

A Usability Evaluation Framework for Web Based Learning Management Systems Used in Kenyan Universities

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Abstract

Despite the fast adoption of web-based learning management systems (LMS) in institutions of higher Learning, insufficient attention has been paid to the usability of these systems in developing countries. Usability evaluation for the web-based LMS needs to be conducted before implementing them so as to get maximum benefits from tones of learning features which are integrated in them. However, the available standard usability evaluation guidelines are inadequate for evaluation of domain specific applications. There are few studies which have made the first steps in proposing guidelines for evaluating web-based LMS. However, they were found not adequate in the current study. On this premise, it is difficult to adapt any of the proposed guidelines without any further improvement. In this study, we proposed a usability evaluation framework for evaluating web-based LMSs used in Kenyan universities. The proposed framework was tested by applying it in usability evaluation of Moodle LMS. Two primary usability evaluation methods (UEMs) were used which are user testing and expert evaluation. Think aloud method and post-evaluation questionnaire were used to supplement user testing. Four expert evaluators were used for expert evaluation and 36 students were used for user testing. The proposed framework was found adequate for use in usability evaluation of web-based LMSs.

Keywords: Usability, Usability Evaluation Framework, Motivation to Learn, User Testing, Heuristic Evaluation

I. INTRODUCTION

The use of web-based learning management systems (LMS) in institutions of higher learning has increased in the recent past. (Allen & Seaman, 2014). Web-based LMS have successfully been implemented and adopted in the developed countries. One of the contributing factors to the success of web-based LMS in developed countries is the support and usability aspect of the LMS (Allen & Seaman, 2014). Usability was originally defined using Shackle's framework as "the capacity in human functional terms to be used easily and effectively used by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios" (Shackel, 1991).

Institutions of higher learning in African countries are implementing web-based LMS in a bid to attain similar benefits as those of developed countries. However, it is different in the African context as many institutions are facing many challenges and it is not a guarantee that they will enjoy same benefit as their western counterparts (Mutisya, 2016). One of major challenges to the success of the web-based LMS is low usage which has been attributed to usability problems (Mabila, Gelderblom& Ssemugabi, 2014).

Most of universities in Kenya these had started offering fully online courses using web-based LMS by the year 2013 (Kashorda & Waema, 2014). However, despite the increased adoption of the web-based LMS, there are considerable challenges in their usage, one of them being LMS usability issues (Kiget, Wanyembi & Ikoha, 2014).

There is a great need to conduct usability evaluation for the web-based LMS in an effort to discover and rectify any usability issues before implementing them. According to Diaz (2019) the available standard usability evaluation guidelines proposed by usability pioneers like Nielsen (1994) are inadequate for exhaustively finding problems in web-based LMS.

Web-based LMS are unique from any other web-applications because the system users double up as users as well as learners. Most of them are designed using constructivism approach which means the Learner is an active participant in the learning process (Zaharias, 2009). In this regard, web-based LMS should strive for intrinsic motivation in their design so that learners are able take control of their learning with affection (Zaharias, 2009). Research has it that intrinsically motivated system learners are more explorative, self-regulated and demonstrate behavior that aims at deep learning and reflection. Motivation to learn is an affective aspect of instructional design which has been neglected in previous usability evaluation guidelines. Paz (2015) recommends establishment of new guidelines for domain specific application. There are different approaches to developing new usability guidelines which

include: 1) expanding the existing usability guidelines, 2) alteration of the evaluation procedure, and 3) alteration of the conformance rating scale (Ling and Salvendy, 2005).

The main aim of this study was to develop a usability evaluation framework for web-based LMS used in Kenyan universities. For this purpose, this study followed the first approach which is expanding the existing usability guidelines so as to incorporate motivation to learn heuristics on top of general and web design heuristics. A number of studies have had the first steps towards developing usability evaluation frameworks and guidelines which can be utilized for usability evaluation of web-based LMS. These studies have considered the additional measurement criteria from the fields of web-design and instructional designs which are important for evaluating web-based LMS. These studies were systematically reviewed in the current study to form the basis of the new usability evaluation framework. The proposed framework was applied in usability evaluation of Moodle LMS which is used in most Kenyan universities according to Moodle registration report (2019).

II. RELATED STUDIES ON USABILITY EVALUATION FRAMEWORKS FOR LMS

Most of the studies available on usability evaluation guidelines for web-based LMSs are based on generic usability heuristics by usability Pioneers like Shneiderman (1987) and Nielsen (1993) without any customization. Limited studies are available which propose usability evaluation guidelines for web-based LMSs with the context of learning in focus. This section will review literature on available studies which have made the first steps towards developing usability frameworks and guidelines for web-based LMSs. In coming up with a new framework, a methodology proposed by Rusu (2011) was used to systematically review and synthesize the existing literature.

Squires and Preece (1999) related the aspect of cognitive and contextual authenticity to Nielsen's usability evaluation heuristics to propose a usability evaluation framework referred to as heuristics for "learning with software". This framework was one of the first steps in integrating usability and learning in the perspective of constructivism approach to learning. The following were the criteria proposed: 1) Match between learner and designer models (2). Navigational fidelity. (3) Appropriate level of learner control (4). Prevention of peripheral usability errors (5). Understandable and meaningful symbolic representation (6). Support for personally significant approaches to learning (7). Strategies for the cognitive error recognition. (8). Diagnosis and recovery cycle (9). Match with curriculum.

Brinck and Wood (2002), without ignoring the heuristics proposed by Nielsen (1994) proposed 10 parameters which are important during web design: The following were the proposed criteria: (1). Content and scope. (2) Speed (3). Navigation (4). Appropriateness to task. (5). Visual design. (6). Compatibility (7). Simplicity (8). Consistency and contrast (9). Error handling (10). Respect for users.

Albion (1999) in his study "Heuristic evaluation of educational multimedia" adapted the 10 heuristics by Nielsen (1994) and educational design heuristics suggested by Quinn (1996) to come up with 28 criteria for evaluating educational applications. The 28 heuristics included 9 educational design heuristics, 9 content heuristics and 10 interface design heuristics. The 9 educational design heuristics are: (1). Clear goals and objectives. (2). Context meaningful to domain and learner. (3). Content clearly and multiply represented and multiply navigable. (4). Activities scaffolded (5). Elicit learner understanding. (6). Formative evaluation. (7). Performance should be criteria-referenced. (8). Support for transference and acquiring, 'self-learning' skills. (9). Support for collaborative learning.

Vrasidas (2004) in his study, "Issues of Pedagogy and Design in e-learning Systems", proposes 8 principles for effective online learning. These principles can be customized to serve as heuristics for evaluating web-based LMSs. These principles are as follows: (1). Learner-centricity (2). Engagement and activity (3). Constructive (4). Situated and contextual learning (5). Collaboration (6). Reflection. (7). Prompt feedback (8) Record-keeping.

Mtebe, Kissaka (2015) in their study "Heuristics for Evaluating Usability of Learning Management Systems in Africa" proposed an expanded criteria for evaluation of web-based LMS. On top of interface heuristics proposed by Nielsen (1994), the study proposed 6 didactic effectiveness heuristics which were: (1) Instructional material (2). Collaborative learning (3). Learner control (4). Feedback and assessment (5). Accessibility (6). Motivation to learn.

Zaharias (2009) in his study "Usability in the Context of e-Learning: A Framework Augmenting 'Traditional' Usability Constructs with Instructional Design and Motivation to Learn", proposed 12 parameters where five of them are interface design heuristic and seven of them were instructional design heuristics. These parameters are: (1). Learnability (2). Accessibility (3). Consistency (4). Navigation (5). Visual design (6). Interactivity (7). Content and Resources (8). Instructional feedback (9). Instructional assessment (10). Learner guidance and support (11). Media use (12). Learning strategies design.

Ssemugabi and De Villiers (2007) included web design heuristics and instructional design heuristics on top of Nielsen (1994) heuristics to come up with a framework of 20 measurement parameters. The proposed framework was used in usability of Info3Net using experts and students as evaluators. From the results, expert evaluators were able to uncover 77% problems compared to 73% by students. Paz et., al (2015) extended the original 10 usability heuristics by Nielsen (1994) to come up with a new set 15 usability heuristics for transactional Web sites. The criteria were established after a structured and systematic methodology proposed by Rusu et al (2015).

Harpur and De Villiers (2015) developed a framework of criteria for evaluating the usability, user experience and educational features of m-learning environments. The framework was developed by customizing, extending/reducing the usability evaluation criteria proposed by Ssemugabi and De Villiers (2007). The framework had five categories with web and educational heuristics being one of them. The educational heuristics proposed in this framework were: 1). Clarity of goals, objectives and outcomes.

2). Effectiveness of collaborative learning. 3). Error recognition, diagnosis and recovery. 4). Feedback, guidance and assessment.

Reeves et al. (2002) proposed a criterion of 15 parameters after refining Nielsen (1994) heuristics. The criteria were tested in a doctoral seminar where by the participants evaluated a Good Manufacturing Practices (GMP) courseware packed into CD-ROMs at the University of Georgia. Using the criteria, they were able to uncover several usability problems. The study proposed 7 new evaluation criteria on top of Nielsen (1994) criteria. The six criteria are: (1). Interactivity (2). Message Design (3). Learning Design (4). Media integration (5). Instructional assessment (6). Resources (7). Feedback.

A. The Proposed Usability Evaluation Framework

The extensive review of related studies in the section above provided a broad spectrum of criteria previously fronted for usability evaluation of web-based LMS. However, the current researchers found the following concerns with these studies: (1) All the studies have not been empirically tested (2) Most of the studies require evaluation of LMS content which was not the focus of current study. (3) Effectiveness of these studies has not been tested in the Kenyan context. (4) None of the studies were found to be exhaustive for usability evaluation of web-based LMS. Therefore, adapting any of these studies without improvement is difficult in the current study context.

Through synthesis of related literature, the current researcher identified 15 usability parameters which were categorized into three: (1) General interface design heuristics. (2) Web Design Heuristics and (3) Motivation to Learn Heuristics. The study introduced motivation to learn category which brings an affective aspect in the framework that is very important in LMSs (Zaharias, 2009). Motivation to learn heuristics fronted in the new framework can be measured in a web-based LMS without having learning content on it which is the case on the previous frameworks. The proposed framework is a short and compressive criterion which is a departure from previous related lengthy frameworks. The study borrowed a lot from Zaharias (2006) and Ssemugabi & De Villiers (2007) in categorization of the Heuristics. The proposed framework is shown on table 1. The original sources of the criteria are also indicated. The evaluation guidelines have also been given which can be extended or customized to suit specific domain.

Table – 1

The proposed Usability Evaluation Framework for Web-Based LMS Used in Kenyan Universities.

Category 1: General interface design heuristics		
1	Visibility of system status	Dix et al (2004), Nielsen (1994)
	1.1 For every action users make, they can see or hear the results of that action e.g. download status, upload status, completion status etc.	
2	Match between the system and the real world	Dix et al (2004), Nielsen (1994)
	2.1 The language used is natural, since the terms, phrases, and concepts are similar to those used in day-to-day or study environment	
3	User Control and Freedom	Dix et al (2004:), Nielsen (1994), Squires and Preece (1999)
	3.1 Users can control the system, easily reverse changes and exit wrong screens through a well-marked undo features and emergency exits links or buttons?	
4	Consistency and adherence to standards	Shneiderman and Plaisant (2005), Nielsen (1994)
	4.1 Same words, phrases, situations, Graphics, icons and menu mean the same throughout the system	
5	Error Prevention and Recovery	Dix et al (2004), Shneiderman and Plaisant (2005), Nielsen (1994)
	5.1 The system has got clear instructions on required inputs(text,passwords,file-types,emails) and prompts me to confirm user actions which might be potentially dangerous like deleting or submitting a test?	
	5.2 The systems give the user error messages and provides a series of steps to recover from the errors	
6	Recognition rather than recall	Dix et al (2004), Shneiderman and Plaisant (2005), Nielsen (1994)
	6.1 There is an obvious relationship between controls (Menu,icons,images)and the respective actions they represent such that you don't need to remember previous task or refer to	
7	Flexibility and efficiency of use	Dix et al (2004), Nielsen (1994)
	7.1 The site guides novice users sufficiently and accelerators Like shortcuts are provided for expert users	
8	Aesthetic and minimalism in design	Dix et al (2004), Nielsen (1994)
	8.1 System dialogues contain relevant information ,no excessive use of text ,graphics and there is good utilization of white space	
9	Learner Support & Guidance	Lanzilotti et al. (2006); Clark and Mayer (2003); Horton (2000); Driscoll (2002);
	9.1 I find the help facilities like interface tours and activity orientation useful and adequate	
	9.2 The site provides a section for frequently asked question (FAQ) which contain answers to challenges users might be facing	
Category 2: Website design heuristics		
10	Simplicity of site Navigation	Brinck and Wood(2002), Reeves et al, (2002)

	10.1 They system incorporates adequate navigation options(Back to home page, back to dashboard, previous page ,next page and breadcrumbs) which enable users to move around the system with ease?	
	10.2 The system incorporates advanced internal search facility which makes its content more accessible?	
	10.3 The colors for links, buttons and tabs are consisted with Web conventions i.e. non-visited links, visited and active use different colors	
	10.4 The course map is available ,well placed and structured to navigate from one course to another with ease	
	<i>Content Structure and organization</i>	
11	11.1 The content organization on the screen is organized in such a way that most important sections are visible and attracts your attention	Brinck and Wood(2002)
	11.2 Related information is placed together in well partitioned and labeled sections	
	<i>LMS (Website) Speed</i>	
12	12.1 Navigation from one section, page or course to another is within reasonable time?	Brinck and Wood(2002)
	12.2 Internal search results are displayed within reasonable time?	
<i>Category 3: Motivation to Learn Heuristics</i>		
	<i>Collaboration Tools</i>	
13	13.1 The site has facilities that encourage group activities such as teamwork, group project and collaborative problem solving e.g. discussion forums and chat activities	Shneiderman et al(1998) DeVilliers(2003),Squires and Preece(1999)
	<i>Interactive Multi-Media Support</i>	
14	14.1 The system employs the use of different interactive multimedia as a mode of instruction e.g. text, graphics, animations, simulations, PowerPoint etc. which stimulate learning	Vrasidas (2004),Squires and Preece (1999), Reeves et al (2002)
	14.2 The system content is interactive and has creative features that enable the learn to learn in an interesting and enjoyable way eg.Use of simulation , drag and drop questions in quizzes	
	<i>Assessment & Feedback</i>	
15	15.1 The system incorporates self-assessment facility and provides immediate feedback in terms of grading for every activity users submit.	Squire & Preece (1999), Vrasidas(2004),Albion(1999)

III. METHODOLOGY

This Study used case study approach to achieve its aim. Triangulation approach was used in evaluating the selected LMS. User testing and expert evaluation were used as the primary UEMs. Think aloud UEM and a Post- evaluation questionnaire were used to supplement user testing. The Post-Test questionnaire was designed using a Likert scale of 1 to 5 (strongly agree, agree, maybe, disagree, strongly disagree. The questions were derived from the proposed usability evaluation framework (Table 1). The rule used in think aloud method was level three verbalizing where students were required to explain their interface expectations as recommended by virtz (1993). The data collected from the different methods was both qualitative and quantitative.

A. Target System

Moodle LMS which is used in most Kenyan universities according to Moodle registration report (2019) was the target LMS.Moodle stands for Modular Object-Oriented Dynamic Learning Environment. Moodle has got many versions which have evolved over years. The target system was Moodle 3.6 which is a stable version launched in the year 2018.Moodle was designed to provide educators, administrators, and learners with an open, robust, secure and free platform to create and deliver personalized learning environments. \Moodle is written in PHP distributed under GNU General Public License.

B. Study Participants

For user testing, second year university students taking Bachelor of Science in Information technology were selected. The students were drawn from Zetech University which is one of the private universities in Kenya. The university was selected purposely because of easy accessibility. The university was considered representative for other Kenyan universities because it admits both government and privately sponsored students. Second year students were selected purposely because they had relatively good knowledge in computer terminologies which were used in the test scenario and the post-test questionnaire. All the 38 second year students participated in the study. For quantitative studies Nielsen (2012) recommends at least 20 participants so as to get statistically significant numbers for a tight confidence interval.

For expert evaluation, four expert evaluators were selected to participate in exercise. Nielsen (1994) recommends 3-5 expert evaluators.

IV. RESULTS & DISCUSSION

A. User Testing Results and Discussion

Think aloud technique and a questionnaire were used to supplement user testing. From the user testing exercise, the LMS was found to have 12 usability problems. The 12 problems were a union set (combined results) from think aloud and post evaluation questionnaire. The target LMS was found to be 80 % usable from the Likert scale questions in the post-evaluation questionnaire. This is because 20 statements out of a total of 25 statements had favorable rating from the student testers. This is not the ultimate picture of usability level of the LMS but a pointer to the real situation. Statement with an average rating of 3 and above were interpreted to mean that the students did not agree with them. This is an indication of problem areas in the LMS. Five statements which the student did not agree with are shown in table 3. Combined usability problems for think aloud and post-evaluation questionnaire are shown on table 5. All the usability problems were correctly mapped to the respective heuristics from the framework which is an indication that the proposed framework is sufficient for usability evaluation of web-based LMS

Table – 3
Statement with Average Rating Above 3

Post Evaluation Questionnaire Statements	Strongly Agree	Agree	May Be	Disagree	Strongly Disagree	Average Rating
	(1) f	(2) f	(3) f	(4) f	(5) f	
7.1 The site guides novice users sufficiently and accelerators like shortcuts are provided for expert users	0	9	19	8	0	3
9.1 I find the help facilities like interface tours and activity orientation useful and adequate	0	8	5	20	3	3.5
9.2 The site provides a section for frequently asked question (FAQ) which contain answers to challenges users might be facing	0	7	2	22	5	3.7
10.2 The system incorporates advanced internal search facility which makes its content more accessible?	0	6	2	26	2	3.7
12.2 Internal search results are displayed within reasonable time?	0	14	2	19	0	3.2

Table – 4
Usability Problems Found during User Testing

	Problems	Heuristic violated
1	The login page is not visible	Content Structure and organization
2	Wrong design for login error message	Simplicity of site navigation
3	I cannot go back to home page easily	Simplicity of site navigation
4	It cannot change my password because I can locate the password edit page	Content Structure and organization
5	The file upload page is not understandable.	Match between the system and the real world
6	The group discussion forums are not user friendly	Match between the system and the real world
7	There is no search facility for courses in the LMS	Simplicity of site navigation
8	I can't exit the quiz section midway	User Control and freedom
9	I cannot save the self-assessment quiz to continue later.	Content Structure and organization
10	The home page and dashboard are not visible when am in courses	Content Structure and organization
11	There is no undo and redo button	User control and Freedom
12	I cannot locate my courses easily from the menu because all the items are packed at one place	Content Structure and organization

B. Expert Evaluation Results and Discussion

The expert evaluation exercise involved four evaluators who evaluated the LMS individually. The evaluators were able to find a total of 21 initial problems. From these problems 6,7,8,12 problems were found by evaluator 1, 2, 3 and 4 respectively. The relatively low number of problems found by a single evaluator confirms the findings that one cannot rely on a single person to perform an expert evaluation (Nielsen & Molich, 1990). The effectiveness of expert evaluation is a group effectiveness but not a single evaluator effectiveness (Nielsen & Molich, 1990). During the expert evaluation exercise, the four evaluators were able to map all the problems to their respective heuristics which were derived from the proposed usability evaluation framework. This can be interpreted to mean that the proposed framework is sufficient for usability evaluation of web-based LMS.

Table – 5
Initial problems found by all the Four Evaluators

	Problem	Heuristic Violated
1	The login page is not properly designed and the login text is too small	Simplicity of site Navigation
2	The upload page section has got many details which are confusing the student	Match between the system and the real world
3	No tooltips used to explain the unlabeled icons in the system	Learner Support and; Guidance
4	No help document for student and a section for frequently asked question	Learner Support and; Guidance
5	No search facility for courses	Simplicity of site Navigation
6	It is not easy to recover from login errors for novice users	Error Prevention and Recovery

7	<i>It is not easy locate the password edit page</i>	<i>Simplicity of site Navigation</i>
8	<i>There is no return to top button</i>	<i>Simplicity of site Navigation</i>
9	<i>No proper design for system status when uploading and downloading something</i>	<i>Visibility of system status</i>
10	<i>The discussion forum is not properly designed</i>	<i>Match between the system and the real world</i>
11	<i>Wrong placement of the dashboard tab and the Home tab</i>	<i>Simplicity of site Navigation</i>
12	<i>The user profile page is too lengthy with too many unnecessary fields</i>	<i>Aesthetic and minimalism in design</i>
13	<i>The marking of the required fields by use of an exclamation mark is not noticeable</i>	<i>Match between the system and the real world</i>
14	<i>The jump to facility is placed at the bottom hence not easy to recognize</i>	<i>Content Structure and organization</i>
15	<i>Lack of Interactive multimedia support in the quiz module</i>	<i>Interactive Multi-Media Support</i>
16	<i>Lack of video and audio segments.</i>	<i>Interactive Multi-Media Support</i>
17	<i>User does not have control and freedom when navigating the screens.</i>	<i>User Control and Freedom</i>
18	<i>Lack of error recovery mechanisms</i>	<i>Error Prevention and Recovery</i>
19	<i>White space not utilized well.</i>	<i>Aesthetic and minimalism in design</i>
20	<i>Lack of feedback mechanism.</i>	<i>Assessment & Feedback</i>
21	<i>There are to expand and collapse menu icons on the vertical menu</i>	<i>Simplicity of site Navigation</i>

C. Combined User Testing and Expert Evaluation Results

Results from user testing were combined with results from expert evaluation to form a union set of 24 unique problems. Out of the 24 problems, 3 problems were not detected by experts. This agrees with Nielsen (1994) that you can rely only on expert evaluation to detect all the problems in a system. However, expert evaluators were able to detect more problems (21 problems) than the student users (12 problems).

To separate the real problems from cosmetic problems, the expert evaluators conducted an expert judgment exercise of the combined problem list as recommend by Andreas (1999). During this exercise, 5 problems were eliminated from the list to bring a total of 19 real usability problems as shown on table 6.

Table – 6
Real usability problems

	<i>Problem</i>	<i>Heuristic Violated</i>
1	<i>The login page is not properly designed and the login text is too small</i>	<i>Simplicity of site Navigation</i>
2	<i>The upload page section is has got may details which a confusing the student</i>	<i>Match between the system and the real world</i>
3	<i>No tooltips used to explain the unlabeled icons in the system</i>	<i>Learner Support and Guidance</i>
4	<i>No help document for student and a sections for frequently asked question</i>	<i>Learner Support and Guidance</i>
5	<i>No search facility for courses</i>	<i>Simplicity of site Navigation</i>
6	<i>It is not easy to recover from login errors for novice users</i>	<i>Error Prevention and Recovery</i>
7	<i>It is not easy locate the password edit page</i>	<i>Simplicity of site Navigation</i>
8	<i>There is no return to top button</i>	<i>Simplicity of site Navigation</i>
9	<i>No proper design for system status when uploading and downloading something</i>	<i>Visibility of system status</i>
10	<i>Match between the system and the real world</i>	<i>Match between the system and the real world</i>
11	<i>Wrong placement of the dashboard tab and the Home tab</i>	<i>Simplicity of site Navigation</i>
12	<i>The user profile page is too lengthy with too many unnecessary field</i>	<i>Aesthetic and minimalism in design</i>
13	<i>The marking of the required fields by use of an exclamation mark is not noticeable</i>	<i>Match between the system and the real world</i>
14	<i>The jump to facility is placed at the bottom hence not easy to recognize</i>	<i>Content Structure and organization</i>
15	<i>Lack of Interactive multimedia support in the quiz module</i>	<i>Interactive Multi-Media Support</i>
16	<i>There are to expand and collapse menu icons on the vertical menu</i>	<i>Simplicity of site Navigation</i>
17	<i>I can to exit the quiz section midway</i>	<i>User Control and freedom</i>
18	<i>I cannot save the self-assessment quiz to continue later.</i>	<i>Content Structure and organization</i>
19	<i>I cannot locate my courses easily from the menu because all the items are packed at one place</i>	<i>Content Structure and organization</i>

V. CONCLUSION AND RECOMMENDATION FOR FURTHER RESEARCH

The aim of the study was to develop a usability evaluation framework for web-based LMS used in Kenyan universities. This purpose was achieved by systematically conducting an extensive literature review on related usability evaluation studies in an effort to propose a new usability evaluation framework. The proposed framework was deployed in usability evaluation for Moodle LMS which is used in most Kenyan universities. From the evaluation results, the LMS was found a total of 19 usability problems which was a union set from user testing and expert evaluation.

All the usability problems found during user testing and expert evaluation were successfully mapped to their respective Heuristics which were derived from the proposed framework. This is interpreted to mean that the proposed framework is adequate for use in usability evaluation of web-based LMS used in Kenya universities. In order to address areas not covered in this study as well as the study limitations, this study recommends that future work should be done test the effectiveness of the proposed framework using different effectiveness measurement criteria like thoroughness and validity.

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