

A Generic Model for Evaluating the Usability of Learning Management Systems

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ABSTRACT

Usability of software systems is one of the most important software quality factors that has been defined by several researchers and international standards, e.g. ISO/IEC 25010, IEEE Std.610.12. Numerous studies have been conducted to evaluate the usability of Learning Management Systems using different usability evaluation methods. This paper aims at proposing a generic model for usability evaluation of Learning Management System based on ISO/IEC 25010, 9214 Standards and usability models that proposed in literature so far. The proposed model includes seven usability attributes i.e. effectiveness, efficiency, error protection, accessibility, operability, learnability, and satisfaction.

Keywords

Usability, ISO/IEC 25010, Learning Management System.

1. INTRODUCTION

Software usability is one of the most important software quality characteristics. Software system usability has made interesting advances in software production, with more and more organizations starting to take usability seriously [1].

The term “usability” has been defined in many standards and researches. For instance, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) ISO/IEC 25010:2011 defined it as the “degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” [2]. Moreover, IEEE Std.610.12 defined usability as “the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component” [3].

Furthermore, usability is a non-functional requirement which means it cannot be measured directly. Therefore, many measurable attributes related to the usability have been identified by several researchers in literature in order to evaluate the usability of software products, for instance, time to complete tasks and errors faced during completing a task are considered from the quantitative usability attributes.

Moreover, some methods are used to evaluate the usability attributes of a software product, such as: user testing where real users experience the software product provided by a list of tasks

that reflect the main goals of the software system. In addition, inspection methods, e.g. heuristic evaluation aims at inspect the user interface by expert evaluators. In contrast of user testing inspection methods allow to evaluate the usability in earlier phases of the software development process such as: evaluating the requirement specifications or the prototype. However, choosing a usability evaluation method adhere to cost, time constraints, and appropriateness.

Learning Management System (LMS) aims at Manage learners monitor their performance and progress across all learning activities types. The LMS manages resources of learning such as courses material, classroom and instructor availability, instructional material, and delivery of online learning [10]. However, several LMSs such as: blackboard, Moodle, Sakai, and latitude learning, are used in different colleges and universities mostly to support the on-campus educational process.

Some studies have started to examine the usability of Learning Management system (LMS) according to its significant role in enhancing the learning process [11, 12, 13, 14, 15, 16]

This study proposes a generic model to evaluate the usability of Learning Management Systems (LMS).

The paper is organized as follow: section two provides a literature review on the usability models. Section three provides a generic view of usability in ISO/IEC 25010 standards. Moreover, section four provides a generic view of usability in ISO 9241-11. Furthermore, the proposed usability model is introduced in section five. Section six compare the characteristics of the proposed model with the existing models, and section seven concludes the paper.

2. LITERATURE REVIEW ON USABILITY MODELS

Usability Evaluation attributes have been identified by several researchers, for instance, Shackel identified four important usability criteria i.e. effectiveness, learnability, flexibility, and user attitude [6].

Later, Nielsen defined the usability as a quality attributes and includes five components [4]:

- *Learnability*: Time to learn how to accomplish the basics tasks.
- *Efficiency*: the speed of performing tasks after learning using the system.
- *Memorability*: remembering how to accomplish the tasks very quickly, after leaving the system for period of time.
- *Errors*: Error's proportion, how easily the errors recovered by the users.
- *Satisfaction*: shows the user satisfaction and pleasant while using the system.

Similar to the usability attributes identified by Nielsen, Brinck *et al.* divided the usability category into functionally correct,

efficient to use, easy to learn and remember, error tolerant, and subjectively pleasing [5]. In addition, Boehm's model of usability classified the usability into portability and maintainability [31].

Moreover, FURPS quality model that presented by Grady R. [7] includes usability as a main quality attribute and determined its criteria as human factors, aesthetics, consistency, documentation.

Furthermore, Shneiderman B. [8], proposed a guideline for software usability measurement objectives i.e. time to learn, speed of task performance, rate of errors by users, subjective satisfaction, retention over time.

According to Abran *et al.* [18], the security attributes come within the usability. Hence, they proposed a consolidate model for the usability including five attributes, i.e. efficiency, effectiveness, satisfaction, learnability, and security.

Alonso-Rios *et al.* [20] proposed a usability model with six attributes, i.e. knowability, operability, efficiency, robustness, safety, subjective satisfaction. Furthermore, Dubey *et al.* [21] considered a classification that included effectiveness, efficiency, satisfaction, and learnability. However, an integrated usability model has been proposed by Dubey *et al.* [22] that included effectiveness, efficiency, satisfaction, comprehensibility, and safety. Moreover, QUIM model identify quality in use in seven characteristics i.e. efficiency, effectiveness, productivity, satisfaction, learnability, safety, and accessibility [30].

Recently, ISO/IEC 25010 standard for Software and quality in use models identified the usability in use attribute as one from the most important quality in use attributes which can be measured by effectiveness in use, efficiency in use, satisfaction in use, and usability in use compliance.

3. USABILITY IN ISO/IEC 25010 STANDARD

ISO/IEC 25010 that has replaced ISO/IEC 9126 [9] is a part of *Software product Quality Requirements and Evaluation (SQuaRE)* series of standards. Furthermore, the quality models that defined in this standard are software product quality model and quality in use model. However, product quality model classifies the quality attributes into eight characteristics i.e. functional suitability, performance efficiency, usability, security, compatibility, reliability, maintainability, and portability [3]. Where the usability has six sub characteristics:

- *Appropriateness recognizability*: the level to which the users can recognize if the system meets their needs from the initial impression.
- *Learnability*: the level of learning to use the product or system with effectiveness, efficiency, freedom from risk, and satisfaction.
- *Operability*: the easy of operate and control the system.
- *User error protection*: the degree to which the system preventing the user from making errors.
- *User interface aesthetics*: the degree to how the graphical interface satisfies the user
- *Accessibility*: the degree to which the system help the users regardless of their different characteristics and disabilities to achieve their goal of using the system.

On the other hand, quality in use model consists of three categories, i.e. effectiveness in use, efficiency in use and satisfaction.

In addition, each category has sub categories to be measured. This study focuses on the usability attribute that includes the following three sub characteristics in order to measure the usability in use:

- *Effectiveness in use*: this sub characteristic is based on ISO 9241-11 that is the degree to which the user can achieve his/her goal with accuracy and completeness.
- *Efficiency in use*: the level of effectiveness achieved to the related resources spent e.g. time and material.
- *Satisfaction in use*: subdivided into Usefulness, trust, pleasure, comfort i.e. physical satisfaction.

Both models i.e. product quality and quality in use are applicable for computer systems and software products.

4. USABILITY IN ISO 9214 STANDARD

ISO 9214 is the international standards on ergonomics requirements for office with Visual Display Terminals (VDTs) [17]. Furthermore, ISO 9214 deals with four main categories of requirements i.e. general, material requirement, environment, and software. However, the four categories divided into 17 parts; where usability specifications measures are included in the software categories and explained in part eleven. In addition, this standards, determined three attributes to measure the usability, i.e. effectiveness, efficiency, and satisfaction in a specified context of use.

5. A GENERIC MODEL TO EVALUATE THE USABILITY OF LMS

There are different views of usability models attributes in literature and in standards, that leads to problems for the evaluators to decide which model needs to be adopted in order to evaluate usability to any software system in general and LMS specifically.

This paper proposes a generic model to evaluate the usability of Learning Management System (LMS), where the main types of users are: administrators, instructors, and learners based on usability models that have been proposed in literature and International standards.

The model includes seven usability attributes i.e. Effectiveness, efficiency, user error protection, operability, accessibility, learnability, satisfaction as shown in figure 1. Following are the main characteristics and its related sub characteristics

1. *Effectiveness*: the degree to which the user can achieve his/her goal with accuracy and completeness [3].
 - a. Task Completeness: the proportion of task that completed correctly.
 - b. Task effectiveness: task completion with regard to the time.
 - c. Error frequency: corrected and uncorrected errors during the task accomplishment.
2. *Efficiency*: the level of effectiveness achieved to the related resources spent.
 - a. Task time: how long does it take to complete a task compared to target time.
 - b. Task efficiency: the user effectiveness compared to task time.

Effectiveness and efficiency measurements provided by ISO/IEC 25022 [28].

3. *Operability*: the easy of operate and control the system in elearning environment
 - a. Completeness: provide all the needed functionality, especially for the learners.
 - b. Customized possibilities: the functions that can be customized and numbers of functions that required to be customized.
 - c. Monitoring possibility: number of items that have monitoring state, such as delivering the assignment from the learners.
 - d. Display consistency: number of items that placed consistency on website pages.

The sub characteristics b, c, and d measurements are provided in ISO/IEC 25023 [29].

4. *User Error protection*:
 - a. Avoidance of incorrect operation: Number of functions implemented to avoid critical or serious operation.
 - b. Input validity checking: proportion of input items provide check for valid data.
 - c. User error recoverability: number of errors that the system can correct and recover.

ISO/IEC 25023 [29] provides measurements to user error protection attributes.
5. *Accessibility*: Using the system with wide range of capabilities and characteristics.
 - a. Visual: number of functions that can be accessed by low vision people
 - b. Auditory: number of functions that can be accessed by people who has hearing problem.
 - c. Multiple language support: number of languages that is supported by the LMS.
6. *Learnability*:
 - a. Time to Learn: time to learn how to complete basics tasks.
 - b. User documentation/Help Facility: number of functions that described completely in user guides and help documentation.

7. *Satisfaction*: include three sub characteristics:

- a. Usefulness: the users satisfaction of their achievements, proportion of customer complaints
- b. Trust: does the user trust the system?
- c. Pleasure: pleasure to use the system and user interface aesthetics

User Satisfaction can be measured using standardized questionnaires such as: SUMI [24], ASQ [25], CUSI [26], PSSUQ [26], QUIS [23], and SUS [27]. While the attributes from 1 to 6 can be evaluated by inspection by experts or by user testing.

Figure 2 shows the model characteristics and sub characteristics.

6. COMPARISON OF THE PROPOSED USABILITY MODEL WITH EXISTING MODELS

Table 1 shows the characteristics of the proposed models and its indication in literature and international standards.

Table 1. Comparison of proposed model characteristics with the existing models.

| Characteristics | Existing Models |
|-----------------------|---|
| Learnability | [4], [6], [5], [7], [8], [18], [21], [22], [30] [3],[29] |
| Operability | [7], [20], [22] [3], [29] |
| User Error protection | [4], [5], [8] [3], [29] |
| Satisfaction | [4], [6], [5], [7], [8], [18] [20] [21], [22], [30],[3], [29] |
| Effectiveness | [6], [8], [18], [21], [22], [30], [3], [28],[28] |
| Efficiency | [4], [5], [18], [20] [21], [22], [30], [3], [28] |
| Accessibility | [22], [30], [3], [29] |

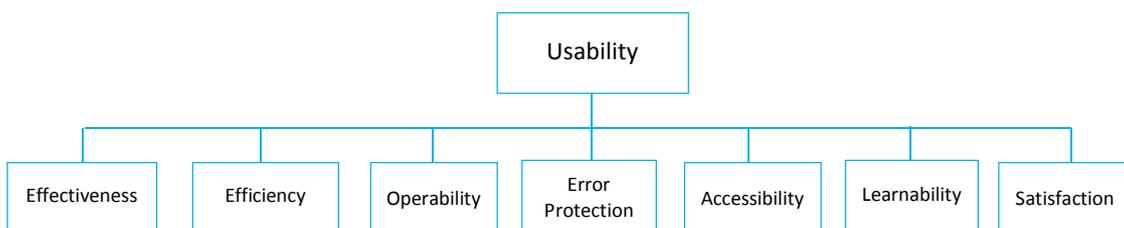


Figure 1. Generic usability model for LMS.

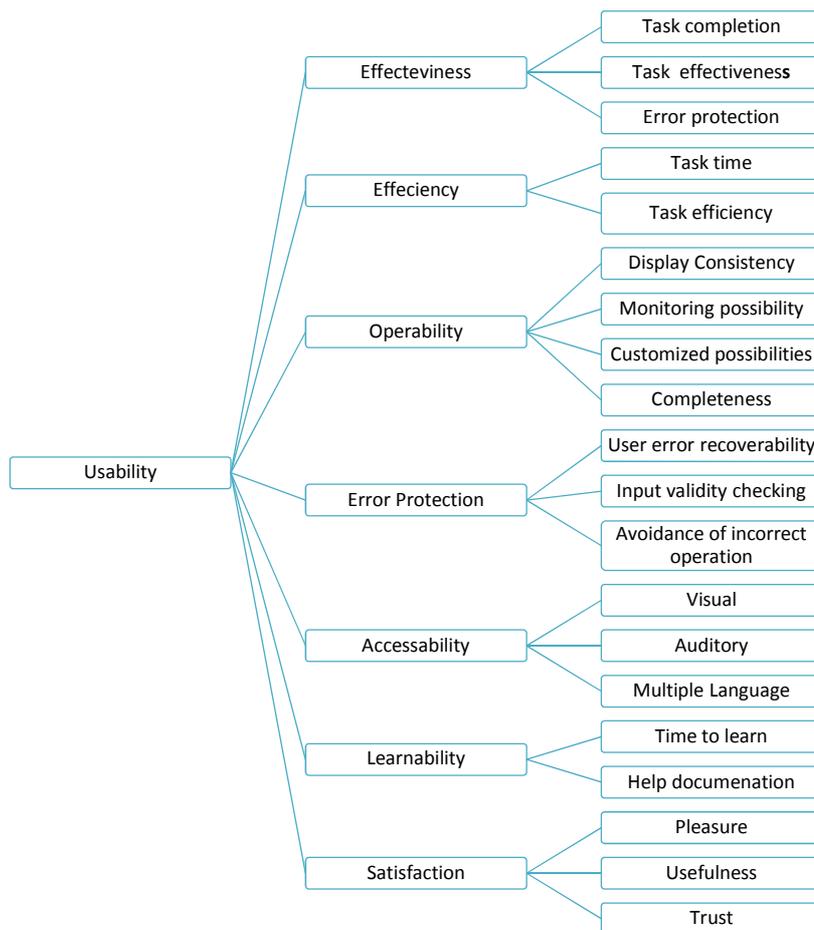


Figure 2. Usability model characteristics and sub characteristics.

7. DISCUSSION

The usability model for evaluating Learning Management Systems (LMSs) is proposed based on literature and international standards and consists of the characteristics that affects the usability in learning systems.

The model is expected to be helpful in evaluating LMS to find the usability problem areas in order to improve the design of the evaluated systems and obtain the best usability results.

8. CONCLUSION AND FUTURE WORK

Usability is an important factor of software quality. Several models have been proposed in literatures and international standards provided different usability attributes in order to be measured. Furthermore, Learning Management Systems are a widespread use in colleges and universities and the usability of such systems has been examined before by different researchers who adopted different general usability models with different attributes. This paper proposes a generic usability model to evaluate the LMS with the needed characteristics regarding the context of use.

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