Usability Maturity Indicators for Virtual Learning Systems

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ABSTRACT

Todays' institutions of higher learning faced with a problem of facilitating learning with a changing profile of students, in bigger and bigger classes. The environment in these institutions is undergoing major changes as many academic institutions are offering courses either partially (Web enabled) or totally (Web exclusive) online to facilitate learning. Most recently, Virtual Learning Systems has become an important feature of electronic service delivery within institutions of higher learning and in response demanding close attention to issues of functionality, sustainability and usability. In this paper we discuss usability of VLS and the associated antecedent characteristics. A field study was employed to get feedback from lecturers and students in one of the universities in Kenya as a case. From the study, we propose keen attention to be given to three usability characteristics: understandability, learnability and operability from the user's perspective.

Keywords: *virtual learning systems, usability maturity, institutions of higher learning*

1. INTRODUCTION

Our society is undergoing a process of rapid change, moving toward what is variously called the "information society", the "knowledge society", the "learning society" or "learning economy" (Sirje & Lawraine 2004). In light of the widespread recognition of the enduring challenge of enhancing the learning of all students—including a growing number of students representing diverse racial, ethnic, and socioeconomic backgrounds—there has been an explosion of literature on teaching, learning, and assessment in higher education (Clifton , Jason & Gupta, 2007). Information and Communication Technology has had profound impact on the way we teach and learn (Omwenga 2011, Lai, Khaddage & Knezek, 2011) which has created an information revolution within an optimistic global society that has embraced virtual learning. However, usability of such information systems affects heavily their overall usage.

The fundamental goal of VLS is to remove the barriers of time and place in the facilitation of learning. The interactive learning relationship empowers students with control over (a) when and what they view, hear, or read, (b) the pace of their learning, and (c) requests for additional information from other student(s) or instructor(s) via the same or other media. Further, the medium to learn is any technology-based conduit connecting instructors and/or educational materials with students, which may (a) change in nature over time (e.g., from personal computer to podcast), (b) include non-electronic interventions (blended learning), and (c) facilitate instructor-student interaction both in real time (synchronously) and in different times (asynchronously)
This study investigates the role of Virtual Learning Systems in support of service delivery in education particularly within the area of end-user systems usability. The study stems from the fact that, in spite of the technology being in place as a primary motivator for delivery of quality education, there still remains dissatisfactions in harnessing its potential

2. RELATED WORK

A variety of alternative approaches to usability evaluation have been proposed in prior work. Melody et al. (2001) identify five distinct approaches: testing, inspection, inquiry, analytical modeling, and simulation. Among these approaches, one common characteristic of usability evaluation methods is their dependence on subjective assessments in the form of user judgments. Thus, usability is not intrinsically objective in nature, but rather is closely intertwined with an evaluator's personal interpretation of the artefact and his or her interaction with it (Agarwal & Venkatesh, 2002). Although self-reported measures are commonly used, research shows that perceived ease of use of a system is strongly correlated to subjective system usage measures, but weakly correlated to objective system usage measures (Straub, Limayem, and Karahanna-Evaristo 1995; Barnett at al. 2006).

Research has been ongoing in identifying approaches to improve online usability (Boling, 1995; Levi & Conrad, 1996; Nantel & Senecal, 2007; Palmer, 2002; Pitkow & Kehoe, 1996). Studies often focus on the download delay, success in finding a page or completing a task, or organization of the information gathered during a Web session (Pitkow & Kehoe, 1996; Nantel & Senecal, 2007). For instance, Nantel and Senecal (2007) suggest that there is a positive relationship between the time users spend waiting for WebPages to download and the probability that they will complete their task on the website. Other research is based on Microsoft Usability Guidelines (MUG). Five major categories are proposed as relevant while designing websites for business: content (relevance, media use, depth/breadth, current information), ease of use (goals, structure, feedback), promotion, made-for-the medium (community, personalization, refinement), and emotion (challenge, plot, character strength, pace) (Agarwal & Venkatesh, 2002; Venkatesh & Ramesh, 2006; Venkatesh & Agarwal, 2006). To date, the literature has conceptualized usability as either a one-dimensional construct or a multidimensional construct composed of two dimensions (Table 1). Except for Palmer (2002), most research has not explored usability as a construct composed of more than two dimensions. Based on the current literature, we suggest that usability is composed of at least three dimensions: ease-of-use navigation, speed, and interactivity

Software metrics on quality and usability of the virtual learning environment are the key influencers on the learning outcome, i.e., student satisfaction. The usability of such learning technologies includes pedagogical and technical usability. Pedagogical usability refers to the support in the process of teaching and learning, while technical usability refers to the interaction between the user and the computer (Melis et al., 2003).

There are several software quality assessment models. First, Earthy (1999) presents a ‘‘Usability Maturity Model: Processes’’ to assess an organization’s capability of performing activities related to human-centered processes. The model consists of seven possible processes likely to take place during system development. In an attempt to conform to ISO 15504, the model describes six capability levels, as listed in Table 8. In his paper, Earthy’s ‘‘Usability Maturity Model: Human Centredness Scale’’ (1998), it presents how organizations could progress through six levels of human-centered processes. Additionally, a rating methodology assesses ‘‘the level of maturity reached by an organisation in its capability to do human-centered design.” Besides, CMM (Paulk, Weber, Curtis, & Chrissis, 1995) and CMMI (Chrissis, Konran, & Shrum, 2006) define maturity levels in stages with the objective of qualitatively illustrating the maturity of the software engineering process.

On the other hand, Lethbridge (2007) presents the User and Usability Maturity Model (UUMM), which has been modeled after the Capability Maturity Model, and which can assess an organization’s capabilities with users and usability-related issues. In this model, there are four dimensions of an IS, including ‘‘involvement with users, training of the team, development processes and evaluation processes.’’ the authors have however not yet used the model to conduct an assessment of an organization.

3. METHOD

A descriptive survey was employed as a research design. In view of this, the study adopted a field survey to collect both qualitative and quantitative data from one of the leading universities in Kenya. Stratified random sampling and purposive sampling techniques were employed to sample population of both students and lecturers using the VLS platform in the university.

To get the sample size, this study seeks to consider adopting the formulas given by Cochran (1977). Cochran’s formula is preferred for this study due to the fact that the target population for university students and non-expert staff is large and the exact number is unknown. Cochran’s equation is given by: $n = Z^2pq/e^2$. Therefore the sample population is 167 students and 26 for teaching staff.

The main research instruments used to collect data in a survey are questionnaires and interviews (Stake, 1978). This study being a field survey used both research instruments.

4. RESULTS AND DISCUSSION

The study model presented in Figure 1 is used to analyze and empirically investigate the relationship between the key usability factors and the usability of virtual learning systems software. The key usability factors studied in this study have been taken from the standard ISO/IEC 9126-1 (2001). Specifically, in this study the aim is to investigate the answer the following research question:

RQ: What are the characteristics of virtual learning systems?

The basis of this question is to investigate how understandability, learnability and operability affect VLS usability from the user’s perspective? There are three independent and one dependent variable in this research model. The three independent variables, the usability factors, include Understandability, Learnability and Operability. On the other hand, the dependent variable of this study is VLS usability. The multiple linear regression equation of the model is as follows:

$$\text{VLS Usability} = \gamma 0 + \gamma 1v1 + \gamma 2v2 + \gamma 3v3 \;\ldots.\; (1)$$

Where γ0, γ1, γ2 and γ3 are the coefficients and v1, v2 and v3 are the three independent variables. In order to empirically investigate the research question following study model was conceptualized

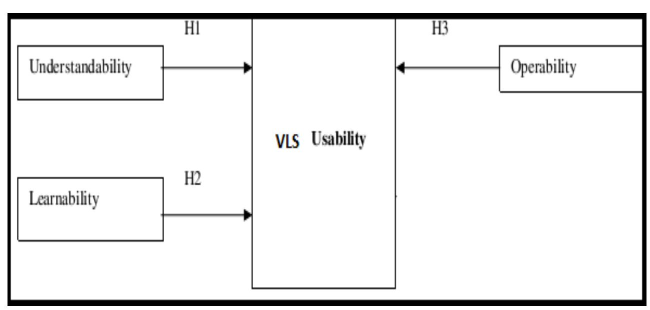

Fig 1: VLS usability quality metrics

The three hypotheses illustrated in the study model are further described in Table 1

Table 1: Study Model Hypotheses User's Perspective)

Hypothesis #	Statement
H1	Understandability is positively related to VLS usability.
H2	Learnability is positively related to VLS usability.
H3	Operability positively affects usability in VLS

From the survey which was implemented by using online survey tool "kwiksurveys" there was 125 responses from the students and 21 responses from teaching staff resulting in to 74.85 % and 80.7% response rate respectively. The basic assumption was that the identity of the participants who participated in the survey was not required. However, to support data analysis of the respondents' experience, we asked them, "do you agree that applying one of the concepts/techniques expressed by the above key factors, usability will, in your opinion, improve VLS usability?" Out of 125 total responses from the students, 79% agreed that in their experience, the application of our key factors will improve the usability of the information system; of the remaining participants, 18% were neutral and 3% disagreed with this statement, as reflected in table 2 and Figure 2 respectively

Table 2: Response by students on application of usability factors improves VLS usability

Measure	No. of respondents	% ge
Strongly Agree	33	26.4
Agree	66	52.8
Neutral	22	17.6
disagree	4	3.2
Strongly Disagree	0	0
Total	125	

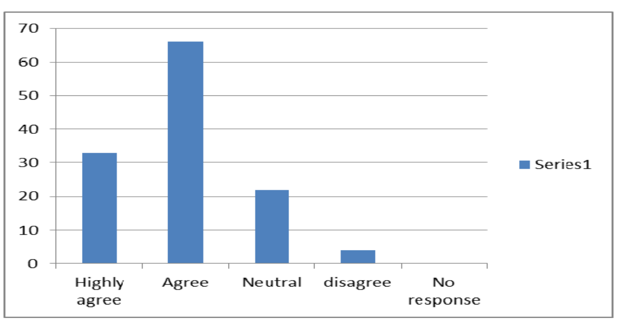

Fig 2: Application of usability factors improves VLS usability

On the other hand, the responses by teaching staff on the question "do you agree that applying one of the concepts/techniques expressed by the above key factors, usability will, in your opinion, improve VLS usability in relation to content use ?" 83 % agreed that their experience will affect usability of VLS system, while the rest of remaining 17% remained neutral and none disagreed with the idea as can be depicted from Figure 3

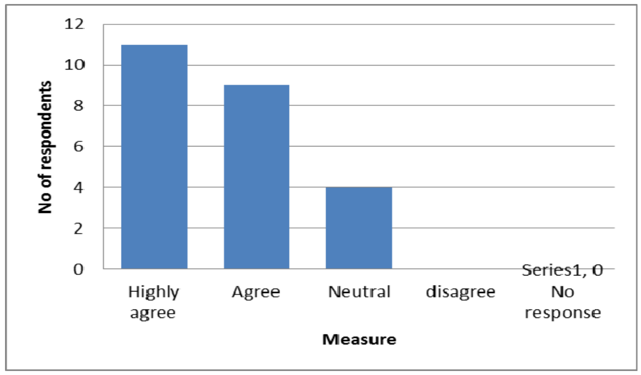

Fig 3: Application of usability factors improves VLS usability

4.1 Hypothesis Testing and Results

In the first phase, parametric statistics were used to determine the Pearson correlation coefficient between the individual independent variables, the usability factors, and the dependent variable, VLS usability, as displayed in Table 3. Specifically, with a value of 0.42 at $P < 0.05$, the Pearson correlation coefficient between understandability and VLS usability was positive, and hence, hypothesis H1 is justified. Similarly, a Pearson correlation coefficient of 0.42 at $P < 0.05$ was observed between learnability and VLS usability, and hence, this relationship was significant at $P < 0.05$. Hypothesis H3 was accepted based on the Pearson correlation coefficient of 0.51 at $P < 0.05$, which occurred between operability and VLS usability. The positive correlation coefficient of 0.40 at $P < 0.05$ was also observed between VLS usability and attractiveness, which indicated that H4 was also accepted. Hence, all hypotheses were found statistically significant and were accepted.

Non-parametric statistical testing was conducted by examining the Spearman correlation coefficient between the individual independent variables, the usability factors, and the dependent variable, VLS usability, as shown in Table 6.8. The Spearman correlation coefficient between understandability and VLS usability was positive, with a value of 0.40 at $P < 0.05$, and hence, hypothesis H1 is justified. For hypothesis H2, the Spearman correlation coefficient of 0.41 was observed at $P < 0.05$, and thus, a significant relationship was found between learnability and VLS usability. Based on the Spearman correlation coefficient of 0.51 at $P < 0.05$, hypothesis H3, which occurred between Operability and VLS usability, was accepted. Hence, the hypotheses H1, H2 and H3 were found statistically significant and were accepted based on non-parametric analysis.

Table 3: Hypotheses testing using parametric and non-parametric correlation coefficients

Hypothesis	Usability Factor	Pearson Correlation Coefficient	Spearman Correlation Coefficient
H1	Understandability	0.42*	0.40*
H2	Learnability	0.42*	0.41*
H3	Operability	0.51*	0.51*

*Significant at P<0.05** insignificant at P>0.05

4.2 Discussion

It is generally believed that testing procedures, especially those related to usability, are conducted differently depending on whether they are for closed proprietary software or for VLS projects. However, many testing issues remain common to both types of software, and, as a result, while most of the questions in our survey are specifically related to VLS, some questions are related to testing procedures in general. For questions related to understandability, we have asked the respondents about the relationship between consistency and understandability. In total, 79% of our student respondents agreed that consistency in VLS software design would increase understandability and hence usability, while 16% remained neutral and only 5% disagreed with the statement as depicted on table 4

Table 4: VLS software design on usability

Response	Percentage %ge	Cumulative %ge
Strong Agree	34	34
Agree	45	79
neutral	16	95
disagree	5	100
Strongly Disagree	0	100
TOTAL	100	

The statement that "software that is easy to understand encourages the user's involvement," is equally important for users of both VLS and proprietary software. As a result, 81% of student users agreed with this statement, 13% of users remained neutral and 6% of users disagreed (Table 5). On the other hand, 86% of staff using the VLS software agreed, 9% remained neutral and the rest (5%) disagreed (Table 6).

Table 5: Response by students on software easy to understand encourages user's involvement

Response scale	Percentage (%ge)	Cumulative %ge
Strongly agree	46	46
agree	35	81
neutral	13	94
Don't agree	6	100
Don't know	0	100

Table 6: Response by staff on software easy to understand encourages user's involvement

Response scale	Percentage (%ge)	Cumulative %ge
Strongly agree	30	30
agree	56	86
neutral	9	95
Don't agree	5	100
Don't know	0	100

Finally, the statement that "software inconsistency results from an inability to understand users' expectations" resulted in 37% of student users that agreed and corresponding 44% of the teaching staff, 40% of student-users and 32% of staff disagreed and 23% of students and corresponding 24% of teaching staff that remained neutral. Thus, overall, from the statistical analysis indicates that hypothesis H1, which states that "understandability is positively related to VLS usability", is found significant and has been accepted in the analysis
Moreover, students were asked about the relationship between learnability and usability, 81% of the students agreed that learnability increases accessibility and hence usability, while 16% remained neutral and 3% disagreed (Figure 4). Additionally, when the teaching staffs (who are content developers) were asked to state whether learnability may be compromised by the efforts of VLS system developers in producing efficient systems; 31% agreed that this was the case, while 42% remained neutral, 23% disagreed and 4% had no response with the statement as can be depicted from figure 5. Finally, 73% of the staff agreed that in order to make systems learnable, VLS developers must understand the limits of their target users especially the students and the teaching staff who are content developers (Fig 6). On the other hand, 15% remained neutral and 12% disagreed with the statement. Based on the statistical investigation, hypothesis H2, which states that "learnability is positively related to VLS usability", has been accepted

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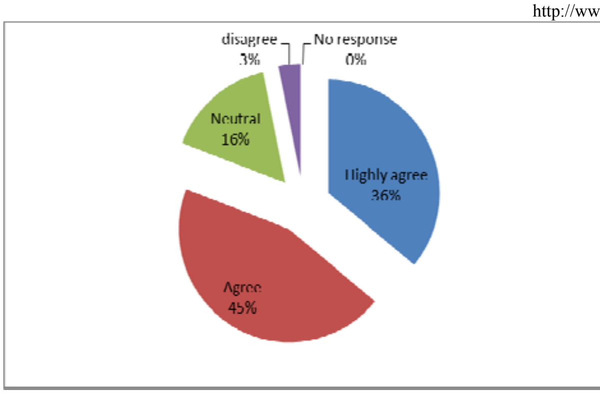

Fig 4: learnability increases accessibility and hence usability

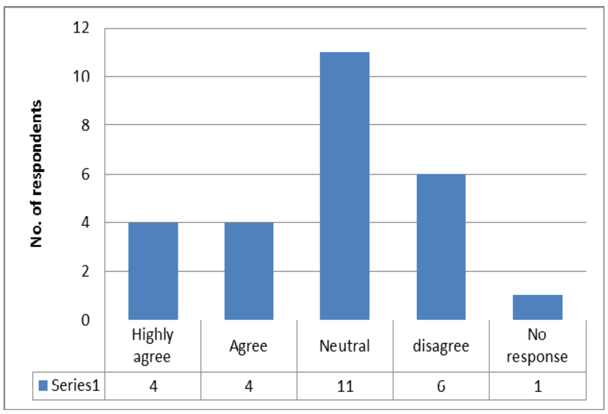

Fig 5: learnability may be compromised by the efforts of VLS system developers

When the teaching staffs were asked on whether " to make VLS systems be more learnable VLS developers must understand the limits of their target users", the response is as depicted in figure 6.6

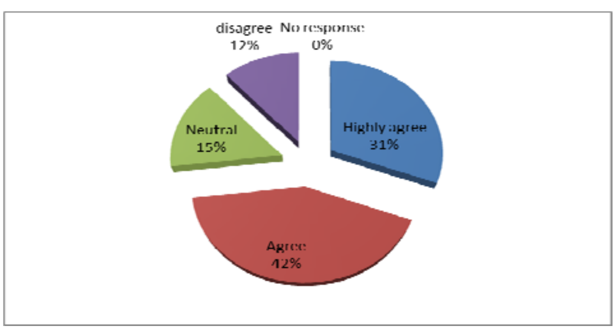

Fig 6: VLS developers must understand the limits of their target users

In order to maintain the unbiased nature of our statements, we asked our respondents whether or not they agree that learnable software is operable and usable. Consequently, 76% of the participants believed that more learnable software is more operable and hence more usable, while 13% remained neutral and the remaining 11% disagreed. For the statement that "operability is directly proportional to user satisfaction," 45% of the respondents agreed, 31% remained neutral and 24% disagreed. Lastly, the belief that "a modularized system design, where users encounter difficulty levels gradually and progressively, results in operable software", was held by 52% of the respondents, while 31% were neutral and 17% disagreed with the statement. Therefore, hypothesis H3, which maintains that, "operability positively affects usability in VLS", is supported by the statistical analysis of our survey and thus accepted

5. CONCLUSION

It has been found out that in virtual learning systems, usability aspects cannot be improved unless there are ways to test and measure them. There are fundamental characteristics that all VLS projects ought to embrace: learnability, understandability and operability. To better reap the benefits of the VLS systems, the paper recognizes the need to embrace the three usability characteristics in the design and implementation of such information systems as they directly affect their success.

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