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A Peek at the Position of Pedagogical Aspects in Usability Evaluation of E-learning System

-- A Literature Review of Usability Evaluation of E-learning System conducted since 2000

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Abstract

Usability has been a hot topic for many years, adding a new dimension when the World Wide Web was introduced and adopted. Many studies have been made on usability evaluation methods in many specific areas, however not so much in E-Learning systems (Ardito et. al, 2006). This study is a report of a literature review of several usability evaluation methods for E-learning systems conducted from year 2000. This paper tries to summarize and compare all of these studies to see how the "pedagogical aspects" or criteria has been treated when performing such evaluations, as well as present a summary of all the usability evaluation methods (UEMs) that have been used in these studies. At last, this paper tries to explain how the current situation happens. The main purpose of the review is to draw a picture for further researcher who is going to look into the field of UE for E-Learning systems.

Key Words: review, usability evaluation, e-learning, pedagogy usability, usability criteria

1. Introduction

Organization and Educational institutions have been investing in information technologies to improve education and training at an increasing rate during the last two decades (Nokelainen, 2006). It makes learning from "far away" and "life-long" become possible thanks to Information and Communication Technology. Electronic learning (e-learning) is identified as an enabler to achieve such goal and receiving considerable interest from software development industry. Just like "e-learning" is a compound word comprised of the abbreviation for "electronic" and the word "learning", e-learning system blends new information techniques into teaching-learning process. Comparing to traditional face-to-face education, not only can e-learning be as influential as the traditional teaching and learning style, but also does it provide a more flexible way of training and learning services to learners with the nature of "any time, any place". Different forms of e-learning products make the consumers many choices, and web-based e-learning is the most common one. As expectation for all other IT product, consumers also want e-learning system to be more effective and efficient, which ultimately satisfy them. However, study showed most e-learning programs exhibit higher dropout rates when compared with traditional instructor-led courses (Bonk, 2002; Moshinskie, 2002; Hodges, 2004). There are many reasons behind this phenomenon, but one major contributor is that the poor design and usability of e-learning system.

Usability as a technique to measure the quality of computer systems has been discussed for several decades. Generally, usability has been defined 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 (Hornbaek, 2006). However, evaluating the usability of e-learning system is not a easy task. An increase in the diversity of

learners, technological advancements, and radical changes in learning tasks (learner interaction with a learning/training environment is often a one-time event) present significant challenges and render the possibility of defining the context of use of e-learning applications (Zaharias & Poylymenakou, 2009). Many researchers expressed that usability of e-learning system is not just in the field of Human-computer interaction but also in educational computing areas. Alsumait and Al-Osaimim (2009) highlights that usability evaluation of e-learning system should address aspects of pedagogy and learning from educational domains, as well as HCI factors such as the efficiency, effectiveness and satisfaction of interfaces. Similar expression can be found, such as "teachers need to be able to evaluate predicatively educational software so that they can make decision about what software to purchase and how to use software in classrooms" (Squires & Preece, 1999); "... pedagogical aspects of designing or using digital learning material are much less frequently studied than technical ones" (Nokelainen, 2006); "the evaluation of educational software must consider its usability and more in general its accessibility, as well as its didactic effectiveness" (Ardito et. al., 2006). Additionally, de Villiers (2004), Dringus & Cohen (2005) Miller (2005) all expressed that the usability evaluation methods should take pedagogical factors into account. Hence, usability practitioners really should get familiar to the pedagogical area such as educational testing research, learning cycle, and rudiments of learning theory, then apply these factors in the process of usability evaluation of e-learning.

In this paper, we present findings from literature review. Based on a systematic review of usability evaluation of e-learning system reported in last ten years, we explore the position of the pedagogical aspects in the evaluation of e-learning system in practice. Additionally, we summarised some valuable findings regarding to design and evaluation of e-learning system which potentially benefits designers and evaluators.

Accordingly, the rest of the papers are composed in four sections. Chapter 2 is background where all related research including usability, pedagogy usability, usability evaluation methods (UEMs) and evaluation of e-learning system; in chapter 3, we present the research method we used and explain how we preceded the data; chapter 4 shows the results following with chapter 5, discussion. In the final chapter, we draw a conclusion.

2 Background

2.1 Usability and Pedagogy Usability

In order to advance through this paper a general definition of usability is needed as well as how this is different from pedagogy usability. According to the ISO 9241 standard usability is: *"The ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component."* Several well-known researchers have defined a list of usability factors that should be followed in order to achieve good usability. Nielsen (1993) call this usability heuristics where he lists several "thumb" rules including: "Visibility of system status", "Match between system and the real world", "User control and freedom", "Consistency and standards", "Error prevention", "Recognition rather than recall", "Flexibility and efficiency of use", "Aesthetic and minimalist design", "Help users recognize, diagnose, and recover from errors", "Help and documentation". These guidelines are designed to achieve usability of a software application, however while many of them also apply on an E-Learning platform there are also other factors one need consider. These are the pedagogy usability aspects, which are more focused on supporting the ease which a user can access, study and learn course materials. Some examples of this could be: "being able to personalize learning paths", "clearly visualize course structure" or "automatically update students' progress tracking" (Ardito et. al, 2004; Costabile et. al, 2005; Ardito et. al, 2005; Ardito et. al, 2006). In order to develop and test these factors different usability evaluation methods can be used.

2.2 Usability Evaluation Categories

Usability evaluation methods can be categorised into two categories, "analytical" and "empirical" methods. The difference is in which way the methods work. Analytical methods are done by usability experts, who put themselves in the intended end-users position. Based on the experts expertise and usability heuristics the expert validates the software (Blecken et. al., 2010), and as no user needs to be involved, these evaluation methods fits best early in the development process. Examples of analytical methods are "Guidelines", "GOMS" or "Heuristic Evaluation". The second category, empirical evaluation methods, requires a user to test the software and it mainly consists of usability tests and questionnaires. These empirical evaluation methods are better suited later on in a development process or when the system is already in use and its goal is to determine the overall usability of the system (Blecken et. al., 2010). It is important to note, however, that these categories should not replace each other, rather complement each other.

2.2.1 Analytical UEMs

As mentioned, analytical methods are performed by experts 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 characterisation; 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 DIN EN 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).

Finally *inspection methods*, which can also be divided into two sub-categories, design principles such as heuristic evaluation or design task analysis such as cognitive walkthrough. In 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).

2.2.2 Empirical UEMs

Empirical usability evaluation methods are done by the intended end-user and can consist of Usability Tests or Questionnaires. These methods can be carried out either on a prototype of the system or on a deployed system. 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 system. By analysing the data i.e. 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 & Chisness 2008). (Blecken et. al., 2010) say 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 & Chisness, 2008; Blecken et. al., 2010). As mentioned above usability tests can be done in several ways, each of them having both advantages and disadvantages.

Video feedback films the users' actions and visible reactions and this can then be analysed by an investigator and the filmed user together. This is useful to thoroughly analyse occurring issues, but it is very intensive.

Log files record and document the users actions in a file which can then be analysed and enables the investigator to see the exact time and sequence of these actions. However, this method requires substantial preparation and is thus not used very often.

The think aloud protocol requires the user to verbally express his or her reactions and say what s/he is doing. According to Nielsen (1993) this is one of them most powerful methods to identify usability problems. This is however unnatural to most users creating a stressful environment which can lead to prolonged answers and task performance time from user (Blecken et. al., 2010).

Attention tracking: User uses the mouse to pint and click in the area or section he find the most noticeable, making the mouse both tool and pointer of focus and attention. This makes it not so good for interactive tasks and it diverts the mouse from its intended use.

Eye Tracking: In this method eyes and views are tracked and recorded. This can later be analysed to see what was most distracting, where the attention where most and how long the user remained on certain sections. This comes with the disadvantage as it requires more technical equipment than other methods (Blecken et. al., 2010).

Questionnaires can be used to collect quantitative data and can consist of different types of questions, multiple choice questions and a rate scale as well as open ended questions. There are several standardised questionnaires for usability evaluation, for example "Questionnaire for user interaction satisfaction" (QUIS), "Software usability measurement inventory" (SUMI) and System Usability Scale (SUS). The latter one is very short and should therefor be conducted together with other usability evaluation methods (Blecken et. al., 2010).

2.2.3 Other UEMs

Despite the fact that there are many usability evaluation methods there are no widely used and established methods that is specifically designed for E-Learning systems (Ardito et. al, 2006). One attempt of such method is the "Systematic usability evaluation" (SUE), this is a combination of both analytical and empirical evaluation methods (Ardito et. al, 2006; Matera et. al, 2002). The SUE utilizes the evaluation patterns, called "abstract tasks" (ATs), which is a detailed description of what tasks the evaluators must perform during inspection (Matera et. al, 2002). This also makes it possible for less experienced evaluators to achieve a good result (Ardito et. al, 2006). SUE adopts "design models" in order to describe the application and identifying as well as naming the relevant objects of evaluation. Finally, in SUE usability attributes which identifies specific usability properties that a system should possess in order to be usable. These usability attributes are obtained by decomposing general usability principles into more specialised usability criteria (Matera et. al, 2002). Several research papers look at how SUE can be used for pedagogical E-Learning systems (Ardito et. al, 2004; Costabile et. al, 2005; Ardito et. al, 2005; Ardito et. al, 2006) and these papers serve as a reference on what and how pedagogical as well as other usability aspects can be achieved. Finally MiLE is a SUE framework for web applications. It is a scenario-driven inspection technique which uses user profiles, scenarios, user goals and usability attributes. (Triacca et. al., 2004). I.e., in MiLE the user requirements, their goals and scenarios are the basis for the evaluation. This is tested through both inspection methods: to verify the feasibility of the scenarios or tasks, as well as heuristics: to verify the compliance of the system using a set of usability principles (Triacca et. al., 2004). "MiLE+" is an evolution of bot SUE and MiLE, i.e., version two of MiLE. MiLE+'s goal is to be easier to use, especially by novice users than its predecessor is. Additionally it aims to be *more systematic* and *structured* (Bolchini & Garzotto, 2007).

2.3 Evaluation of E-learning System

Both analytical and empirical UEMs can be used to evaluate e-learning system. Meanwhile, a large number of combination methods are developed and applied in practice. Choosing among different UEMs is a trade-off between cost and effectiveness (Ardito et. al., 2006). Analytical methods, such as heuristic evaluation due to its nature of "easy administering" and "less cost" are still popular when evaluating e-learning system (Ardito et. al, 2006; Tselios, Avouris & Komis, 2008; Ssemugabi & de Villiers, 2007; Salman et. al., 2009; Kemp et. al., 2008). Besides, empirical evaluation methods, i.e., user testing (Ardito et. al, 2006; Masemola & De Villiers, 2006; Guo et. al, 2009; Adebesin et. al., 2009; Granić, 2008; Tselios et. al., 2008; Bolchini, et. al., 2008) and questionnaire/survey (Di Bitonto et. al., 2009; Zaharias, 2006; De Villiers, 2004; Chai et. al., 2008; Guo et. al, 2009; Ytikseltiirk, 2004; Guo et. al, 2010; Adebesin, De Villiers & Ssemugabi, 2009; Bolchini et. al., 2008; Ssemugabi & de Villiers, 2007; Salman et. al, 2009) are widely chose. Meanwhile, some new framework is introduced to this area as well, such as MiLE (Milano-Lugano Evaluation method) and SUE.

Among the reports of these studies, some researchers had designed and conducted the evaluation with considering of pedagogy aspects. Squires and Preece (1999) adapted Nielsen's heuristics with taking socio-constructivism tenets. Furthermore, Tselios et. al., (2006) divided the e-learning system into (a) primary course-ware, behaviouristic-based educational systems mainly restricted to material and concept browsing, (b) secondary course-ware, mainly constructivist based, open learning environments and (c) tertiary course-ware, socio-constructivist and socio-cultural based collaborative learning environments. They argued that different methods should be adapted according to the types of e-learning system. For example, based on their empirical study, they expressed that combination of an expert based inspection method coupled with an evaluation involving representative users is suitable for primary course-ware. Zaharias and Poylymenakou (2009) described a questionnaire-based usability evaluation method for e-learning applications. They explained that their methods focus not only on cognitive but also affective considerations that may influence e-learning usability. They pointed out that the most prominent affective learning dimension is the motivation to learn. Ardito et. al., (2006) presented the SUE method as mentioned above which specifically enable to drive the evaluators in the analysis of an e-learning application. Alsumait and Al-Osaimi (2009) in their study expanded Nielsen's traditional ten heuristics to 21 heuristics

with detailed explanations, which they believed was more closely focused on child e-learning applications. In their paper, they proposed and explained several e-learning usability factors: learning content design, assessment, motivation to learn, interactivity and accessibility. Leaving the child domain aside, these factors covered most of the pedagogical usability factors.

3 Research Method

This review was created in order to bring a perspective on what usability and pedagogical aspects that is important to consider when evaluating an e-learning system. There are several usability evaluation methods available with its roots in the 1980's. Many of these methods do not, however deal with any pedagogical aspects and were designed for the systems developed at that time. These methods have then been changed according to new requirements from later years; however there hasn't been much adaptation to the e-learning area. While the SUE and MiLE is an attempt to do this, not many organisations use these, as can be seen in our result. Rather most studies reports that there is very low activity in developing a method for e-learning systems. (Costabile et. al, 2005; Granic & Glavinic, 2006; Ardito et. al, 2006; Chai et. al., 2008; Granić, 2008; Zamzuri et. al., 2010) In this study we want to highlight the usability and pedagogical aspects that organisations have considered important from several case studies in order to help further researchers to develop an evaluation method tailored for e-learning systems. There are many obstacles such method would need to overcome, and from the case-studies that have been studied in this report many of the obstacles can be identified. Nikmehr and Doroodchi (2008) stressed that: *"E-learning content must be appropriate and meaningful to engage learners. Hence technical issues should be considered in order to design effective content."* This not only indicates the need to motivate the users or learners, but also to create software that is efficient and effective to use. Further Costabile et. al (2005) says: *"An instructional interface is especially effective when the learner is able to focus on learning content rather than focusing on how to access it."* This indicates the need to a system that is easy to navigate. This is further strengthened by Yuqing Guo et. al (2009) saying *"An effective and efficient e-Learning platform should hide systems' complexity and provide an easy and flexible interaction operation."* which also stresses the need for flexibility. All of the case studies in this paper reports data like this which serve as the foundation for the different usability and pedagogical aspects that is important to consider in an e-learning system. In these papers, a wide range of UEMs has been designed and used in different types of e-learning systems, such as web-based systems, educational games, applications, etc. Most of these papers are case studies or action research. The papers authors either examined one or a few UEMs by evaluating one or a few e-learning systems, or to introduce a modification or combination of known UEMs. The researchers want to build an understanding of the topic based on the participants' ideas (Creswell, 2003). Many researchers have also reported valuable findings after conducting several case studies in the area.

In order to analyse this existing research there are two main research methods to use in the field of academic research, namely qualitative and quantitative. Sometimes, a combination of these two methods is possible according to the needs of the research topic. It is important to select suitable methods based on the comprehensive understanding of strengths and drawbacks of each method as well as the research topic. Qualitative research is exploratory and usually applied when little or no research can be found in the research area, while quantitative research is used mostly in statistical context (Creswell, 2003). In this paper, we performed a quantitative research based on available literature reporting usability evaluation of e-learning system. We wished to reveal how the pedagogical aspect is treated in usability evaluation of e-learning system during the last ten years (2000-2010), by analysing the usability factors each study used. Additionally, we hope to obtain some valuable findings for designing and evaluating e-learning system.

3.1 Data Collection & Analysis

For our literature review we used the York method (Centre for Reviews and Dissemination, 2009). This review process contains three phases: (1) define inclusion criteria and identification of relevant evaluation research, (2) systematic analyze on selected studies and extraction of usability measure factors, and (3) synthesis of the findings.

To help to select relevant reports of evaluations from the huge amount of potential relevant reports, the inclusion criteria for our literature review was applied:

- Studies had to examine usability of an E-Learning system.
- Studies had to contain sufficient data/result from a case study of an E-Learning system, although studies did not necessarily have to be the main focus of the study.
- Studies had to be original and empirical. Theoretical conceptualizations were excluded. However those may be used as background theory.
- Evaluation methods used in the studies had to fall in the categories presented, although extra methods may be used as background theory.
- English publications only.
- Published in the last ten years, i.e. between year 2000 and year 2010.

The inclusion criteria where identified by analysing the goal of our research to ensure only the relevant and all relevant papers where studied. In other words the criteria are based on the scope of this research, thus criteria (1) where natural to have. Since the goal of the research is to identify pedagogical aspects of usability evaluation the second (2) criteria emerged. The case study doesn't have to be the main part or focus of the papers, as long as there is a result part discussing the different usability aspects or criteria. The third (3) criteria where defined to exclude all theoretical papers, raw and hard data where required for our result. Fourth (4), the studies had to use some kind of formal and established evaluation method in order for us to be able to compare them. Criteria number five (5) the publication had to be in English, as this is the only language both researchers have in common. Finally as criteria number six (6) the papers had to be fairly new as we are dealing with a topic on the web where almost everything have happened during the last ten years. Looking beyond that would give results focused on legacy systems or applications of operating systems not being used today. Many of the usability evaluation methods originate from that time and software; however these methods have been changed over time to fit today's needs. Thus we found it reasonable and enough to focus our attention to those publications.

Retrieving the relevant research was done by searching for journals and proceedings in the field of HCI through a range of academic databases, or specifically: IEEE Xplore, ACM Digital Library, Elsevier ScienceDirect, ProQuest, SpirngerLink and Wiley Interscience. Google scholar has only been used to help to get potential relevant reference and citation. All of these search engines provide advanced search function which helped to make the initial search more specific. Each of the journals and conference proceedings were searched with the search term "usability evaluation" and "e-learning" or one of its synonyms (i.e., online learning, distance learning, or electronic learning) in meta-data. Additional requirements whereas follow: (a) full text accessible using charmers library network, (b) published in last ten years, i.e., since year 2000 and (c) publication uses English language only. Using key word search in meta-data is to reduce huge number of result; the year chosen was according to our study scope; and English is the only common language both authors share, for the convenience of further cross review. As we wanted to find case-studies in the area of usability evaluation of e-learning systems it was natural to extract the keywords from this phrase, resulting in the requirement stated above. Title as well as abstracts from the resulting papers were then read and judged according to inclusion criteria. Sometimes the papers conclusion were also studied in order to help to select the relevant papers. These papers were then read in their full and the actually relevant papers, were selected. A cross review was also made on each paper passing the title and abstract level to ensure that the paper was actually interesting as well as to find relevant parts of a paper the other researcher did not detect. The result can be seen in Table 2.

	Preliminary search result	After Reading Abstract	After Reading in Full
Journals & Conferences	194	42	23
References & Citations	33	12	4
	227 (read abstract)	54 (read in full)	27 (actual relevant)

<div align="center">Table 1: overall result of search process</div>

	Preliminary search result	After reading abstract	After reading in full
IEEE Xplore	74	11	7
ACM	58	18	12
ScienceDirect	38	3	2
SpringerLink	21	7	3
ProQuest	2	2	2
Wiley InterScience	1	1	0
	194 (read abstract)	42 (read in full)	23 (3 overlaps)

<div align="center">Table 2: result from using different engine</div>

While reading the papers in full from the journals and conferences listed above, we found some citation to other papers that seemed very interesting which also met the inclusion criteria. We put them in the potentially relevant category. Abstracts from these papers were then read and the actually relevant papers were selected in the same way the initial papers were selected. In this case, Google Scholar was used to access the articles. Table 2 shows the general results, 227 papers were read in abstract and 53 papers were read in full, the actual relevant papers were 28 in total.

When conducting the literature search, we categorized each study evaluation purpose, evaluation approach, measure for evaluation, and interesting findings. These categories were refined as the analysis process proceeded. The results are presented in next chapter.

4 Result

4.1 Criteria been used among the studies

Table 3 below is the result of the number of E-Learning articles that motivated the following usability and pedagogy factors. These factors are explained in table 4.

The usability factors as seen in table 3 above are the result of our study after analysing 27 articles concerning usability in E-Learning systems. The papers naturally used different terms to explain the criteria, thus the factors in table 3 where created by analysing those terms. This is further explained in table 4 including both explanation and quotes from the papers.
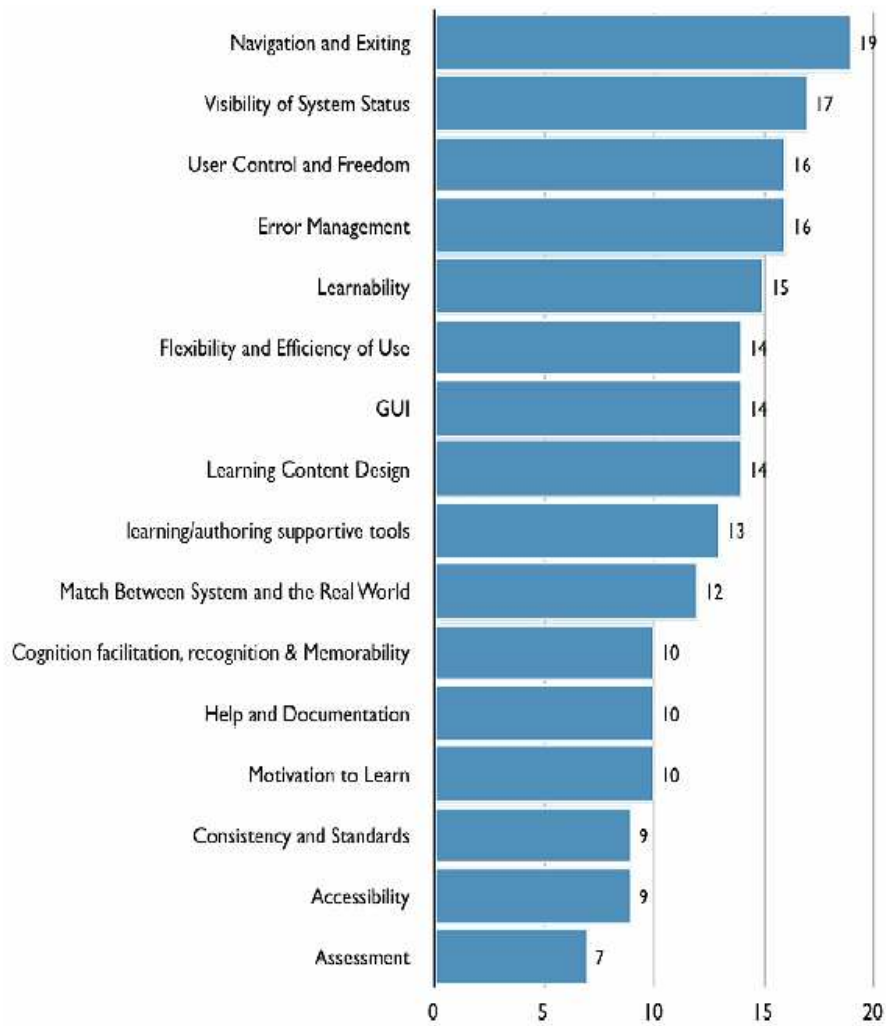
Navigation and Exiting — 19
Visibility of System Status — 17
User Control and Freedom — 16
Error Management — 16
Learnability — 15
Flexibility and Efficiency of Use — 14
GUI — 14
Learning Content Design — 14
learning/authoring supportive tools — 13
Match Between System and the Real World — 12
Cognition facilitation, recognition & Memorability — 10
Help and Documentation — 10
Motivation to Learn — 10
Consistency and Standards — 9
Accessibility — 9
Assessment — 7

Table 3: usability factors in E-learning articles

Looking at the result of table 3, the top factors are general usability issues such as navigation, feedback and user control, while most pedagogy criteria are below average even though the result is solely based on articles discussing E-Learning, something that is (will be) discussed in discussion chapter. Important to note however is that some general usability factors are more or less important due to the fact that an E-Learning system is being evaluated. For example the Flexibility and Efficiency of use as well as Visibility of System status are particularly important for E-Learning systems which can also be seen in the result (table 3).

Following is a table describing each usability and pedagogical factors identified from the different papers studied. The factors' names may differ from paper to paper, however the meaning is the same which are presented as explanation in the table. Finally the table contains a column with examples from three different papers mainly using SUE (de Kock, van Biljon & Pretorius, 2009; Alsumait & Al-Osaimi, 2010; Ardito et. al, 2005) to further describe the criteria.

Factors category	Explanation	Examples from papers
Visibility of System Status • feedback	Concerns system feedback and to the user, both in terms of system status, presenting a score or other information and similar.	- The e-learning program keeps the leaner informed about what is happening through appropriate feedback within a reasonable time. – The learner gets frequent, clear feedback that encourages him/her to carry on. – The learner should always be able to identify his score/status and goal in the program.
Match Between System and the Real World • Match users' expectations, familiarization, fit intended user group.	Having a good match between system and real world will improve the learnability of the system, however this issue is specifically concerned with logical metaphors and phrases etc.	– The e-learning program interface employs standard words, phrases and concepts familiar to the leaner and makes information appear in a natural and logical order – All learning objects and images should be recognizable and understandable, and speak to their function
User Control and Freedom • respond to user action • adaptivity	The system should be designed in a way making the user initiate the actions rather than the responders.	Allowing easy recovery from the former always, and from the latter when it is pedagogically appropriate. -- The user is encouraged to explore the software. -- The learner can easily turn the application on and off, and can save his user profile in different states.
Consistency and Standards • same style • work flow	Consistency and standards is about making the user feel familiar to the website by using language, words and concepts that the user can recognise and understand.	-- The learner experiences the user interface as consistent (in control, color, typography, and dialog design). – Control keys are intuitive, convenient, consistent, and follow standard conventions. – The e-learning program is consistent in its use of different words, situations, or actions, and it follows the general software and platform standards
Error Management • prevents, • identifies, • diagnoses and • offers corrective solutions	How error is handled, avoided and corrected. Provide relevant information and steps to be taken if an error occurs and explain what and why something went wrong.	-- The e-learning program is carefully designed to prevent common problems from occurring in the first place. -- The e-learning program does not allow the learner to make irreversible errors. -- The e-learning program is designed to provide a second chance when unexpected input is received -- It distinguishes between input errors and cognitive errors.

Learn-ability • supports timely and efficient learning of software features	How easy the system is to learn. How long does it take for a user to master the system?	-- The e-learning program makes objects, actions, and options visible so that the learner does not have to remember information from one part of the program to another. – Instructions for the use of the program are visible or easily retrievable, so that the child does not have to memorize unnecessary things. Icons and other screen elements are intuitive and self-explanatory.
Cognition facilitation, recognition & Memorability • simplicity	Relevant objects, actions and options should be clear. The user should not have to remember too much itself.	-- cognitive support -- recognition rather than recall
Flexibility and Efficiency of Use	This criteria concerns the possibility for the system to adopt to different users with different learning styles and tastes.	-- The e-learning program is designed to speed up interactions for the expert learner, but also to cater to the needs of the inexperienced learner. -- provide possibility to personalize interface graphic
GUI • Aesthetic • Graphical elements • colour	This concerns not only how "pretty" the interface is but also how logical the structure is and how easy it is to read and understand.	-- Font -- Colour -- graphic convey information clearly -- graphic provide text information with mouse-over -- Layout is satisfactory and logically grouped and labeled. -- The screen are pleasing to look at.
Help and Documentation • providing users with help files and documentation	This concerns help and documentation files and how easy it is to find the relevant information. This is different from error management as help also is related to functions and "tutorials" how do do things, not just explaining an error.	-- The learner should be given help while using the program. Help should be easy to search. Any help provided is focused on the learner's task, and lists simple concrete steps to be carried out. (Task-oriented information) – The help file/s provide relevant and concise information. -- The help messages are brief and informative. -- It is easy to find a solution to a problem. -- The instructions are represented in an ordered list of concrete steps.
Navigation and Exiting • facilitate software exploration and provide outlets to	How easy the system is to navigate and find your way in it. How logical the structure are etc.	-- Navigation objects and tools are kept in particular and clearly-defined positions. -- Exit signs are visible. The learner may leave an unwanted state without

terminate actions		having to go through an extended dialogue. -- Cancel, Redo, Undo option are available. -- provide search function by keyword.
Accessibility	How can the software be accessed.	– The e-learning program may be used on a variety of equipment and platforms such as laptops, PDA. -- All repository access to both teacher and learner -- enable off-line use of platform maintaining tools and learning context
Learning Content Design • course design • media use	Concerns pedagogical aspects in learning/course materials. Terminology, layout and media use are some examples from the papers.	– The vocabulary and terminology used are appropriate for the learners. – Abstract concepts (principles, formulas, rules, etc.) are illustrated with concrete, specific examples. – The organization of the content pieces and learning objects is suitable to achieve the primary goals of the e-learning program. – Learning objects are well organized and easy to navigate and logical. -- media use and management -- course map, cross reference
Assessment	The use of assessment available to the user.	– The e-learning program includes self-assessments that advance learner's achievement. – The e-learning program provides the instructor with learner evaluation and tracking reports. -- Are Learning objective, instructional and assessment strategies closely aligned
Motivation to Learn & interactivity • engagement • confidence • response	According to SUE (ref) the main goal of E-Learning systems should be to support users in learning. To do this, users need to be motivated, which can be stimulated in several ways. Some papers suggested multimedia and games as well as challenges and assignments.	– The e-learning program stimulates further inquiry in different ways. – The e-learning program is enjoyable and interesting. It uses games, simulations, multimedia, and activities to gain the attention and maintain the motivation of learners. – The learner becomes engaged with the e-learning program through activities that challenge the learner. – The learner should be able to respond to the program at his leisure. The program, on the other hand, needs to respond immediately to the learner. – The learner has confidence that the e-learning program is interacting and operating the way it was designed to

		interact and operate.
learning/authoring supportive tools • course management • communication • profile	Tools or other features to support the user with his/her actions to ultimately support learning.	-- File upload and download -- Learning objects easily created and reused -- ICTs in use, bot asynchronous and synchronous tools -- profile space and management -- provide easy-to-use authoring tools; enable to define alternative learning paths.

Table 4: Usability factors category

4.2 UMEs been used among the studies

UMEs	cases number (N' =37)	%
Guideline	1	2.7
Formative	2	5.4
Inspection - HE	7	18.9
UT	9	24.3
Questionnaire	13	35.1
SUE	5	13.5

Table 5: usability methods been used

During the study of 27 papers, 37 UEMs that have been performed was found. As shown in table 5 above, six different type of UEMs have been used including guidelines evaluation, formative evaluation, inspection method (mainly HE, or modification of HE), various kinds of usability testing, questionnaire/survey, and other kind (in this study, a combination methods called systematic usability evaluation, SUE). Among these studies, we can see that questionnaire-based method has been used most, following by usability testing and heuristic evaluation. From the table, it is clear that empirical evaluation methods with 59.4% beat an analytical evaluation method which is 27%. Other methods, which are usually a combination framework of several UEMs take up 13.5%.

5 Discussion

5.1 Pedagogy Aspects in Practice

The criteria found concerns are both general and pedagogical usability aspects. "Learning content design", "assessment", "motivation to learn" and "learning/authoring supportive tools" are defined related to pedagogical aspects. From the result, it tells that the most used factors among these four is "learning content design" which is a slight higher than average. All the other three are below average. After we calculated all cases that contained at least one pedagogical factor we got a result of 18 studies, which is two

thirds of all studies. One third of the studies only applied general usability factors to evaluate an e-learning system.

The reasons behind those studies excluding pedagogy aspects can be various. We studied these papers again with main concentration on their purposes of evaluation. According to their purposes those papers could be categorized into 1) the studies was focusing on specific intent instead of evaluating usability, 2) the studies were aware of pedagogy aspects, however, they did not included sufficient factors to check the pedagogy aspects, and 3) the studies didn't show or showed very little aware of pedagogy aspects. For the first category, one paper not taking pedagogy aspects into account is because the study are not merely focused on evaluation the system for its own sakes. Instead, they used a target system in the process of establishing a framework for formal usability testing, not of business systems, but of interactive e-learning applications in the cognitive domains of computational disciplines. Even though, this paper did not consider pedagogy aspects, it made a major contribution to evaluating e-learning system in cognitive domain by using lab facilities (Masemola & De Villiers, 2006). The second category was the most common one i.e., where most papers fit in. These studies shared the common natures that even though the researchers realized the importance of pedagogy aspects, they still applied general UEMs to evaluate the e-learning system from an effectiveness, efficiency and satisfaction perspective. This is apparently not enough to reveal the pedagogy effectiveness. One paper reported an evaluation of Korean Language learning system by using multiple methods. The authors mentioned that they had considered such factors as being interactive and providing feedback; having specific goals; communicating a continuous sensation of challenge; providing suitable tools; and avoiding any factor of nuisance interrupting the learning stream during the design and implementation phase. However, when performing the usability evaluation, they used traditional HE with user testing based on ISO9241, which apparently is not sufficient to check the factors they listed. The last category is most concerning, as those studies show no aware of the importance of pedagogical usability. Those researchers have not mentioned any pedagogical aspects in their papers at all. In fact, usability of e-learning designs is directly related to their pedagogical value which is actually the intrinsic part of e-learning system. Even though they made improvement based on the UE result and make the system more usable, still such a system may not have any pedagogical sense (Albion, 1999; Squires & Preece, 1999). An interesting finding in one paper (Yiikseltiirk, 2004) is that the studies revealed eight suggestions gained from six semi-constructed interviews. Seven out of eight suggestions can fit into the pedagogical usability factors (motivation to learn, learning/authoring support, learning content design). This is something we argued about. Some pedagogy usability issues did exist among e-learning system. If the researchers could take the pedagogy aspects into account when performing usability evaluation on e-learning system, they will most likely reveal such problems.

Let us go back to the 18 cases containing pedagogical usability factors. Only one case covers all factors, the others more or less miss some factors. This may be because different e-learning platform are evaluated, the features of system contained, and different type of learners. Additionally since there are no established and well-known method for evaluating e-learning systems taking pedagogical aspects into account it is natural that the results vary between different studies.

Assessment as the least quoted factor of all catches our attention. Seven out of 18 cases includes assessment factors when performing the evaluation. The reason why the other eleven cases exclude these factors can be explained by that most of those e-learning systems do not support assessment feature, therefore there is no need to introducing this factor. However, among those eleven cases, we found actually some of them are capable to have the assessment feature in order to enhance the didactic effectiveness. Ridgway et. al. (2004) reveal the potential in replacing large paper-based examination systems through electronic formats to allow more flexibility, for example in the correction process. They pointed out that "E-assessment is a stimulus for rethinking the whole curriculum". The effect of learning is the main motivation that people choose e-learning system. Dochy (2005) pointed out that innovative learning environments which introduce constructive principles have to adapt the assessment practice to the heart of the matter, that means to focus "the application of knowledge" when solving problems to be able to succeed. He presented that powerful effects of assessment refer to the learning effects and the consequential validity of assessment (pre-assessment effects, post-assessment effects) and suggested that assessment should be designed strategically to have educationally sound and positive influences. Hence, it is really recommended

that e-learning system according to their types to provide different types of e-assessment. Valuation of the previous knowledge (pre-assessment) will make e-learning system generate learning material that respects the learner's previous knowledge takes into account individual differences in skills and knowledge and encourages them to take advantage of it during studies (Nokelainen, 2006). While post assessment will help users to review the courses and solid the knowledge gained, which ultimately enhance the learning effects.

Learning content design and learning/authoring support are the most used factor that has been included among the 18 cases. They are respectively included in 13 and 14 cases. It is great to see that most researchers considered these pedagogical aspects as important factors which determining the quality of an e-learning system. Checking "learning content design" helps to well organize and present of the course materials. While "learning/authoring support" enables the e-learners be free to choose the path of learning he or she prefers in order to make most use of the materials more effectively and economically (Nokelainen, 2006). One sub-aspect we brought up here is communication. Lynch (1998) emphasized that "Communication is the Key to Maintaining the Learning Community". As an online learning system should be able to be used by students at many different and widely spread locations as well as anytime it fits the user the system needs to support communication in order to serve as a true E-Learning system. With the collaboration through communication tools, the e-learners will feel familiar to traditional face-to-face teaching environment. Costabile et. al. (2005) stated that participants of their case study had expressed a positive opinion on the communication tools, allowing collaborative learning: the teaching process can be managed for one or more learners, through synchronous and asynchronous interactions. Just like Nikmehr and Doroodchi (2008) mentioned that *"it's worth mentioning that social interaction plays an important role in usability of E-learning systems and also effective collaboration is a critical success factor of E-learning systems."* This brings the designers of e-learning system both a challenge and an opportunity.

The last pedagogy aspect we discussed here is motivation. From the review, we found 10 cases stressed the need to motivate the user to learn, as this should be the main goal of an E-Learning system. As mentioned in introduction part, many e-learning systems failed due to one major contributor, these systems did not catch learners' motivation (Zaharias & Poylymenakou, 2009). Zaharias and Poylymenakou (2009), together with Schunk (2000) stressed that the need to enhance learners' internal priorities and drives that can be best described by motivation to learn which is the most prominent affective learning factor that can greatly influence users' interactions with an e-learning application. During our study, we found that many cases evaluate the user's satisfaction rather than motivation, which we find inappropriate. Satisfaction is about how happy the users feel about the system, while motivation is more than just how satisfied the users are with the system, but also concerns the user's engagement and confidence of learning knowledge through e-learning system. Just because a user is satisfied with the interface of the system doesn't mean he or she is motivated to use it. Therefore, evaluating on "motivation to learn" should be very important when performing usability evaluation of e-learning system. Most case studies should take this aspect into account.

5.2 UEMs been used

Looking at the summary of the different case-studies in this report shows that a wide verity of usability evaluation methods where used, both analytical and empirical as well as the combination method, SUE. Questionnaire-based evaluation have been used widely in many studies, the reason may because that it gives a very specific result of how the user experienced the system. Questionnaires can easily be applied on many testers, as it is a quantitative way of receiving data, and as many of the case studies reported from a deployed system it is natural and beneficial to gather data from many users. Finally as there are several standardised questionnaires that can be used it is also easy to set up and require little work to do. At the same time, however, it can be specified for the specific type of user, requiring more work to set up but may give more relevant answers. Some comparative studies, however revealed that heuristic evaluation (HE) is a better choice than others, especially usability testing. As Ssemugabi and de Villiers (2007) explain in their study evaluating the Info3Net application, users found 73% of the problems, while experts found slightly more, 77%. The authors also conclude that it only required four experts compared to over 60 users. They also states, however that analytical and empirical methods should be combined, something that more researchers can confirm, in order to gain a more comprehensive result. Tselios, Avouris and Komis (2008)

argue that different type of e-learning system should adapt different evaluation methods. They categorised them into a) primary courseware, which is mainly material and content browsing, (b) secondary courseware, i.e., open learning environments and (c) tertiary courseware, which they define as collaborative learning environments (Tselios et. al., 2008). A combination method called SUE (Ardito et. al, 2004; Costabile et. al., 2005; Ardito et. al, 2005; Ardito et. al, 2006) was noticeable as the method have been adapted to the e-learning context, taking several pedagogical aspects into account.

Drawing a conclusion on which method is best is difficult if not impossible task, since each method has its strengths and drawbacks and there is no specific method for evaluating e-learning systems. The best method should be selected according to the type of learners, technological advancements, and radical changes in learning tasks. Empirical method is believed better at finding actual issues that the average user will encounter as the tests are performed by users themselves. This however requires the system to be either finished or have some working prototypes and require several users compared to just a few experts that is required in the analytical methods. The analytical methods on the hand fits better early in the development as no user needs to be involved (Blecken et. al., 2010). 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."*, thus a combination of the methods seems to be better. In our study, we found a systematic usability evaluation method called SUE was better than others, not only because it covers most usability factors related to pedagogical aspects, but also a blended way of different UEMs. The MiLE and MiLE+ method, which is also a combination method doesn't seem to have got any attention in evaluating e-learning applications, as none of the studies in this report uses it. This is interesting as already in 2004, Triacca et. al., 2004 presented a MiLE method for evaluating e-learning applications, even though it might be possible to improve this method for e-learning no one has presented such work either. Something confirms the low activity and research on improving or developing e-learning evaluation methods.

In a conclusion, besides covering all-round usability factors, especially pedagogy usability, a suitable or a set of suitable UEMs should also be adaptive to different type of learners as well as different type of e-learning system.

5.3 Different type of learners

As any student should be able to use the E-Learning application any type of user should be expected, both novice and experienced computer users. However in E-Learning systems different types of learners also needs to be considered, i.e. different students learn better in different ways (Nikmehr & Doroodchi, 2008). Thus the e-learning system needs to be designed in a way so that all may learn; one size does not fit all. Hence it seems reasonable to make the e-learning system flexible and adoptable depending on what type of learner the users are. The authors describe eight different types of learners, all who learn in different ways, among them active and reflective learners. Active learners learn better by doing, which means they would most likely not be very interested in reading big chunks of text (Nikmehr & Doroodchi, 2008). Instead they would prefer a straightforward navigation-system that makes it easier to find the information they need. Reflective learners on the other hand would appreciate descriptions about the instructional material in order to think about it before diving in (Nikmehr & Doroodchi, 2008). As mentioned there are a total of eight learner types, but by just listing two of them it is obvious that different learners require a totally different interface. To overcome this authors recommend creating usage scenarios based on each type of learner that is expected to use the system in order to achieve the best result.

6 Conclusion

In this paper, we present a literature review on usability evaluations of e-learning system reported in last ten years to examine the position of pedagogical and usability aspects when evaluating e-Learning systems. Totally 27 papers were analysed. During the study, we summarized four important pedagogical usability

factors with detailed explanations, namely, learning content design, assessment, motivation to learn and learning/authoring supportive tools. We tried to address these factors in each paper and to gain overview of how the studies deal with pedagogy usability. We found that one third of the studies are not fully aware of the importance of pedagogical aspects in usability, which it is inappropriate since the pedagogical usability is of at-least the same importance as general usability for an e-learning system. Furthermore, and perhaps most important, we urge evaluators should be aware of the pedagogy usability when performing usability evaluation in the future. We also give suggestions to designers of e-learning system that some features can be added to enhance learning effects of e-learning system, i.e., assessment and communication. We also hope this paper could arise further e-learning researchers' attentions on pedagogy aspects in both design and evaluation phase as well as provide an interesting and broad entry point for readers who are new to the topic.

Limitation:

1. Due to the lack of authority to access the full text of some papers, we excluded some potential papers which might be relevant to this topic.
2. The pedagogical usability factors we summarized are based on our knowledge of this area and what we had learnt from the case studies. It is possible to have such areas that both our knowledge and case studies do not cover.
3. In our result we present both how usability and pedagogical aspects are treated when evaluating e-learning systems. However we do only discuss the pedagogical aspects which is a limitation because usability aspects can also, indirectly improve the pedagogical usefulness of the system.

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