 4 has the highest usability rating point compared with group two has lowest usability rating point, but all applications in groups has an a excellent usability and indexing usability level as positive that means all web-based learning applications contains the important features or factors that make these application are full usable.

Table (4.6): The overall usability rating points for usability factors

Category	Rating Point
Satisfaction	4.82 ± .429
Efficiency	4.78 ± .419
Ubiquity	4.73 ± .679
Effectiveness	4.65 ± .585
Error Tolerance	4.30 ± .823
Control & Management	3.10 ± 1.637
Total	4.397 ± .163

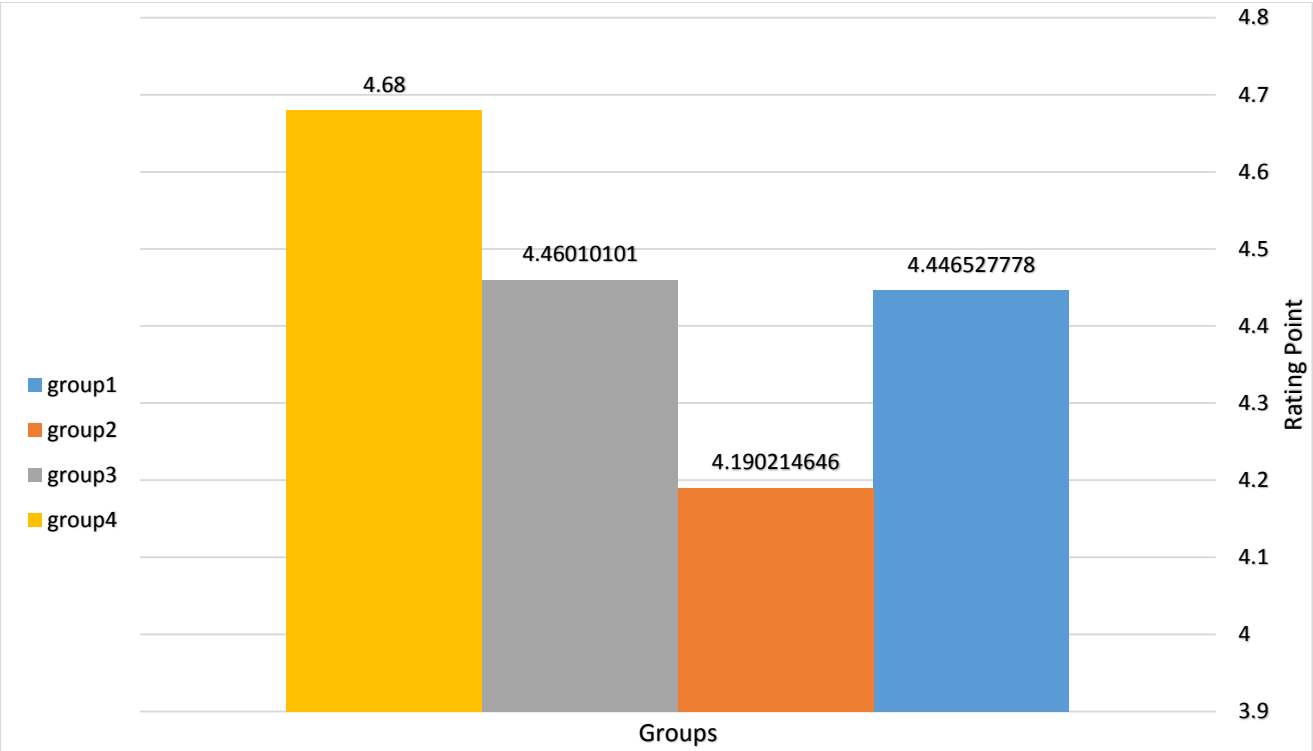


Fig (4.2): The overall usability rating points in four groups

4.9.2 Effectiveness factor:

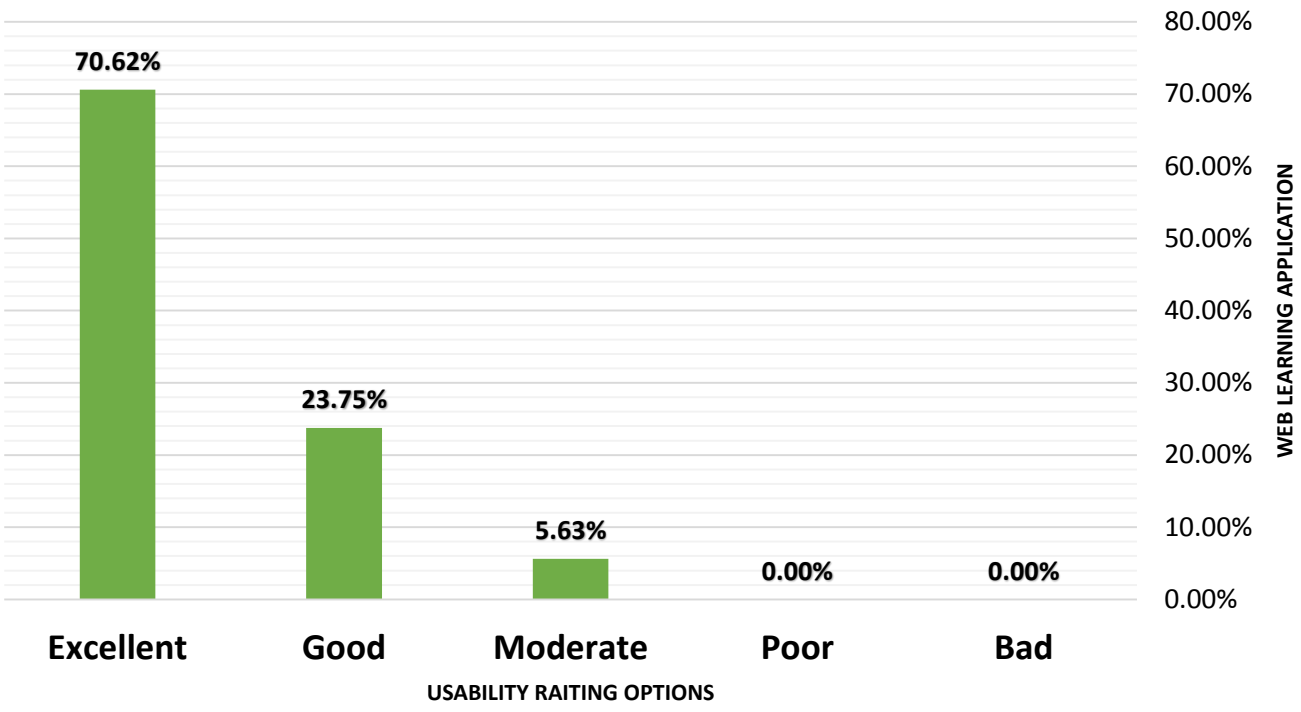
The Effectiveness factor has four criteria. Fig (4.3) shown that all criteria of this factor under test will ratting in excellent usability for the web-based learning applications by over 70.62%, 23.75% from the web-based learning application had ratted good usability, 5.63% from the web-based learning application had ratted usability as moderate and no web-learning applications had a rated as poor usability or pad usability.

The results showed that the most important criteria in effectiveness factor for the usability of learning web-based application from the viewpoint of user. The completeness criterion as it has a highest rating point as shown in (table 4.7) rather than navigation criterion has a lowest rating point.

According to the indexing of usability in (table 4.4). All criteria in this factor has positive indexing usability level. That means all these criteria are very important in design, and must be available in web-based learning application in order to be able to complete a task of within a proper period, in addition, the interface and design are user friendly and be familiar to finish the steps and complete a learning task follow a logical sequence. The web-based learning application must contain a good menus or obvious links to support and help users to complete a task of learning. Lastly, the web-based learning application is easy to find where you and the information you needed when working on a learning task, and make the information clearly points me to the next step/task in a workflow. This is in agreement with the results obtained by (ISO 9241-11) and earlier studies of Nielsen (1993).

Table (4.7): The usability rating point of criteria for the effectiveness's factor

Criteria	Rating Point
Completeness	4.75 ± .439
Organization	4.73 ± .506
Visibility	4.60 ± .632
Navigation	4.53 ± .716
Total	4.65 ± .585



FIG(4.3): The proporation of the rating options for the effectiveness factor

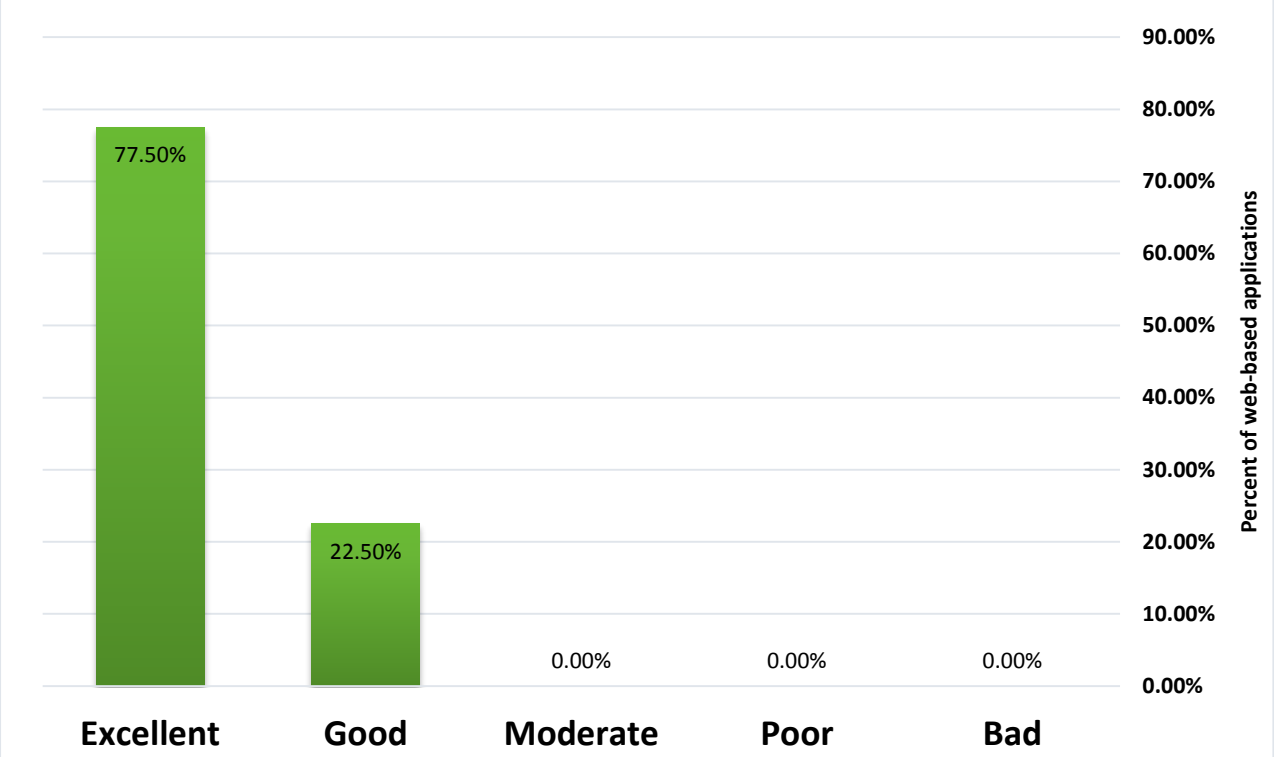
4.9.3 Efficiency factor:

Efficiency factor contains four criteria. Fig (4.4) shown that all criteria of this factor under the test will ratting in excellent usability for the web-based learning applications by over 77.5%, 22.5% from the web-based learning application had ratted good usability, and there are no web-learning applications had a rated point as moderate, poor or bad usability. The rating mean from both criteria shown in the (table 4.8), the highest rating point is 4.80 for speed criteria and lowest rating mean is 4.78 for the navigation criteria.

The result in (table 4.4) and the indexing of usability referred to in the table (table 3.4) explain that all criteria in this factor has indexing usability level as positive. That means all these criteria are important, and must be available in Web-based learning application in order to be able to access resources, and work on learning tasks efficiently and the speed in downloading and navigation is so fast enough. Also may support and provide the trainer or administrator/editor, it can easily to modify/configure forms or templates as necessary. In addition, the web-based learning application must be understandable and use multi-languages on a task screen; icons, menus, and information are familiar and understandable to users and the layout, interface design are consistent through the completely online application. This is in agreement with the results obtained by earlier studies of Nielsen (1993), ISO. (9242-11, 1998), Dawson (2006) and Person (2007).

Table (4.8): The usability rating points of criteria for the efficiency factor

Criteria	Rating Point
Speed	4.80 ± .405
Flexibility	4.80 ± .405
Consistency	4.73 ± .452
Total	4.78 ± .419



Fig(4.4) The proportion of rating options for Efficiency factor

4.9.4 Control and management factor

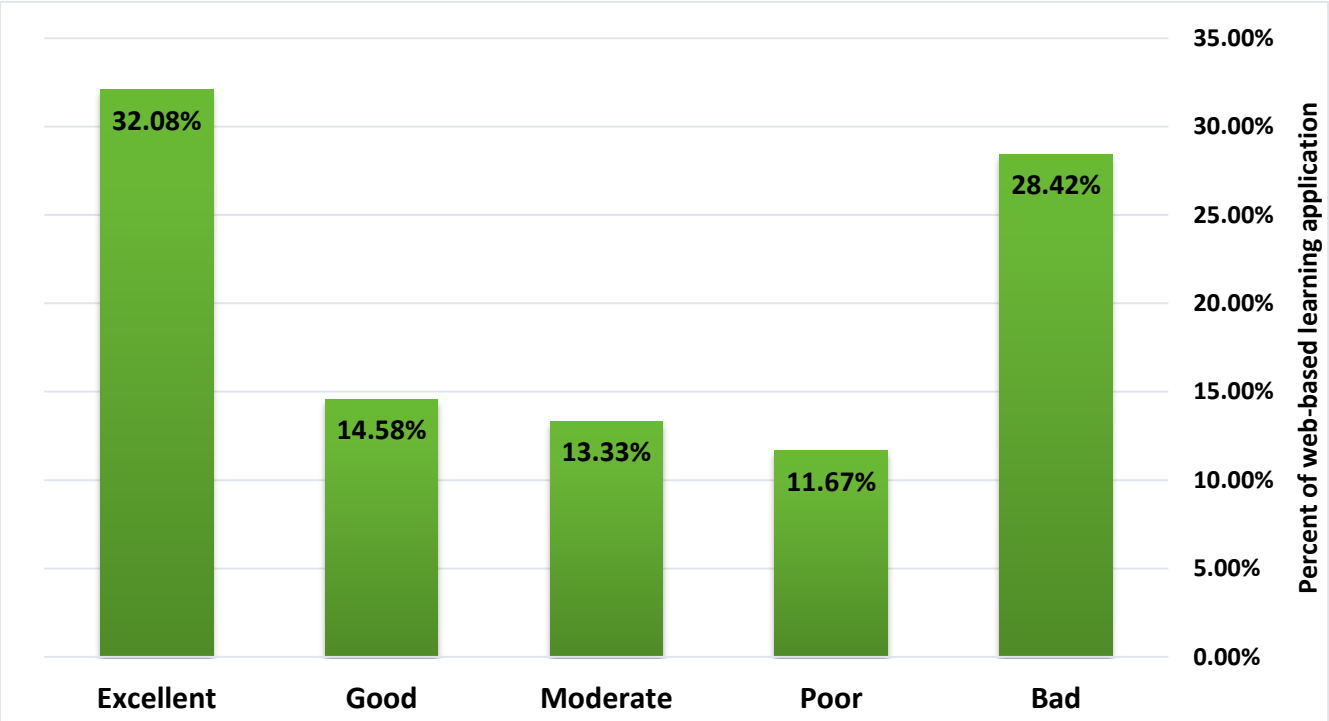
The control and management factor has six criteria. Fig (4.5) shown that all criteria of this factor under test will ratting in excellent usability for the web-based learning applications by over 38.8%, 14.58% from the web-based learning application had rated good usability, 13.33% from the web-based learning application had rated moderate usability, 11.67% of web-learning applications had a rated as poor usability and 28.42% of web-based learning applications had rated as bad usability. The rating mean from both criteria shown in the (table 4.4).The highest rating point is 3.57 for user management criteria and lowest rating point is 2.55 for the file/content protections criteria.

Results shown in Table 4.9 in addition to the usability indexing mentioned in the table 4.4. There were found four criteria indexed the usability level as cosmetic and two criterion indexed the usability level as minor. That means these criteria has needed more fixing in the web based learning application and offer more fixing features of user management, that can make the web-application is easy to add and assign users, and give more manage users roles and more assign of jobs for administrator or trainer. Also, fix features of Automated notification for ability to send a notification to the learning team, and if has received a notification in the interface or email indicate the task status when it in progress, or completion. In addition, fixing the awareness features because the web-based learning application must indicate user to the next step or action will be even when complete the current action or task. Furthermore, it has to be a fix or review of the property of user control on the web-based learning application, because the web-learning application must be able to assign the jobs like online instruction, monitor other user for moderator, and make a permission to levels of user to control for manage files or shared files and note. Fixing the status of the features about file and content sharing and management because the web-based learning application must be easily to upload, download and sharing the files, notes and

contents. In lastly, the important criteria would like to fix the features about the file/content protection and security because the web-based learning application may give warning when the users try to modifying files or notes on the workspace and full secure for storing file or content. This is in agreement with the results obtained by earlier studies of Nielsen (1993), ISO. (9242-11, 1998), Dawson (2006) and Person (2007).

Table (4.9): The usability rating points of the criteria for the control and management factor

Subcategory	Rating Point
User Management	3.57 ± 1.647
Automated Notification	3.47 ± 1.724
Awareness	3.22 ± 1.593
User Control	3.15 ± 1.545
File/Content Management	2.65 ± 1.494
File/Content Protection	2.55 ± 1.632
Total	3.10 ± 1.637



Fig(4.5) The proportion of rating options for Control and Managment factor

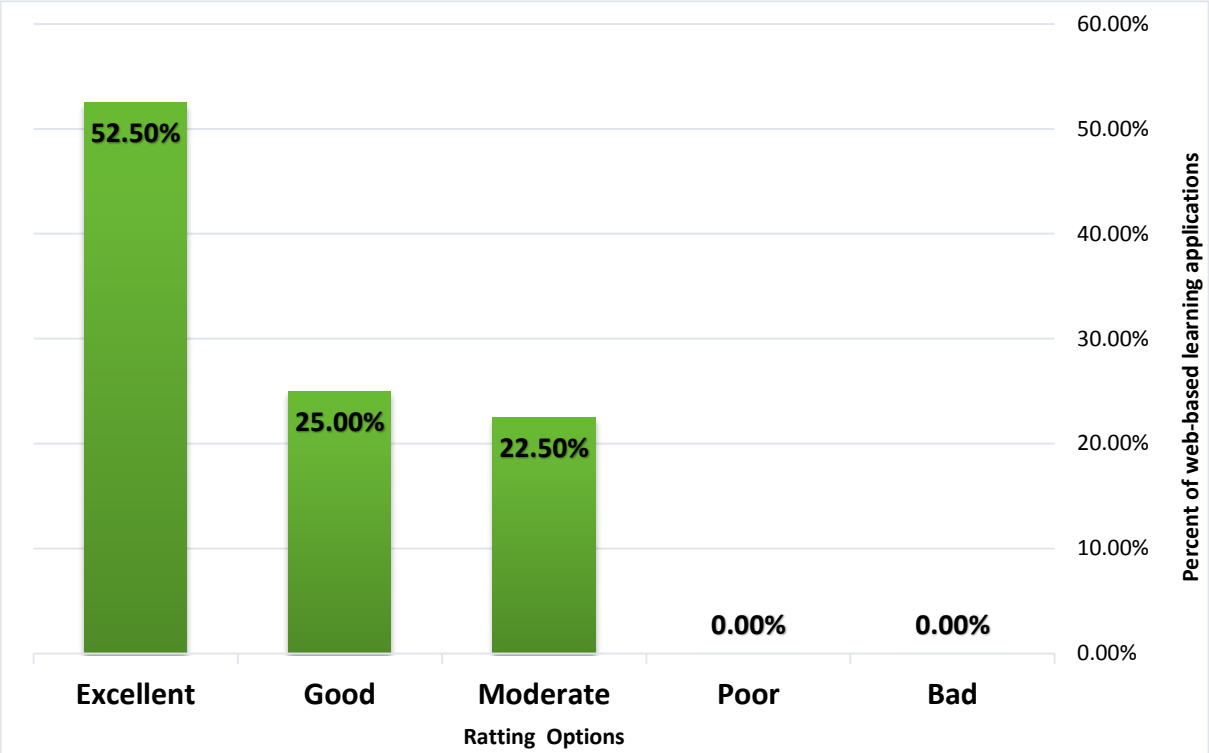
4.9.5 Error Tolerance factor

The error tolerance factor has one criterion. Fig (4.6) shown that the criterion of this factor under test will ratting in excellent usability for the web-based learning applications by over 52.5%, 25% from the web-based learning application had rated good usability, 22.5% from the web-based learning application had rated moderate usability, and there are no web-learning applications had a rated as poor usability or pad usability. The rating mean from both criteria shown in the (table 4.10).The highest rating point is 4.30 for user management criteria and there is no lowest rating point for this criterion.

According to table 4.10 and the indexing of usability level in (table 4.4) the criterion of this factor has indexed the usability as positive and important feature of all web based learning application in the sample. That means the web-based learning application must warns user about to make a potential error and gives error alerts indicates the clearly how to correct errors. Whenever the user make a mistakes and able to recover it easily and quickly. This is in agreement with the results obtained by earlier studies of Nielsen (1993), ISO. (9242-11, 1998), Dawson (2006) and Person (2007).

Table (4.10): The usability rating point of the criteria for the error tolerance factor

Criteria	Rating point
Error Prevention	4.30 ± .823
Total	4.30 ± .823



Fig(4.6) The proportion of rating options fot the error tolerance factor

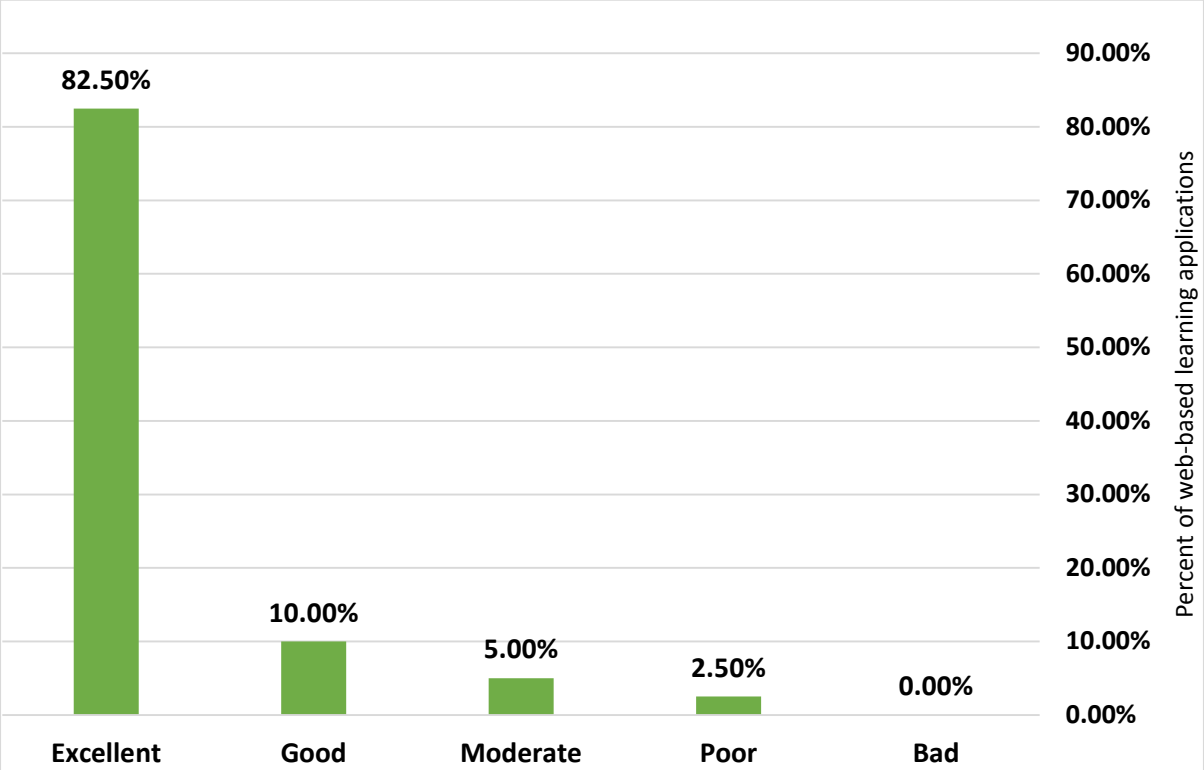
4.9.6 Ubiquity factor:

The ubiquity factor has one criterion. Fig (4.7) shown that the criterion of this factor under test will ratting in excellent usability for the web-based learning applications by over 82.5%. 10% from the web-based learning application had rated good usability. 5% from the web-based learning application had rated moderate usability, and 2.5% of web-based learning applications had ratted as poor usability, finally, there are no web-learning applications had a rated as bad usability. The rating mean from both criteria shown in the (table 4.11).The highest rating point is 4.73 for user management criteria and there is no lowest rating point for this criterion.

According to (table 4.11) and the indexing of usability level in (table 4.4) the criterion of this factor has indexed the usability as positive of all web based learning application under test, that means the web-based learning applications must has support both novice and expert users, and offer an advance features to expert users. This is in agreement with the results obtained by earlier studies of Nielsen (1993), ISO. (9242-11, 1998), Dawson (2006) and Person (2007).

Table (4.11): The usability rating point of the criteria for the ubiquity factor

Criteria	Rating Point
Support different user	4.73 ± .679
Total	4.73 ± .679



Fig(4.7) The proportion rating options for the ubiquity factor

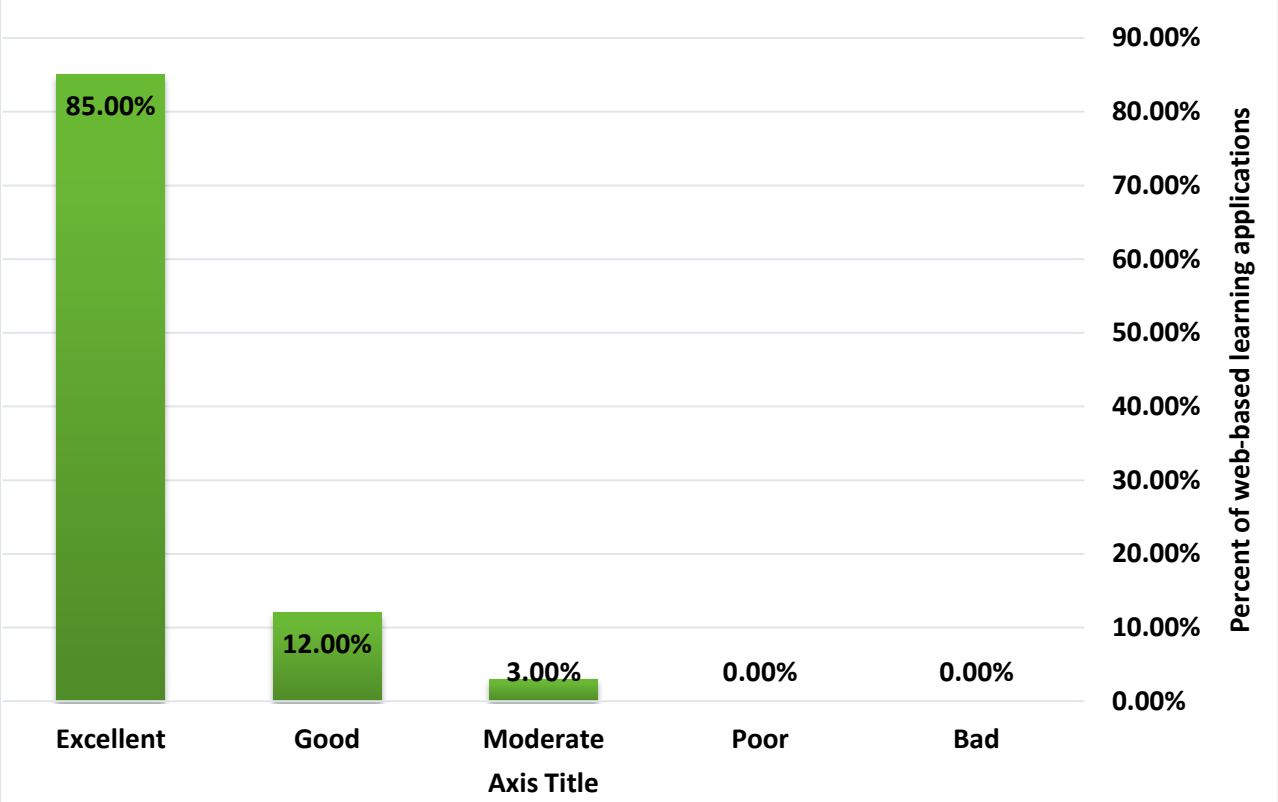
4.9.7 Satisfaction factor

The satisfaction factor contains five criteria. Fig (4.8) shown that all criteria of this factor under test will ratting in excellent usability for the web-based learning applications by over 85%, 12% from the web-based learning application had rated good usability, 3% from the web-based learning application had rated moderate usability, and there are no web-learning applications had a rated as poor or bad usability. The rating point from both criteria shown in the (table 4.12).The highest rating point is 4.93 for learnability criteria and lowest rating point is 4.60 for the atheistic criteria.

According to result in (table 4.12) and the indexing of usability in (table 3.4). All criteria in this factor has indexing usability level as positive. This means that all criteria is important and necessary characteristics and must be provided and supported in the web-based learning application, because it may easy to learn and support help and documentation to explain how can use it for user and it, and easy to memorable. Simple in language, menus, and smart links, additionally it make user expect the function and capabilities to have it, and the application interface was pleasant and very interactive. This is in agreement with the results obtained by earlier studies of Nielsen (1993), ISO. (9242-11, 1998), Dawson (2006) and Person (2007).

Table (4.12): The usability rating point of criteria for the satisfaction factor

Criteria	Rating Point
Learnability	4.93 ± .267
Memorability	4.93 ± .267
Simplicity	4.90 ± .304
Functionality	4.75 ± .494
Atheistic Design	4.60 ± .709
Total	4.82 ± .457



Fig(4.8) The proportion of rating optins for the satisfaction factor

4.9.8: usability of web-based learning applications in groups:

The result in fig. 4.9 shown that group 4 that contains payment or commercial web-based learning applications is the first one and had a high usability rate point for all factors, on the other hand, also found the group two that contains academy web-based learning applications is the last group of ranking. Also found the best factor has full usability-rating point is the ubiquity factor in all groups of web-based learning applications, conversely, the control and management factor has lowest usability rating points for all groups. That means the usability indexing for groups 1,3,4 consider cosmetic problems in the factor of control and management and this factor have an important but need more fixing, group 2 indexing the usability for this factor control and management as minor or little important feature but has need more fixing.

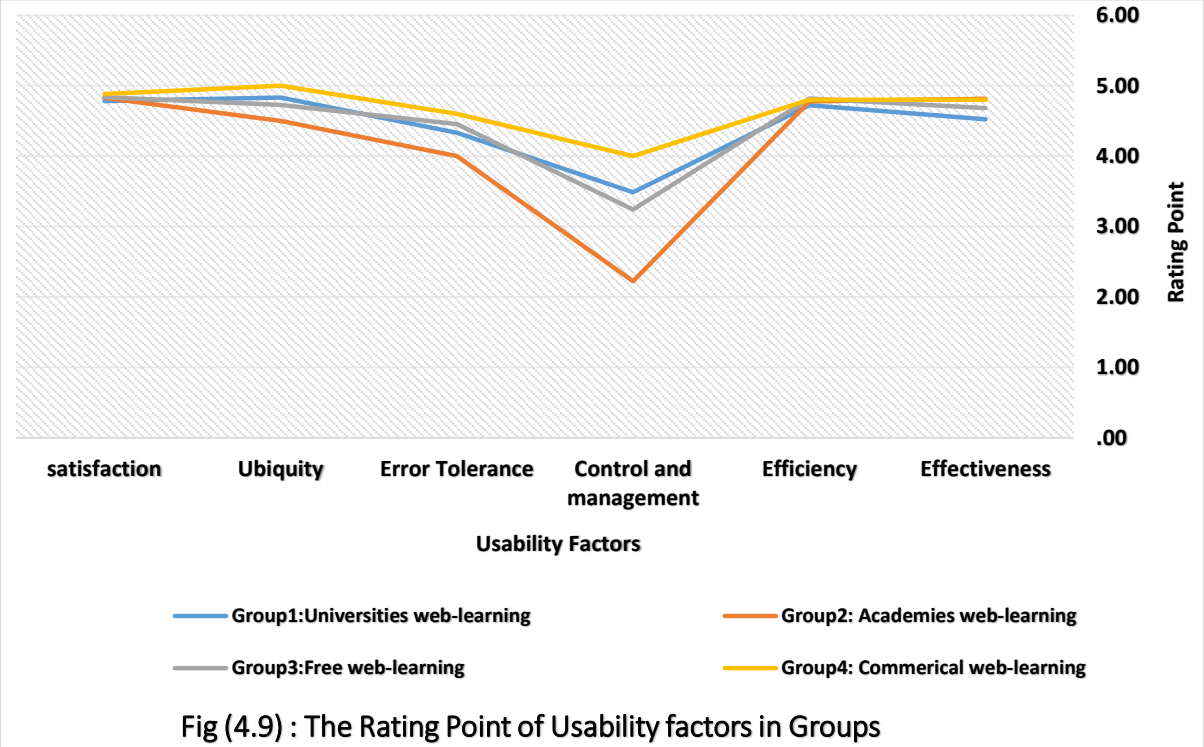


Fig (4.9) : The Rating Point of Usability factors in Groups

Chapter Five

Conclusion & Recommendations

5.1 Result Summary

This study aimed to select a framework for evaluation the usability of web-based learning applications. The selected framework was discussed in the previous chapters defended by nine stage, will identify the important metrics for the evaluation usability of web-based learning applications.

Table (5.1) Final Selected Framework for Usability Evaluation of Web-Based Learning Applications

1. Specify Usability Evaluation Goals
2. Determine web-learning application
3. Select Usability Metrics **a. User Satisfaction** i. Learnability ii. Memorability iii. Simplicity iv. Functionality v. Atheistic Design **b. Efficiency** i. Speed ii. Flexibility iii. Consistency **c. Ubiquity** i. Support Different User **d. Effectiveness** i. Completeness ii. Organization iii. Visibility

iv. Navigation **e. Error Tolerance** i. Error Prevention **f. User Control & Management** i. Automated notification ii. User management iii. Awareness iv. User control v. Content/file management vi. Content/file protection
4. Select Usability Evaluation Method
5. Select Task
6. Testing Design
7. Capture Usability Data
8. Analyze Usability Data
9. Present Usability Result

Using the factors and criteria above, the framework can be applied for either formative or evaluative usability of web-learning applications.

Measurements

Measurements of the factors and criteria are either on a scale of 1 to 5 or depending on whether or not they exist in the application. Criteria measured from 1 to 5 are on a scale where 1 is bad and 5 is excellent.

For the attributes concerning minimizing the number of proprietary, the measurement for factor is calculated by taking the summation of total point of criteria and divided by total number of criteria in factor.

Overall Usability of web-based learning application have are either on another scale of 1 to 5 are on a scale 1 is failure usability and the metrics are not response and 5 is positive usability and metrics are very important. For measure the overall usability of web-based learning application are calculated by dividing

the summation of the factors by the total number of web-based learning application, resulting in a number ranging from 0..100 point

Usability Evaluation Method

The procedure for assessing the usability evaluation of a web-based learning application was as follows. The evaluator will become familiar with the salient aspects of the web-learning application. (A small team, rather than a single evaluator, can also perform the assessment). A sample of key user types will be given a task concerning test. From study, combine usability evaluation methods are used empirical method and analytical method (survey and observation), if the situation warrants, personnel can be recruited to help with the evaluation. that agrees with Ssemugabi and de Villiers (2007) state that "*analytical and empirical methods should be combined, something that more researchers can confirm, in order to gain a more comprehensive result*".

Earlier studies suggested that several dimensions were related to and relevant in a usability evaluation. this study shows that a wide verity of usability evaluation methods where used, both analytical and empirical as well as the combination method that agrees with Ssemugabi and de Villiers (2007) state that "*analytical and empirical methods should be combined, something that more researchers can confirm, in order to gain a more comprehensive result*". In addition, combination of the usability evaluation methods seems to be better, that agrees with a case study on comparative usability evaluation Koutsabasis et. al., (2007) revealed that "*no method was found to be significantly more effective or consistent that others*". They also pointed out that "*a single method is not enough for comprehensive usability evaluation. If it is important to find most problems parallel evaluations can be carried out.*". and also agrees with Tselios, Avouris and Komis (2008) argue that different type of e-learning system should adapt different evaluation methods.

A concise report will be generated using inputs from the above process that: 1) summarize usability level of factors and criteria for usability of web-learning application, 2) Makes recommendations for improvements.

5.2 Conclusion

This study aimed to develop a framework for evaluation the usability of web-based learning applications, and test a selected framework in real context of web-based learning application. Usability evaluation was done empirically with blended methods were applied validated the objectives. The selected framework could identify all usability features scale and approach has been adopted in this study involving the users who have a regular interaction with this types of applications. Different usability evaluation methods may give different results because each method touches different mind approaches. Some methods are more precise and contain factual theoretical data. On the other hand, some give statistical data, which facilitate evaluator to analyze outcome. This developed usability framework may help evaluator to focus on the essentials that make working with. Web-learning application to be easy for users.

5.3 Recommendations

This study was needed to further clarify the efforts are needed to determine how best to adjust weights for different types of systems. The metrics used to measure usability need study and refinement.

The recommendations suggested by this study to improvement the web-learning applications. The Following are the recommendations were suggested:

- Study more new factors and criteria affect in usability evaluation of these web-based learning applications. Because this study cannot cover all metrics and new tools were used in web-based learning applications are increased.
- This study recommend researchers to use the combination evaluation methods in evaluation process. Because when using a different usability evaluation methods may give different results because each method touches different mind approaches.

- For new studies in usability evaluation of web-learning application, this study recommend to use querying method blinded with empirical methods to take a best result.

References

Alverno, C. (2012). *Alverno Collage*. Retrieved November 14, 2013, from http://depts.alverno.edu: http://depts.alverno.edu/cil/basic/webapps/typeswebapps.html

Andy, W. (2012). Software Engineering Aspects of Web Based Applications. *Software Engineering ; University of Wisconsin, Platteville; woodan@uwplatt.edu*.

Aristovnik., A. (2012). The impact of ICT on educational performance and its efficiency in selected EU and OECD countries:The impact of ICT on educational performance and its efficiency in selected EU and OECD countries. *X MPRA*.

Benbunan-Fich, R. (2001). Using Protocol Analysis to Evaluate the Usability of a Commercial Website. *39*(2), pp. 151-163.

Bevan, N. (1995). Human-Computer Interaction Standards. *E. Anzai & Ogawa (eds) (Chair), Symposium conducted at the meeting of the 6th International Conference on Human Computer Interaction.* Yokohama.

Brinck, T. (2013, August 29). *Groupware - Introduction, Applicatons, Design Issues, and links.* Retrieved August 29, 2014, from usability first: http://www.usabilityfirst.com/about-usability/web-application-design/collaborative-software-groupware/

Bruck Nagy, A. P., Buchholz, A., Karssen, Z., & Zerfass, A. (2005). Technologies and Perspectives for the European Market Impact of E-Learning,. Berlin: Springer-Verlag.

Cook, D. A. (2007, Feb). Web-based learning: pros, cons and controversies. *Clinical Medicine, 1*, pp. 37-39.

Costabile, M., De Marsico, M., Lanzilotti, R., Plantamura, V., & Roselli, T. (2005). On the Usability Evaluation of E-Learning Applications. *In: Proceedings of the 38th Hawaii International Conference on System Science* (pp. 1-10.). Washington: IEEE Computer Society.

Costabile, M., De Marsico, M., Lanzilotti, R., Plantamura, V., & Roselli, T. (2005). *On the Usability Evaluation of E-Learning Applications.* New York: ACM Press.

Crossman, D. (1997). *The Evolution of the World Wide Web as an Emerging Instruction* (Vols. In: B.H. Khan. (Ed.), Web-Based Instruction). New Jersey: Educational Technology.

Crowther, S. M., Keller, C. C., & Waddoups, L. G. (2004). Improving the quality and effectiveness of computer-mediated instruction through usability evaluations. *3(15),289-303.*(15).

Cyzyk, M., & Choudhury, S. (2008). A Survey and Evaluation of Open-Source Electronic Publishing Systems. Retrieved from https://wiki.library.jhu.edu/download/attachments/22964/Open+Source+ePublishing+Systems+White+Paper.pdf?version=1

Dawson, J. W. (2006). A holistic usability framework for distributed simulation systems. Central Florida, Florida, United States. Retrieved from http://ezproxy.auckland.ac.nz/login?url=http://proquest.umi.com/pqdweb?did=1203572691&Fmt=7&clientId=13395&RQT=309&VName=PQD3233646)

Dimitracopoulou, A. (2005). Designing collaborative learning systems: current trends & future research agenda. *Paper presented at the meeting of the Proceedings of th 2005 conference on Computer support for collaborative learning the next 10 years!* Taipei, Taiwan. Retrieved from http://portal.acm.org.ezproxy.auckland.ac.nz/citation.cfm?id=1149293.1149309&coll=ACM&dl=ACM&CFID=12025639&CFTOKEN=38359002#

Dix, A., Finlay, J., Abowd, G., & Beale, R. (1998). Human-Computer Interaction. Staffordshire Hemel Hempstead: Prentice-Hall.

Dix, A., Finlay, J., Abowd, G., & Beale, R. (2004). *Human-Computer Interaction* (Vol. 3rd Ed.).

Dobolyi, K. (2010). *An Exploration of User-Visible Errors in Web-based Applications to Improve Web-based Applications.* virginia: University of Virginia.

Downey, L. L. (2007). *Group Usability Testing: Evolution in Usability Techniques* (Vol. 2).

European Commission. (2000). Communication from the Commission: E-Learning – Designing "Tejas at Niit" tomorrow's education.

Firdyiwek, Y. (1999). Web-Based Courseware Tools: Where is the Pedagogy?. *Educational Technology*, pp. 29-34.

Fitzpatrick, R. (1999).

http://www.comp.dit.ie/rfitzpatrick/papers/chi99%20strategies.pdf. Retrieved

06 21, 2013, from Strategies for Evaluation of Software Usability.

Folmer, E., & Bosch, J. (2003). Usability Patterns in Software Architecture. Retrieved from http://is.ls.fi.upm.es/status/results/patterns.pdf. Retrieved from http://scholar.google.com/scholar?oi=bibs&hl=ar&cluster=12311976914176813066&btnI=1

ForakerDesign. (2005). *Your Online Guide to Usability Resources - Methods.* Retrieved from http://www.usabilityfirst.com/methods/index.txl

Gellner, M., & Forbrig, P. (2003). Extreme Evaluations – Lightweight Evaluations for Software Developers. Retrieved from http://www.se-hci.org/bridging/interact/Gellner.pdf

González, M. P., Collazos, C. A., & Granollers, T. (2006, September 17-21). Guidelines and Usability Principles to Design and Test Shared-Knowledge Awareness for a CSCL Interface In Groupware: Design, Implementation, and Use. *12th International Workshop, September 17-21, 2006. Proceedings, 4145*, 102-117. doi:10.1007/11853862

Govindasamy, T. (2002). Successful Implementation of e-Learning Pedagogical Considerations. In *The Internet and Higher Education* (pp. 287-299).

Graham, C. R., & Misanchuk, M. (2004). Computer-Mediated Learning Groups: Benefits and Challenges to Using Groupwork in Online Learning Environments. In T. S. Roberts (Ed.), *Online collaborative learning [electronic resource] : theory and practice* (pp. 181-202). Hershey PA: Idea Group Publishing.

Green, D., & Pearson, J. M. (2006). Development of a Web Site Usability Instrument based on ISO 9241-11. *Journal of Computer Information Systems*, 66-72.

Green, D., & Pearson, J. M. (2006). Development of a Web Site Usability Instrument based on ISO 9241-11. *Journal of Computer Information Systems*, 66-72.

Hom, J. (2010). *Thinking Aloud Protocol.* Retrieved 09 01, 2014, from jame shom: http://usability.jameshom.com/

Hope, A., & Guiton, P. (2006). Strategies for Sustainable Open and Distance Learning.

Horton, W. (2006). *E-learning by Design.* (I. John Wiley & Sons, Ed.) Pfeiffer.

Hu, G., & Chang, K. H. (2006). Web sites usability, usability requirements specification & usability evaluation. *Meeting of the Proceedings of the 44th annual Southeast regional conference.* Melbourne, Florida. doi:http://doi.acm.org/10.1145/1185448.1185640

Hu, G., & Chang, K. H. (2006). Web sites usability, usability requirements specification & usability evaluation. *44th annual Southeast regional conference.* Melbourne, Florida.

ISO/IEC 9126-1. (2000). *Software Product Evaluation–Quality Characteristics and Guidelines for the User.* ISO/IEC 9126-1.

ISO-9241-11. (1998). *http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=16883*. (ISO) Retrieved June 18, 2013, from ISO 9241: Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on usability.

Ivory, M. Y. (2001). *An Empirical Foundation for Automated Web Interface Evaluation.* UNIVERSITY of CALIFORNIA at BERKELEY.

Ivory, M. Y., & Hearst, M. A. (2001). The state of the art in automating usability evaluation of user interfaces. *ACM Computing Surveys,*. Retrieved from http://ezproxy.auckland.ac.nz/login?url=http://proquest.umi.com/pqdweb?did=109542419&Fmt=7&clientId=13395&RQT=309&VName=PQD

Jolliffe, A., Ritter, J., & Stevens, D. (2001). The Online Learning Handbook: Developing and Using Web-Based Learning. London: Kogan Page.

Karat, C., Campbell, R., & Fiegel, T. (1992). Comparison of empirical testing and walkthrough methods in user interface evaluation. pp. 307-404.

Karoulis, A., & Pombortsis, A. (2003). Heuristic Evaluation of Web-based ODL Programs. In C. Ghaoui (Ed.), *Usability Evaluation of Online Learning Programs* (pp. 88-109). Hershey PA,: Information Science publishing.

Karoulis, A., Anastasia., & Pombortis, A. (2003). On Expert-Based evaluation of the Usability and the Learnability of Web-Based Open and Distance Learning Environments. pp. 1-6.

Khan, B. H. (2001). *Web-based Training.* Educational Technology Publications.

Kildare, R., Williams, R. N., & Hartnett, J. (2006). An online tool for learning collaboration and learning while collaborating. *Symposium conducted at the meeting of the Proceedings of the 8th Austalian conference on Computing education. 52*, pp. 82-103. Hobart, Australia: Australian Computer Society, Inc.

Kirakowski, J. (2000). *Questionnaires in Usability Engineering: A List of Frequently Asked Questions (3rd Ed.).* Retrieved 09 01, 2014, from http://www.ucc.ie/hfrg/resources/qfaq1.html

Luskin, B. (2010, March 24). *Think exciting e-learning and big-e*. (Educause review online) Retrieved April 29, 2013, from http://www.educause.edu/ero/article/think-exciting-e-learning-and-big-e: http://www.educause.edu/ero/article/think-exciting-e-learning-and-big-e

Martinidale, T., Cates, W. M., & Qian, Y. (2005). Analysis of recognized Web-based educational resources. *Computers in the Schools, 3*, pp. 101-117.

Marzie, A., & Mohamed, A. ,. (2008). AN EMPIRICAL STUDY OF UNIVERSITY WEBSITES. *IX*(2).

Miller, M. (2009). Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online. Que Puplishing.

Miller, M. J. (2005, Jan). *Usability in E-Learning.* Retrieved June 18, 2013, from http://www.learningcircuits.org/2005/jan2005/miller.htm.

Molich, R., & Dumas, J. S. (2008). *Comparative usability evaluation (CUE-4)* (Vol. 27).

Moodle. (2014, 09 04). *Features.* Retrieved from Moodle.org: https://docs.moodle.org/27/en/Features

Nakamichi, N., Shima, K., Sakai, M., & Matsumoto, K. (2006). *Detecting low usability web pages using quantitative data of users' behavior.* Shanghai,China. doi:http://doi.acm.org/10.1145/1134285.1134365

Nielsen, J. (. (1994). Heuristic Evaluation. In N. &. (Eds.), *Usability inspection methods* (pp. 25-62). New York: John Wiley & Sons, Inc.

Nielsen, J. (1993). *Usability Engineering.* Cambridge: Academic Press.

Nielsen, J. (1995). *Multimedia and Hypertext. Internet and Beyond* . LONDON: Academic Press.

Nielsen, J. (2012, 01 04). *Introduction to Usability*. Retrieved 12 12, 2014, from Usability 101: http://www.nngroup.com/articles/usability-101-introduction-to-usability/

Nielsen, R. L. (1994). "Executive Summary". In *Usability Inspection Methods.* New York: John Wiley.

Nogueira, J. L., & Garcia, A. C. (2003). Understanding the tradeoffs of Interface Evaluation Methods. Retrieved from http://www.addlabs.uff.br/equipe/cristina/papers/ac1_45.zip

Notess, M. (2001). *Usability, user experience, and learner experience*. Retrieved 11 2013, 26, from http://elearnmag.org/subpage/sub_page.cfm?section=4&list_item=2&page=1

Oliver, R., & Herrington, J. (2000). *Learning, Using Situated Learning as a Design Strategy for Web-Based.* Cowan Australia: Idea Group Inc.

Oztekin, A., Delen, D., Turkyilmaz, A., & Zaim, S. (2013, May 09). A machine learning-based usability evaluation method for eLearning systems. *Decision Support Systems*, pp. 1-11. doi:http://dx.doi.org/10.1016/j.dss.2013.05.003

Parks, E. (2004). What's the "e" in e-Learning? *http://www.askinternational.com/knowledge/articles/eBasic/whatsElearn.html*.

Pearson, J. A., Pearson, A., & Green, D. (2007). "Determining the Importance of Key Criteria in web usability". *Management Research News, 30*(11), 816-828.

Pinelle, D., & Gutwin. (2008). Evaluating teamwork support in tabletop groupware applications using collaboration usability analysis. *Personal and Ubiquitous Computing. Special Issue: User-centred design and evaluation of ubiquitous groupware, 12*(3), pp. 237-254. doi:http://dx.doi.org/10.1007/s00779-007-0145-4. doi:doi:http://dx.doi.org/10.1007/s00779-007-0145-4

PLANTAK VUKOVAC, D., KIRINIC, V., & K LICEK, B. (2010). *DAAAM International Scientifiec Book* (Vol. 27).

Preece, J. (1993). A Guide to Usability: Human Factors in Computing. *The Open University*, pp. 108-112.

Preece, J., Rogers, Y., Sharp, H., Holland, S., & Carey, T. (2002). Interaction Design: Beyond Human-Computer Interaction. New York: John Wiley & Sons.

Quesenbery, W. (2003, November 9). The Five Dimensions of Usability. In M. J. (Eds.), *Content & Complexity: Information Design in Technical Communication* (pp. pp.81-102). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Qureshi, K. M., & Irfan, M. (2009). *Usability evaluation of e-learning applications, A case study of It's Learning from a student's perspective.* RONNEBY, SWEDEN: Blekinge Institute of Technology.

Rosson, M. B., & Carroll, J. M. (2002). *Rosson, M. B., & Carroll, J. M. Usability engineering: Scenario-based development of human computer interaction.* San Francisco,USA: Morgan Kaufmann.

Rubin, J., & Chisnell, D. (2008). *Handbook of Usability Testing: How to plan, design and conduct effective tests* (2 ed.). Indianapolis Indiana: Wiley India Pvt. Ltd.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design, and conduct effective tests* (2nd ed.). Indianapolis, Indiana, USA: Wiley Publishing, Inc.

Ryu, H. (2007). Walkthroughs in Web Usability: Cognitive, Activity, and Heuristic Walkthrough. (P. Z. Kurniawan, Ed.) *(Eds.),Human Computer Interaction Research in Web Design and Evaluation*, pp. 229-256.

Sauro, J., & Kindlund, E. (2005). A method to standardize usability metrics into a single score. *SIGCHI conference on Human factors in computing systems.* Portland,Oregon,USA. doi:http://doi.acm.org/10.1145/1054972.1055028

Scholtz, J. (2004). Usability Evaluation. 1-8.

Scholtz, J. (2004). Usability Evaluation. Retrieved 08 29, 2014, from http://www.itl.nist.gov/iad/IADpapers/2004/Usability%20Evaluation_rev1.pdf - pages 1-8

Shilwant, S., & Haggarty, A. (2006, 02 16). *Usability Testing for E-Learning.* . Retrieved from http://www.clomedia.com/content/templates/clo_article.asp?articleid=1049.

Shneiderman, B., Borkwowski, E., Alavi, M., & Norman, K. (1998). Emergent Patterns of Teaching/Learning in Electronic Classrooms. *Educational Technology Research and Development*((4)), pp. 23-42.

Shneiderman, B., & Plaisant, C. (2004). *Designing the user interface: Strategies for effective human-computer interaction.* Boston,USA: Pearson/Addison Wesley.

Simeral, J. E., & Branagham, J. R. (2000). A comparative Analysis of Heuristics and Usability Evaluation methods. pp. 307-309.

Smith, P. J. (2011, Sep. 12). *Stack Overflow*. Retrieved November 2013, 2013, from http://stackoverflow.com/questions/7386734/different-types-of-application-in-web-development

Smulders, D. (2001, August). *Web Course Usability*. Retrieved 11 23, 2013, from http://www.learningcircuits.org/2001/aug2001/elearn.html

Squires, D., & & Preece, J. (1999). Predicting quality in educational software: Evaluating for learning, usability and the synergy between them. *11*((5)), pp. 567-483.

Srivastava, S. C., Chandra, S., & Lam, H. M. (2009). Usability Evaluation of E-Learning Systems. *IT Education*.

Ssemugabi, S., & Villiers, R. D. (2007a). Usability and Learning: A Framework for Evaluation of Web-Based e-Learning Applications. *C. Montgomerie & J. Seale (Chair), AACE. Symposium conducted at the meeting of the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007,*. Vancouver, Canada.

Starr, R. M. (1997). Delivering Instruction on the World Wide Web: Overview and Basic Design Principles. pp. 7-15.

Tarafdar, M., & Zhang, J. (2005). "Analyzing the Influence of Website Design Parameters on Website Usability". *Information Resources Management Journal, 80*(4), 62-80.

Tavangarian D., L. M. (2004). Is e-learning the Solution for Individual Learning? *Journal of e-learning*.

Tobin, T., & Kesselman, M. (1999). EVALUATION OF WEB-BASED LIBRARY INSTRUCTION PROGRAMS. *INSPEL 34(2000)2,*, pp. pp. 67-75.

Tsai, S., & Machado, P. (2004). *E-learning Basics: Unveiling the Ambiguity in Current Terminology.*

Vanderdonckt, J. (1999). Development milestones towards a tool for working with guidelines, Interacting. *with Computers*, *12*(2), 81-118.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward A Unified View. MIS Quarterly,. pp. 425-478.

Vrasidas, C., & McIsaac, M. (2000). Principles of Pedagogy and Evaluation for Web-Based Learning. *Educational Media International*,(37(2)), pp. 105-111.

Wikipedia. (2014, 09 04). *http://en.wikipedia.org/wiki/Moodle.* Retrieved from http://en.wikipedia.org: http://en.wikipedia.org/wiki/Moodle

Wong, B., TT, N., & E, C. (2003). *Usability metrics for e-learning. workshop on human computer interface for semantic web and web applications.* Jayaratna N, 3–7 November, 2003, Catania, Sicily, Italy. Berlin Heidelberg ,New York, Germany: Springer-Verlag.

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks: SAGE Publications.

Zaharias, P. (2006, April 22-27). A Usability Evaluation Method for e-learning: Focus on Motivation to Learn. Montreal, Quebec, Canada.

Zaharias, P., & Poulymenakou, A. (2006). Implementing learner-centered design: The interplay between usability and instructional design practices. *Journal of Interactive Technology and Smart Education, 3(2)*, pp. 87–100.

Zhang. (2008). Usability Evaluation Methods. Retrieved 8 29, 2014, from http://www.usabilityhome.com/

Zhang, Z. (2007). Usability Evaluation. In P. Zaphiris, & S. Kurniawan (Eds.), *Human Computer Interaction Research in Web Design and Evaluation* (pp. 209-228). London, UK: Idea Group Publishing. Retrieved 08 29, 2014

Appendices

Appendix (1)

Data of usability testing of the 40 web-based learning applications

No	Web-based learning application (website)	effectiveness				Efficiency			Control and management						Error Tolerance	Ubiquity	Satisfaction					Total Points (weight)
		Completeness	Navigation	Organization/Design	Visibility	Speed	Consistency	Flexibility	User Management	Awareness	User control	File/Content Management	Automated Notification	File/Content Protection	Error Prevention	Support different user	Functionality	Learnability	Memorability	Simplicity	Atheistic Design	
01	http://online.stanford.edu/	4	5	5	4	4	4	5	5	3	4	3	5	5	5	5	5	4	5	**5**	5	90
02	http://www.extension.harvard.edu/open-learning-initiative	4	4	4	3	5	4	4	1	2	2	2	2	1	3	5	3	5	5	**5**	3	67
03	http://oli.cmu.edu/learn-with-oli/see-our-free-open-courses/	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	**5**	5	99
04	http://ocw.uci.edu	5	5	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	5	**5**	5	98
05	http://ocw.usu.edu/	4	3	4	5	5	4	4	1	1	1	1	1	1	3	5	4	5	5	**5**	4	66
06	http://www.reading.ac.uk/Study/study-moocs.aspx	5	5	5	5	5	5	5	4	3	4	3	5	3	5	5	5	5	5	**5**	5	92

No	Web-based learning application (website)	effectiveness				Efficiency			Control and management						Error Tolerance	Ubiquity	Satisfaction					Total Points (weight)
		Completeness	Navigation	Organization/Design	Visibility	Speed	Consistency	Flexibility	User Management	Awareness	User control	File/Content Management	Automated Notification	File/Content Protection	Error Prevention	Support different user	Functionality	Learnability	Memorability	Simplicity	Atheistic Design	
07	http://www.open.edu/openlearn/education	5	5	4	4	4	5	5	5	4	5	3	4	3	5	5	5	5	5	**5**	4	90
08	http://ocw.unu.edu/ocw/Courses_listing	4	4	5	4	5	5	5	4	2	2	2	1	1	3	5	4	5	5	**5**	4	75
09	http://www.masterclassmanagement.com	5	4	4	4	5	4	5	3	1	3	3	4	2	4	4	4	5	5	**5**	3	77
10	http://cms.sustech.edu	5	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	**5**	5	98
11	http://www.tajac.org/	5	5	5	5	4	5	5	5	2	2	2	4	2	4	5	5	5	5	**5**	5	85
12	http://ous.edu.sd/	5	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	**5**	5	98
13	http://Env4d.org/	4	4	5	4	4	4	5	4	3	2	2	3	2	4	3	4	5	5	**4**	3	74
14	http://ocw.capilanou.ca	4	3	4	5	5	4	4	1	1	1	1	1	1	3	5	4	5	5	**5**	4	66
15	http://www.baetbeauty.com/	5	4	5	5	4	5	5	4	5	4	3	5	3	5	5	5	5	5	**5**	5	92
16	http://www.gresham.ac.uk/	5	5	5	5	5	5	5	1	1	1	1	1	1	4	5	5	5	5	**5**	5	75
17	http://gcfleaenfree.org/	5	5	5	5	5	5	5	1	1	1	1	1	1	4	5	5	5	5	**5**	5	75

No	Web-based learning application (website)	effectiveness				Efficiency			Control and management						Error Tolerance	Ubiquity	Satisfaction					Total Points (weight)
		Completeness	Navigation	Organization/Design	Visibility	Speed	Consistency	Flexibility	User Management	Awareness	User control	File/Content Management	Automated Notification	File/Content Protection	Error Prevention	Support different user	Functionality	Learnability	Memorability	Simplicity	Atheistic Design	
18	http://www.microsoft.com/en-us/education/training-and-events/it-academy/default.aspx#fbid=otPA7RsVKrH	4	5	5	5	4	4	4	2	2	2	1	1	1	4	3	4	4	4	**4**	5	68
19	http://ocw.mit.edu/courses/	5	5	5	5	5	5	5	1	1	1	1	1	1	4	4	5	5	5	**5**	5	74
20	https://www.khanacademy.org/	5	5	5	5	5	5	5	3	2	2	1	2	1	3	5	5	5	5	**5**	5	79
21	http://www.saylor.org/	5	5	5	5	5	5	5	5	3	3	1	4	1	3	5		5	5	**5**	5	80
22	http://www.rwaq.org/	5	5	5	5	5	5	5	4	5	5	4	5	5	5	5	5	5	5	**5**	5	98
23	http://academicearth.org/education/	5	5	5	5	5	5	5	1	1	1	1	1	1	4	4	5	5	5	**5**	5	74
24	http://www.aldarayn.com/	5	5	5	5	5	5	5	4	5	4	4	5	3	5	5	5	5	5	**5**	5	95
25	http://www.lynda.com/	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	5	5	5	**5**	5	98
26	https://www.coursera.org/	5	5	5	5	5	5	5	5	5	4	3	5	2	5	5	5	5	**5**	5	5	94
27	https://www.edx.org/	5	5	5	5	5	5	5	5	5	4	3	5	2	5	5	5	5	**5**	5	5	94

No	Web-based learning application (website)	effectiveness				Efficiency			Control and management						Error Tolerance	Ubiquity	Satisfaction					Total Points (weight)
		Completeness	Navigation	Organization/Design	Visibility	Speed	Consistency	Flexibility	User Management	Awareness	User control	File/Content Management	Automated Notification	File/Content Protection	Error Prevention	Support different user	Functionality	Learnability	Memorability	Simplicity	Atheistic Design	
28	http://oyc.yale.edu/	5	3	3	3	5	5	5	1	1	1	1	1	1	3	5	5	4	**4**	4	4	64
29	http://www.WIZIQ.com/	5	5	5	5	5	5	5	5	5	4	3	5	4	5	5	5	5	**5**	5	5	96
30	http://alison.com	5	5	5	5	5	5	5	5	5	4	3	5	2	5	5	5	5	**5**	5	5	94
31	http://ocw.tufts.edu	4	3	4	3	5	4	4	1	1	1	1	1	1	3	5	5	5	5	**5**	5	66
32	https://www.futurelearn.com	5	5	5	5	5	5	5	4	3	4	3	5	3	5	5	5	5	5	**5**	5	92
33	https://www.open3study.com	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	**5**	5	100
34	http://www.gedforfree.com/	4	4	4	4	5	4	4	5	4	2	1	3	1	5	5	5	5	5	**5**	4	79
35	http://www.waybuilder.net/free-ed/	4	3	4	4	5	4	4	1	3	1	1	1	1	3	2	4	5	5	**4**	3	62
36	https://www.udemy.com/	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	**5**	5	100
37	https://www.udacity.com	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	**5**	5	100
38	http://k23.com	5	5	5	5	5	5	5	4	3	4	2	4	5	4	5	5	5	5	**5**	5	91

No	Web-based learning application (website)	effectiveness				Efficiency			Control and management						Error Tolerance	Ubiquity	Satisfaction					Total Points (weight)
		Completeness	Navigation	Organization/Design	Visibility	Speed	Consistency	Flexibility	User Management	Awareness	User control	File/Content Management	Automated Notification	File/Content Protection	Error Prevention	Support different user	Functionality	Learnability	Memorability	Simplicity	Atheistic Design	
39	http://www.e-learningcenter.com/	5	4	4	4	4	4	4	4	3	3	2	4	1	4	5	5	5	4	**5**	3	77
40	http://www.kendal.ac.uk	5	5	5	5	5	5	5	4	4	4	3	4	2	5	5	5	5	5	**5**	5	91

Key: 1: Poor ; 2: Fair ; 3: Good ; 4: Very Good ; 5: Excellent