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Review of Usability Evaluation Methods and Other Factors for Implementing an Open Source Learning Management System in Saudi Arabia

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ABSTRACT

Possible methods suitable for evaluating the usability of e-learning websites that provide a Learning Management System are examined. In doing so, some systems are sng which system and which usability evaluation metuggested with a focus on the Saudi educational context and open-source solutions so as to aid those considerihod to adopt. Other issues related to implementation besides software usability are also highlighted including the appropriateness of the Technology Acceptance Model which takes usability into account.

KEYWORDS

Software usability; Usability evaluation; Learning Management System; Technology Acceptance Model; Open source; Moodle

1 INTRODUCTION

This review of the literature examines possible methods for evaluating the usability of e-learning or Learning Management Systems (LMS) for academic institutions, especially those in Saudi Arabia that seek a low-cost solution. The information may also be applicable to other similar contexts to be useful for anyone considering implementing an LMS and evaluating its usability, and where an LMS may also be referred to as an e-learning platform, Course Management System (CMS), or Virtual Learning Environment (VLE). The purpose is to give valuable information that may inform decision makers faced by the choice of evaluation methods for evaluating the usability of an LMS while subject to time, cost and other constraints.

In addition, the paper gives a brief overview of Moodle as one example of an open-source LMS since the cost factor is an important consideration for these institutions, and it also highlights some relevant issues besides software usability that may be important in deciding which LMS to implement. This wider consideration is necessary because regardless of how easy to use or effective a certain technology is, it cannot serve its purpose without a proper implementation [1]. This also leads to highlighting the Technology Acceptance Model (TAM) as a possible theoretical framework for studying the acceptance of an LMS based on its usefulness and usability.

2 LEARNING MANAGEMENT SYSTEMS

An LMS and all other such systems mentioned above rely on a computer connected to the Internet, and make it possible for students to learn by obtaining course materials, sending assignments, taking quizzes, communicating with their teachers and fellow learners, etc. For teachers, an LMS assists by allowing them to create, make available, manage, customise and modify a range of digital content and learning objects, to reuse that content and track their students' learning, and for a university, an LMS enables it to expand its student body though delivering courses to students around the world. Since the advent of the Internet, various technologies have been used to enhance learning, such as email, Bulletin Board Systems (BBS),

blogs, wikis, and chat clients, but a typical LMS offers many more features to provide a more comprehensive learning environment.

Notably, an LMS enables the communication to be conducted remotely, and either synchronously or non-synchronously. That is, an LMS removes the restrictions of time and distance in providing an educational environment [2]. This offers many advantages for learners, especially in terms of being able to learn at their own pace at their own convenience, and from anywhere as long as they have the aforementioned physical hardware requirements. It does however, impose on students the need to be independent, collaborative and active participants.

In short, an LMS is characterised by its provision of four types of spaces: (1) information space for providing educational content and reference materials, (2) exhibition space to exhibit learning products, such as documents and videos, (3) an interaction space for users to communicate and exchange information, and (4) production space where processes are implemented to generate traces of learning, such as exercises and tests [3]. As a piece of software, a typical LMS would be described as being multiplatform, having a graphical interface, based on a client-server architecture, and which allows for multimedia, information management, communication and user interaction.

One way of distinguishing most LMS's is by describing them as being either proprietary or open-source. By open source is meant that the source code is openly available, which enables users to have access to the source code, modify it, add features and redistribute the software. These are typically available for free. A closed-source LMS on the other hand does not provide open-source access to the code, which is typically a proprietary LMS provided by a commercial entity and is not therefore free. A few examples of popular commercial LMS's are Blackboard, WebCT, Brightspace, and WizIQ, and of open-source ones are Moodle, Sakai, Ilias, ATutor, Canvas, and Schoology. In deciding between these two types, important factors to consider would be features, supported technologies, license fees, support and maintenance, security, and IT resources. In comparison, although commercial LMS's may be costlier, they generally come with better support, whereas open-source LMS's are usually obtainable free of charge and are more flexible and customisable.

Delivering a course of study through a Learning Management System (LMS) has increased dramatically in Saudi Arabia in recent years [4]. A major reason for this trend is Saudi Arabia becoming the largest market for information and communication technologies in the region [5], and the huge budget allocation for e-learning systems and encouraging their implementation by the Ministry of Higher Education. One of the earliest LMS's to be implemented was EMES (E-Learning Management Electronic System) at King AbdulAziz University in 2007. Although most implementations are in universities, LMS's have now also been introduced into K-12 public schools in Saudi Arabia [6].

Of the 34 universities in the kingdom (as of 2015), a Ministry of Higher Education (MoHE) survey of 25 of them revealed that Blackboard is by far the most commonly used LMS [64]. It is used by 76% of the universities in the sample (Table 1) although many of these universities have only been developed in recent years as part of the kingdom's drive to transform itself into a 'knowledge economy' [65]. In this sample, Moodle is only used by one single institution (University of

Tabuk), so there is a lot of scope to promote open source alternatives.

Table 1: Types of LMS's in use in Saudi universities

No.	LMS	No. of Universities	Percentage
1	Blackboard	19	76%
2	None or not yet installed	3	12%
3	Desire2Learn	2	8%
4	Moodle	1	4%
	TOTAL	25	100%

The situation is more or less similar in other countries as well in that there is a discernible diffusion of online education. Reference [66] identified four distinguishable stages of this diffusion at a selected Mexican university over a 13 year period (1996-2009). It was noticed that initially, online education began as individual initiatives by academics in the late 1990s who emerged as agents of change and stimulated interest in other academics, which led to the formation of small communities sharing information and experiences. The next stage (1999-2002) was characterised by a more active role in the diffusion, and the third stage (2003-2007) by a clearer structured focus centred on the use of ICT for teaching and learning. During the subsequent period (2008-2009), a clear institutional policy had not been defined by the university examined. Although the periods may differ for other universities and countries, similar diffusion characteristics can be observed, and with it, issues such as selecting and evaluating a suitable LMS have become important.

3 LMS USABILITY

3.1 LMS Selection

Besides the above criteria for selecting an LMS, its evaluation may be undertaken from a pedagogical or institutional perspective [7], or by conducting a usability evaluation, or a combination of these. The use of an LMS, which plays a central role in this arrangement for learning, introduces potential software usability issues at both ends, and usability has become an important concern in developing an LMS [8]-[9]. The problem is that evaluating an LMS can be a complex task, as found for instance when evaluating the effectiveness of an open source LMS [10]. The price and feature list of an LMS are not therefore the only factors to consider. In particular, a technologically mediated educational process should be expected to provide an easy to use, clear and understandable interface, accessible content and course materials, and an efficient means for a two-way communication between the teachers and students.

3.2 Usability

Usability is an important software quality attribute recognised in the standard ISO/IEC 9126-1. The same standard defines usability as “the capability of the software product to be understood, learned, used, and attractive to the user, when used under specified conditions”. The traditional attributes of usability, as described by Nielsen [11], were that the software should be easy to learn, efficient to use, easy to remember, have few errors, and be subjectively pleasing, which may be labelled as learnability, efficiency, memorability, reliability and satisfaction respectively. He [11] further introduced the concept of web usability as describing web pages that are intuitively organised, easy to navigate, and which help users find the information they seek with ease. This

position is supported by Roy & Pattnaik [12] who also argued that the most important aspects of a website from a usability point of view to satisfy users, are the user friendliness of its navigation system, and its effectiveness in enabling users to accomplish tasks. Effectiveness is in relation to performance in being able to accomplish tasks, which may be measured for instance, by number of users being able to accomplish them within a certain time. A site would be considered as user-friendly by its users if they can easily interact with it in order to perform the tasks required of them [13].

Although different researchers have defined usability in terms of different components, the components that may be particularly important for ensuring a highly usable e-learning system are learnability, rememberability, efficiency in use, reliability and user satisfaction [14]. Learnability for instance, refers to the degree of learning required to accomplish tasks, and which may be measured by the time taken to perform them, and general satisfaction of the user would be ensured by making them want to continue to use the system happily; want to see it improved in some way, or prefer not to use it or to use another system in its place. Evaluation based on a range of factors is essential for evaluating usability because usability does not pertain to any one of them exclusively, and a range of technical, attitudinal, cognitive and other factors provides a more balanced indication of usability. An ideal LMS would be one that has all such components expected of an LMS, and which can ensure students can learn effectively from an institutional and also system perspective [15].

In a study specifically on the usability of e-learning systems, [16] recommended that such a system can only be considered as usable if it is easy to use and useful for learners with respect to accomplishing their learning tasks, that is, if the software is able to help them improve in their learning. Others have also highlighted further motivational aspects as being important for e-learning, such as a feedback mechanism, comprehensiveness, and curiosity [17]; interactivity, avoiding interruptions or distractions to learning, and providing a continuous feeling of challenge [18].

3.3 Importance of Considering Usability

For software in general, enhancing usability can lead to improvements such as making it easier to use the software, reducing time spent in learning to use it, improvements in productivity, greater user satisfaction, etc. The usability of websites has always been a matter of concern since the very beginning of the Internet era [19], and the characteristics of human-computer interaction play a major role in defining their usability [20]. Some usability aspects can also be subjective, as it is also affected by users' cognitive and perceptual abilities [21].

Usability is an especially important consideration for e-learning software because it can help to develop systems with improved didactical and pedagogical approaches [22]. For an LMS, the consideration of usability is moreover important because it can affect the learning experience for students and their academic performance [23]-[24]. Any lacking in usability compromises the quality of the online course delivery system, can cause waste of time, and increase the need for and cost of providing training.

In spite of such potential benefits, usability is often neglected in designing and implementing e-learning software [25]. The reason for a lack of usability evaluation may be that in comparison to other tests, it is considered tedious, least rewarding and expensive to implement [26], and it

may also require training and close coordination between developers and programmers. Moreover, only a few studies have been conducted, and there is still no standard adopted for evaluating the usability of learning management systems.

3.4 Usability Evaluation Methods

Importantly, the effectiveness of educational software also relies on some principles that distinguishes it from other web-based software, so these would need to be taken into account when selecting an evaluation method. These include the design of learning objects and learning activities, the medium of presentation, and the provision for communication between teachers and students [27]. And for methodology, one possible framework that can be applied is the DECIDE framework based on the following six components [28]: (1) Determine goals for the evaluation to address, (2) Explore questions to be answered, (3) Choose evaluation paradigm and techniques for answering those questions, (4) Identify practical issues to be addressed, (5) Decide on how to deal with ethical issues, and (6) Evaluate, interpret and present the data.

Many usability evaluation methods have been devised for evaluating various kinds of software including web-based software. These methods may be categorised as: (1) Survey questionnaire based methods, (2) Other non-survey structured methods, (2) Inspection based methods, and (4) Non-user involved methods. There are several examples of the first type, such as Software Usability Measurement Inventory (SUMI), System Usability Scale (SUS), Questionnaire for User Interaction Satisfaction (QUIS), Website Analysis and Measurement Inventory (WAMMI), Computer System Usability Questionnaire (CSUQ), and Usefulness, Satisfaction and Ease of Use (USE). Of these, WAMMI has been specifically prepared for evaluating websites [29], so it would appear that it may be particularly suitable for evaluating an LMS.

The Think Aloud approach, which is another form of systematic method, may also be used for websites as an alternative to WAMMI, but it is likely to be more time consuming [30], and unlike WAMMI, the results cannot be used to compare usability between different systems [31]. Another possible alternative is eye-tracking, but it requires special equipment and technical expertise [32], and Heuristic Evaluation, an inspection based method, has been shown to be particularly useful for detecting structural defects of sites [33]. Other methods also used are interviews, surveys, expert reviews, and personas. However, the decision of which method to adopt in evaluating usability would be subject to the typical constraints of time and cost [26], and depend on such factors as the stage of the software development lifecycle (SDLC), availability of skills and expertise in evaluation [34], and the extent of need for an objective, systematic and complex evaluation. It is also possible to combine different methods, as done by [27] in a study that combined evaluation from three different categories identified above, namely heuristic evaluation, usability questionnaire, and a task-driven technique. As for sample size in evaluating usability, as pointed out by Nielsen [11], it is usually sufficient to determine this quickly with as little as three to five users [35].

The System Usability Scale (SUS) mentioned above is a very short, “quick and dirty” [36], and freely available usability evaluation questionnaire widely used for measuring usability. It is recognised as a robust tool [37], even for small sample sizes [38]. A comparison of five different tools (SUS, QUIS, CSUQ and two vendor specific ones), has shown that along with the CSUQ, the

SUS achieved the goal of providing a reliable measure across a range of sample sizes the quickest [38]. This tool comprises of 10 items (5 positively and 5 negatively worded statements), which are assessed using a five-point Likert scale ranging from strongly disagree to strongly agree. A survey by [39] listed 14 products for which the SUS questionnaire was used for testing usability and proposed a further 9. Although e-learning platforms were not included in either of their lists under the category of web products, e-learning platforms can also be assessed using SUS like other web products.

3.5 LMS Usability Evaluation

The SUS has been used for evaluating the usability of an LMS by [40] who evaluated the SPIRAL platform; [41] who used it to evaluate a distributed learning resource repository called DELTA; [42] who used it to measure user satisfaction of three edutainment platforms; [43] who evaluated the UNITE e-learning platform in nine schools that used it; [44] who used it for evaluating the usability of a Moodle based VLE in conjunction with heuristic and cooperative evaluation; [45] who assessed the Topolor system which combines social e-learning with adaptive e-learning; [46] who used it to assess the perceived usability of a simulation based e-learning system, and in eleven studies conducted by [24]. These latter studies together involved 769 students in which eClass and Moodle were evaluated. The 'perceived usability' of these LMS's was found to be satisfactory, especially in terms of validity and reliability. In the study by [44], all three tools identified the existence of usability issues.

Reference [47] developed an instrument for evaluating the usability of an LMS. with respect to its user interface in terms of features, its web application features, and other features specifically related to the LMS. The LMS evaluated was an in-house system designed around the time Moodle was made, and the heuristic evaluation of Nielsen was applied, which involved identifying its functioning and optimum operating conditions. In addition, they checked for its compliance with international standards: ISO 9241 based on the criteria of efficiency, effectiveness and satisfaction, and ISO 9126 based on learnability, operability and comprehensibility. This led to devising six questions for evaluation from which the following essential attributes were identified: searchability, communicability, reliability, configurability, design, comprehensibility, ease of use, and navigability. Six experts were hired to evaluate the system. This method enabled serious usability problems to be uncovered, especially in terms of reliability in the form of frequent interruptions, error messages and failures, but also communicability, searchability and configurability. The software scored highest in terms of comprehensibility.

Reference [10] compared a range of open source LMS's based on a simple evaluation of technical factors and features to find one suitable for a higher education institution. Commercial ones were not included because the objective was to find a cost effective solution, but there was also a requirement to have all the major features expected to be found in a commercial product. Five open source LMS's were selected from fifty on UNESCO's website: Moodle (v.2.2), ATutor (v.2.0.3), Ilias (v.4.2.1), EFront (v.3.6.10) and Claroline (v.1.10). All five of them are themselves based on open source technologies, namely PHP, a server-side scripting language, and MySQL, a database management system. The analysis was undertaken by creating courses, updating their contents, and creating learning activities. In terms of usability, all of them were found to be easy to

use. Three of them – Moodle, ATutor and Ilias – excel with respect to providing flexible language support, usage statistics, and an advanced assessment system; EFront stood out alone by having the most visually attractive interface, and Moodle by providing the ability to track user logging, rich graphical statistics of activities and reports, and more advanced access and security controls. Moodle was also found to have certain features not present in the other LMS's at the time of comparison, such as support for external video conferencing, file transfer, and whiteboard tools that can be integrated in the LMS. Since their first recommendation was Moodle, more details are given of this LMS.

3.6 Moodle

Moodle (Modular Object-Oriented Dynamic Learning Environment) is web-based course management system that is recognised as a popular LMS. It is available for free and is based on open-source technologies, which allows it to be easily modified and adapted. Moodle provides a wide range of features typical of an LMS, such as a registration system for both instructors and learners, user profiles, assignments, class schedules, wikis, chats, glossary, email, performance statistics, etc. Several studies have evaluated Moodle, some focusing on specific modules [48]-[49], [27] and others have compared Moodle with other LMS's [50]-[51].

Moreover, Moodle is designed to provide a collaborative learning environment based on the pedagogical principles of social constructivism, has multi-lingual support, and it supports the SCORM (Sharable Content Object Reference Model) and IMS (Instructional Management System) open standards for an LMS. Support for these open standards is beneficial because it ensures greater interoperability, portability, reusability and sequencing for the LMS [52], and also accessibility, adaptability, durability, and maintainability [27]. The SCORM specification for instance, contains elements of provisions by IEEE, AICC and IMS in a single document, which makes it easy to implement.

3.7 Consideration of Other Factors

From the perspective of project management, many other factors would also need to be considered besides those already considered above, namely price, features and technical factors, in deciding which open source LMS to implement. In the case of an institution for instance, it should ensure the LMS is in line with its vision and mission, and that it can easily handle the number of potential users [53].

A study by [53] highlights examples of such challenges in implementing an e-learning system faced by a university in Saudi Arabia, which they ascertained through adopting a case study approach. Their findings show that various issues can arise that must therefore be considered beforehand. These issues include the time it would take to develop online courses from scratch, availability and sustainability of human resources, and uncertainties related to technology. Technological uncertainty and the issue with human resources can also change over time, which may require changes in the implementation.

Apart from arranging for the e-learning system in an attempt to improve the quality of student learning and in a way that it could evolve in line with educational change processes, they also had to convince the institution to adopt the technology and overcome the initial "course of techno-hype" [53], which was challenging and necessitated a number of changes to the original plan. These changes included adopting Moodle instead to benefit from better specifications, providing

improved interactivity, and meeting the requirements of the Saudi MoHE (Ministry of Higher Education) to blend the course with face-to-face teaching, There may also be legal issues to consider, as currently, Saudi Arabia does not permit the offering of online degrees.

Furthermore, cultural issues also need to be considered, as it was found to present a major challenge in the case of Saudi Arabia. Some faculty members found it difficult to adapt to the new way of teaching, and some students experienced difficulties. Difficulties for students was not exclusive to Saudi students, as the phenomenon has also been reported by others, such as [54] and by [55] for Jordanian students. Overcoming such cultural issues would require training, which can be time consuming and costly. In some countries, other such issues peculiar to that place may arise. For instance, when [1] investigated the implementation of an e-learning system in a university in Pakistan, English proficiency and electricity failure were found to be the most significant barriers. However, some LMS's such as Moodle do have multilingual support and the problem of frequent power outages only restricts synchronous learning, not asynchronous learning.

For developing countries generally, limited resources and lack of technical expertise can be restricting factors to proper implementation, as can cost of technology, deficient strategies, resistance to change, poor course delivery and competition [56]. As pointed out by [57], most developing countries lack quality experts to implement and maintain information and communication technologies. Lack of computer skills is not only prevalent in developing countries however, as it is also not uncommon in developed countries.

Reference [58] identified four barriers to adopting an LMS in a university in New Zealand: computer skills, conceptions of an LMS's role, desire for recreating old work practices, and emotions. Computer skills were highlighted as barriers, a 'cognitive load' and hindrance to mastering the functionality of an LMS. Difficulties were experienced especially by staff who lacked even basic computer skills, and the researchers also faced issues relating to getting users to interact with each other. The study also showed the potential of technology to arouse negative emotions of frustration and exhibiting reluctance to change. Consequently, there was a tendency to replicate some past practices to ease the LMS adoption process. For instance, they preferred to perform certain tasks the way they were previously accustomed to doing. Nonetheless, the LMS implementation was successful overall, as the institution was praised for its strong technical support, which shows the importance of this factor in making an implementation successful. Other such enabling factors identified were learning from the implementations of other institutions, and allowing for a feedback mechanism.

The above study highlights the importance of taking the users into account. A study by [59] specifically analysed how learners interact with an e-learning site by means of a survey with a view to assessing the effectiveness of e-learning material used by a particular Indian e-learning portal, and to predict the acceptability of the adaptive environment for learners. The learners reported perceiving e-learning as valuable due to its role in reducing time, effort and money in retrieving information. Moreover, a vast majority of the 146 students surveyed expressed satisfaction with the e-learning environment due to the aforementioned and various other benefits, such as convenience, scope for interaction, ease in seeking clarification,

etc. User satisfaction is an important component of usability, and factors such as usefulness and ease of use perceived by users makes it easier for them to accept the technology and new way of learning.

3.8 The Technology Acceptance Model

A useful theoretical framework that can be applied for understanding the likely acceptance and usage of the implementation of an LMS is the Technology Acceptance Model (TAM), an information systems theory proposed by [60] that takes into account perceived usefulness and perceived ease of use. That is, the usefulness and ease of use perceived by users are considered to be predictors of the attitude to accepting a technology. Reference [61] used this model for the e-learning context in an empirical study involving students from a university in Taiwan. They found it to have good internal consistency; that the more useful the system is perceived to be and the easier or friendlier the system interface is to use, the users are indeed more willing to use it. Likewise, user satisfaction is closely linked with active participation and commitment [62].

In an adaptation of TAM specifically for e-learning systems, [63] combined the model with Innovation Diffusion Theory (IDT) to investigate factors that may affect the behavioural intentions of 552 business employees in Taiwan to use an e-learning system. The study validated both TAM and IDT for the organisational context as providing better results overall when combined. Although the results confirmed the research model and hypotheses, those who had expectations for the system to be usable in terms of it being simple to understand and easy to use were disappointed, as it did not prove helpful in improving job performance. To address these findings, they therefore recommended for e-learning systems to be designed in a way that is relevant to employees' and user-friendly for enhancing the perception of ease of use. This confirms the view that two constructs of usefulness and ease of use are important factors in determining the extent to which an e-learning system would be accepted.

4 CONCLUSION

A number of software usability evaluation methods were identified in this paper that can be adopted for evaluating the usability of a learning management system. It also defined an LMS, identified its characteristics, examined some issues in evaluating an LMS, described usability and identified its components relevant to an LMS, established the importance of considering usability, and highlighted other related factors to consider in implementing an LMS. The Technology Acceptance Model was also introduced as a theoretical framework for understanding technology acceptance in terms of perceived usefulness, and perceived ease of use as one important aspect of usability.

Given that many universities in Saudi Arabia have only been established in recent years, the finding that many existing universities use a proprietary LMS, and the neglect of usability considerations, there is plenty of scope for promoting both an awareness of the importance of usability and adopting open source based learning management systems for supporting e-learning. It is recommended to conduct a thorough investigation of usability issues related to the use of an LMS. Moreover, the newness of the technology and the finding that some universities are not currently using any LMS shows the potential for applying the Technology Acceptance Model in further research in this context.

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