Does e-learning usability attributes correlate with learning motivation?

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ABSTRACT

Evaluating the usability of e-learning is not a trivial task. Learners' diversity, technological variety and radical changes in learning tasks are some of the significant challenges need to be considered when conducting the e-learning usability evaluation. Traditional usability measures of effectiveness, efficiency, satisfaction and cognitive learning factors are no longer adequate for newer contexts of e-learning usage. It is critical that e-learning designers assess affective dimension, in which the learners may experience while interacting with e-learning. To this end, motivation to learn, which is one of the affective aspect, has been identified as a new usability measurement. A theoretical framework has been developed to investigate the relationship between e-learning usability attributes and learning motivation. This paper reports the method and results of the empirical evaluation of e-learning usability attributes towards motivation to learn among Open University Malaysia (OUM) learners.

Keywords: usability, usability attributes, e-learning, motivation to learn,

1. Introduction

In the digital age, the speed of learning has become vital differentiator for organizations and individuals in the pursuit of knowledge. The advent of the Internet has greatly influenced the way knowledge is transmitted. An exponential growth of knowledge also has made it imperative for learning to happen quickly. This fact has increased the necessity for learning and in combination with the new technology opportunities, has led to the emergence of e-learning.

E-learning has been identified as the enabler for individuals and organizations to keep up with changes in the global economy that now occur in Internet era and it is one of the most significant recent developments in the Information System (IS) industry (Wang, 2003). E-learning solutions facilitate the delivery of the right information and skills to the right people at the right time (Ruttenbur, Spickler, & Lurie, 2000).

However, without a usable and effective interface, an e-learning system cannot be efficient. A properly designed interface is able to draw the learners' attention, motivate

them toward interaction with the system and help them achieving their goals without confusion and fatigue (Faiola, 1989, Galitz, 1989; Jacques, Preece, & Carey, 1995). Providing learners with a usable environment can lead to improved performances (Donahue, et Al., 1999; Nielsen, 2003).

Apparently, the traditional usability measures of effectiveness, efficiency and satisfaction are inadequate for new contexts of technology assisting learning (Soloway et al., 1994). A major challenge of current usability research is to address user affect. It is critical that systems designers assess the range of possible affective states, in which users may experience while interacting with the system (Hudlicka, 2003).

Therefore, new measures need to be established (Hornbaek, 2005). In the context of e-learning, affect has recently gained considerable attention. It has been argued that affect is the energy which learners bring to the learning environment connecting them to the "*why*" of learning. New developments in learning theories such as constructivism heavily emphasis on the affective domain of learning; new thinking in adult learning theory and practice stresses the need to enhance learners' internal priorities and drives that can be best described by motivation to learn.

The latter, a concept intimately linked with learning (Schunk, 2000), is the most prominent affective learning factor which can greatly influence learners' interaction with an e-learning application. Motivation to learn is proposed in this research as an anchor for the development of a new usability measure for e-learning design. This paper reports the method and results of the empirical evaluation of e-learning usability attributes towards motivation to learn among Open University Malaysia (OUM) learners.

Thus, this study seeks to answer the following research questions:-

1. Is there a relationship between Usability Attributes and Motivation to Learn?
2. Is there a relationship between Web Usability and Motivation to Learn?
3. Is there a relationship between Pedagogical Usability and Motivation to Learn ?
4. Is there a relationship between Universal Usability and Motivation to Learn ?

2. Research Objectives

Based on the research questions above, the primary aim of the study are set out as follows:-
To investigate the relationship between Usability Attributes and Motivation to Learn.

1. To examine the relationship between Pedagogical Usability and Motivation to Learn.

2..To examine the relationship between Web Usability and Motivation to Learn.

3. To examine the relationship between Universal Usability and Motivation to Learn.

2. Background Literature

Electronic learning (e-learning) has been identified as the enabler for individuals and organizations to keep up with dynamic changes in the global economy that now occur in Internet era (Zaharias,2004). Current e-learning systems development only focuses on cognitive factors s (e.g., perception, memory and problem solving, etc.) that affect learning.

These primarily cognitive designs often overlook other sources for individual learning differences of affective nature, such as motivation and emotions. Modern cognitive science has stressed the importance of affective learning factors, especially motivation to learn. (O'regan, 2003). Horton (2000), states that for students to succeed in distance learning, motivation and self-discipline plays a key role.

Currently, there are lack of e-learning studies which focus on the affective dimension of individuals (Zaharias, 2004). Zaharias (2004) had conducted a study based on an established methodology in HCI research and relied upon a conceptual framework which integrates web usability and instructional design parameters and associates them with a main affective learning dimension, intrinsic motivation to learn.

On top of that, several sets of recommendations for the evaluation of technical usability have been developed over the last twenty years (e.g., Shneiderman, 1998; Chin, Diehl & Norman, 1988; Nielsen, 1993; 1994; Lin, Choong, Salvendy, 1997; Preece, Rogers & Sharp, 2002; Chalmers, 2003; Tognazzini, 2003). However, pedagogical aspects of designing or using digital learning material are much less frequently studied than technical ones.

Nokelainen (2006) had done a study on the criteria for evaluating the pedagogical usability of digital learning material. The purpose of the criteria is not to brand any learning material as “good” or “bad,” but to help learners to choose the most suitable alternative for any particular learning situation.

Finally, a study on Universal Usability (Shneiderman, 2000) supporting a broad range of hardware, software, and network access, accommodating individual differences among users, such as age, gender, disabilities, literacy, culture, income, and so forth as well as bridging the knowledge gap between what users know and what they need to know about a specific system are the three main challenges faces by computer system developers.

The above mentioned usability parameters grouped as usability attributes, namely Web usability (Zaharias,2004), Pedagogical Usability (Nokelainen,2006) and Universal Usability (Shneiderman,2000), showed that there is a research gap and might has a relationship towards motivation to learn.

This research relies on Keller’s ARCS Model of Motivational Design (1983), in order to further analyze and interpret the motivation to learn construct. According to Keller (1983) motivation to learn construct is composed of four sub-constructs: attention, relevance, confidence and satisfaction.

3. Conceptual Framework

An extensive review on literature was conducted in search of a conceptual framework. Despite the growing profusion of the e-learning research, nevertheless there has been little exploration of affective learning dimension of learners. A conceptual framework was developed taking into consideration the needs of the user as a learner. This was achieved through examining the literature relating to web usability, universal usability, pedagogical usability with a special emphasis on motivation to learn aspect as the most important affective learning factor, Zaharias (2004), Nokelainen (2006), Shneiderman (2000).and Keller (1983,1987,1989). Table 1 presents studies conducted on usability attributes and motivation to learn.

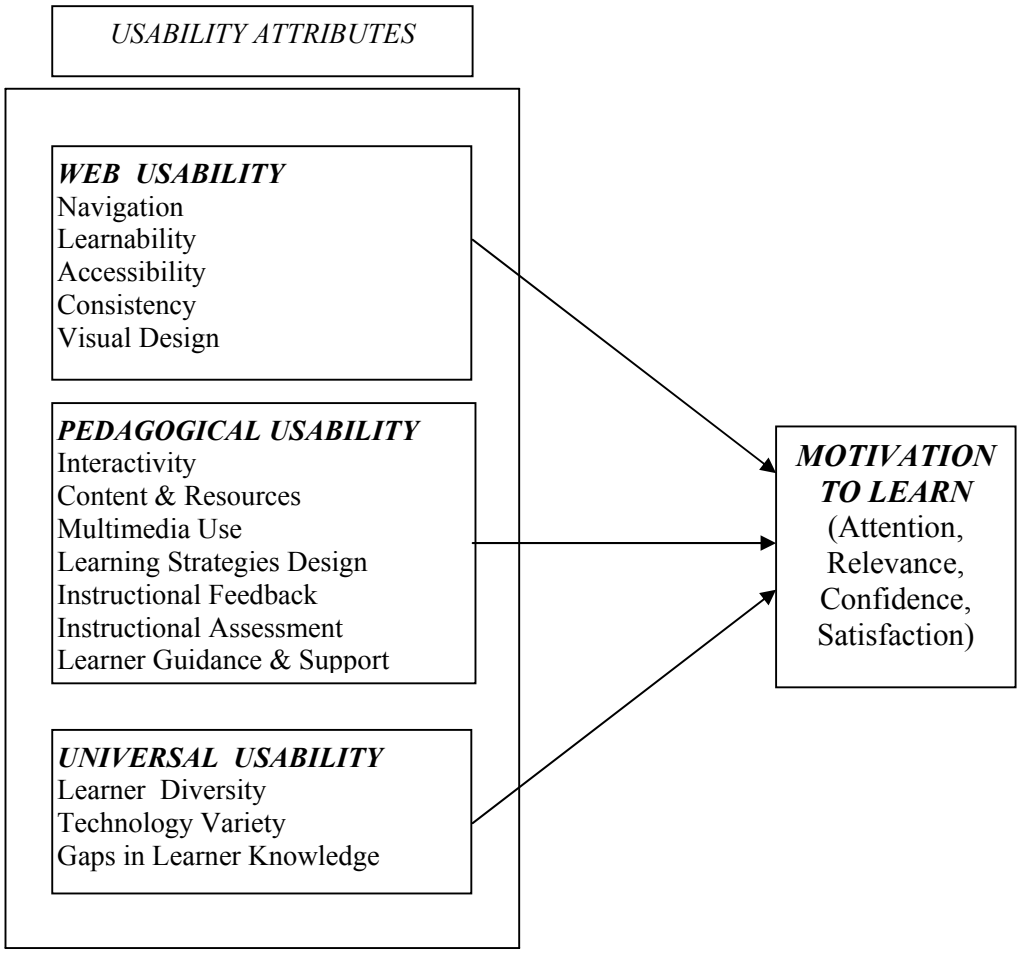
Table 1 presents a summary of usability attributes

Previous Research	E-learning Usability Attributes
Powell (2000); Lynch and Horton (1999); Nielsen (2000); IBM (2000); Weston et al. (1999); Evans and Edwards (1999); Stanton et al. (1992); Stoney and Wild (1998); **Reushle et al. (1999);** Ford and Chen (2000); Reeves et al, (2002); Shiratuddin and Hassan (2001)	**Navigation** : Supports the way learners move through the instruction and how the instruction is designed to facilitate understanding of *organization* and *structure of content.*
IBM (2000); Lynch and Horton (1999); Shiratuddin and Hassan (2001); Weston et al. (1999); Nielsen (2000); Horton (2001); Khan (2002)	**Accessibility** : It refers to loading time, browser compatibility, visual preferences etc.
Powell (2000); Reeves et al. (2002); Shiratuddin and Hassan (2001); Lynch and Horton (1999); Miller (2002); Khan (2002)	**Consistency** : It is about the consistent use of fonts, text, and various design features' placement (navigational aids, menu bar etc.)
Powell (2000); Shiratuddin et al. (2003); Nielsen (2000); Horton (2000); Shirley (1999); Morkes and Nielsen (1998); Stoney and Wild (1998)	**Visual Design** : It is about the design features' placement in order to minimize cognitive overload, attract learner's attention etc.
Weston et al. (1999); **Reushle et al. (1999);** Reeves et al, (2002); Hiltz and Turoff (2002); Laurillard (1995); Stoney and Wild (1998); Powell (2000)	**Interactivity**: It is about content-related interactions and tasks that support meaningful learning.
Lingaard (1994); Quinn et al. (1993); Guillemette (1995); Feldstein (2002); Al-Hunaiyyan et al. (2001); Reeves et al. (2002)	**Learnability** : It refers to the ease with which new or occasional learners may accomplish some learning task using the interface.
Silius et al. (2003); Reushle et al. (1999); Weston et al. (1999); Jonassen (1998); Smulders (2002); Reeves et al. (2002); Nielsen (2000);	**Content and resources**: It is about the design of learning content and resources necessary to support effective learning.

IBM (2000); Keeker (1997); Horton (2000)	
Herrington et al. (2000); Weston et al. (1999); Nielsen (2000); Keeker (1997); IBM (2000); Shiratuddin et al. (2003); Driscoll (2002); Wild and Quinn (1998); Clark and Mayer (2003); Horton (2000)	**Multimedia Use** : It is about the use and inclusion of several media in the e-learning design; must serve clear pedagogical and/or motivational purposes.
Brown et al., (1989); Tam (2000); Squires and Preece (1999); Jonassen (1994); Clark and Mayer (2003); Roschelle and Teasley (1995);Dillenbourg (1999); Jonassen (1998); Horton (2000)	**Learning strategies design** : It is mainly about interactions in that have been designed in accord with sound principles of learning theory.
Driscoll (2002); Spitzer (1996); Laurillard (1996); Merrill et al. (1992); Johnson and Aragon (2002); Horton (2000)	**Instructional Feedback** : It is about the provision of feedback that is contextual and relevant to the problem or task in which the learner is engaged.
Dick and Carey (1996); Smith & Ragan (1999); Govindasamy (2002); Weston et al. (1999); Twomey (1996); Brown et. al(1999)	**Instructional Assessment** : It is about the design of assessment opportunities that are aligned with the learning objectives and content.
Alexander et al. (1998); Horton (2000); Driscoll (2002); Jones and Farquhar (1997) Govindasamy (2002); Clark (2002); Clark and Mayer (2003); Wade (1994); Herrington et al. (2000)	**Learner Guidance and Support** : It is about the design of online help, documentation, and other tools that support and may guide the learner.
Shneiderman (2000), Nielsen (1991), Horton (2005), (Khan, 1997)	**Technology Variety :** It is about the need to provide learners with flexible and compatible hardware, software and networks equipment.
Shneiderman (2000), Nielsen (1991), Horton (2005); Khan (1997), Horila,Nokelainen, Syvanen & Overlund (2002)	**Learner Diversity:** It is about consideration on individual pecularities such as skills, age, gender, income and culture.
Shneiderman(2000); Nielsen (1991); Horton (2005); Baecker et al. (2000) Benyon(1993)	**Gaps in Learner Knowledge** : It is about how to overcome a certain gap in knowledge which occurs due to novel ways of manipulating e-learning system
Keller (1983, 1987, 1989)	**Attention**: It refers to arousing and sustaining curiosity and interest
Keller (1983, 1987, 1989)	**Confidence**: It refers to development of a positive expectation for successful achievement.
Keller (1983, 1987, 1989)	**Relevance**: It refers to learners' needs, interests, and motives.
Keller (1983, 1987, 1989)	**Satisfaction**: It refers to extrinsic and intrinsic reinforcement for effort.

Based on the previous studies on e-learning usability, a conceptual framework was proposed in Figure 1.

Figure 1 : Conceptual Framework



4. Research Methodology

Prior to the development of the questionnaire, a conceptual framework was established, which employs a) a combination of web usability, pedagogical usability and universal usability parameters and b) motivation to learn construct. According to the conceptual framework, usability parameters that were chosen from an array of studies for inclusion into the questionnaire are presented in Table 1.

4.1 Item Sampling

The usability parameters included in the conceptual framework were the main constructs included in the questionnaire. These constructs were measured with items adapted from prior research. Items were carefully selected so that to cover all parameters included in the conceptual framework. The items in the questionnaire were presented in groups relating to each parameter; the aim of the questionnaire was to capture usability parameters that seem to have an effect on motivation to learn when measuring the usability of e-learning rather than to develop an equal scale of each parameter (i.e. parameters represented by an equal number of items). The items were examined for consistency of perceived meaning by getting 5 experts to allocate each item to content areas. Some items were eliminated when they produced inconsistent allocations.

4.2 Pre-Test

Prior to completion of the questionnaire, a pre-test was undertaken to ensure that items were adapted and included appropriately in the questionnaire. A self-administered questionnaire was distributed to 20 respondents which had some prior experience with e-learning. Data obtained was analyzed mainly for response completeness; some adjustments were made and subsequently some items were reworded. The whole procedure led to the development of pilot-test questionnaire, which consisted of 68 items: 58 items measuring usability attributes and 10 items measuring motivation to learn. Criteria corresponding to each usability parameter were assessed on a 5 point Likert-scale, where the anchors were 1 for strongly disagree and 5 for strongly agree. There was also space for free-form comments.

4.3 Pilot Test

60 survey questionnaires were distributed among learners of Faculty of IT and Multimedia Communication, Open University Malaysia during the pilot test. The survey exercise was conducted in Semester January 2007. The respondents were asked to evaluate the e-learning courses which had already used and interacted with. They self-administered the questionnaire and for each question, were asked to circle the response which best described their level of agreement with the statements Only 53 survey questionnaires were fully completed. 7 were not return or have missing data. 29 male and 24 female were involved in this pilot test.

4.4 Pilot Test Analysis and Results

For the pilot test, a factor analysis was conducted, in order to identify the underlying dimensions of usability attributes of e-learning , as perceived by learners. 68 items representing 14 usability attributes as shown in Table 2 were factor analyzed using the principal components method with a Varimax rotation procedure to delineate the underlying dimensions of usability of e-learning.

The Kaiser-Mayer-Olkin (KMO) Measure of Sampling Adequacy was 0.889, which is comfortably higher than the recommended level of 0.6 (Hair et al., 1998).

The following criteria were used in extracting the factors: a factor with an eigenvalue greater than one would be selected (Hair et al., 1998). A principal components extraction with Varimax rotation was used. Using a criterion of eigenvalues greater than one, a 14-factor solution was extracted explaining 83.82% of the variance (Table 2). In order to assess the internal consistency of the factors scales, Cronbach's Alpha was utilized.

As Table 2 exhibits all factors show high internal consistency as indicated by high Alpha coefficients (ranges from 0.717 to 0.879), which exceed the recommended level of .70 (Lewis, 1995, Hair et al.,1998). In addition the composite variable *Motivation to Learn* shows a very high internal consistency as Alpha coefficient indicates (a =0.873).

Factors	Reliability Cronbach Alpha	Eigenvalue	Percentage of Variance Explained
Navigation	α =.822	24.155	37.742
Learnability	α =.862	4.913	7.677
Consistency	α =.812	3.921	6.127
Visual Design	α =.784	3.249	5.077
Interactivity	α =.717	2.976	4.650
Content & Resources	α =.835	2.254	3.521
Multimedia Use	α =.879	2.202	3.440
Learning Strategies Design	α =.862	1.877	2.933
Instructional Feedback	α =.870	1.789	2.796
Instructional Assessment	α =.784	1.571	2.370
Learner Guidance & Support	α =.855	1.340	2.094
Learner Diversity	α =.753	1.283	2.005
Technology Variety	α =.850	1.108	1.732
Gaps in Learner Knowledge	α =.847	1.056	1.650
Percentage of total variance explained			83.815

Table 2

Data analyses led to the refinement of the questionnaire and a more parsimonious solution has been reached with 14 factors representing usability parameters of e-learning : Navigation, Learnability, Consistency, Visual Design, Interactivity, Content & Resources, Multimedia Use, Learning Strategies Design, Instructional Feedback, Instructional Assessment, Learner Guidance& Support, Learner Diversity, Technology Variety and Gaps in Learner Knowledge.

4.5 Main Survey

A main survey was conducted in Semester May 2007. 1000 questionnaires were distributed to six OUM regional centres. The target population of the survey were learners from all Faculties. They self-administered the questionnaire and for each question, were asked to circle the response which best described their level of agreement with the statements. Out of the 1000 questionnaires that were distributed, 664 complete responses were returned and thus the response rate was 66.4%. Among them were 323 male and 341 were female.

4.6 Main Survey Analysis and Results

The Kaiser-Mayer-Olkin (KMO) Measure of Sampling Adequacy was 0.937, which is comfortably higher than the recommended level of 0.6 (Hair at al., 1998).

A principal components extraction with Varimax rotation was used. Using a criterion of eigenvalues greater than one, a 10-factor solution was extracted explaining 72.35% of the variance (Table 3). In order to assess the internal consistency of the factors scales, Cronbach's Alpha was utilized. Inter- item Cronbach Alphas values for all items are high.

As Table 3 exhibits all factors show high internal consistency as indicated by high Alpha coefficients (ranges from 0.917 to 0.826), which exceed the recommended level of 0.70 (Lewis, 1995, Hair et al.,1998).

10 items representing the *Motivation to Learn* construct shows a very high reliability as measured by Cronbach Alpha coefficient (0.937)

Factors	Reliability Cronbach Alpha	Eigenvalue	Percentage of Variance Explained
Consistency	α = .826	24.762	45.021
Visual Design	α = .870	2.744	4.989
Interactivity	α = .864	2.218	4.033
Multimedia Use	α = .882	1.871	3.402
Learning Strategies Design	α =.917	1.677	3.050
Instructional Feedback	α =.839	1.589	2.889
Instructional Assessment	α =.886	1.330	2.419
Learner Guidance & Support	α =.892	1.283	2.332
Technology Variety	α =.897	1.233	2.242
Gaps in Learner Knowledge	α =.896	1.087	1.976
Percentage of total variance explained			72.352

Table 3

5. Discussion

Motivated by the need to address the specificities of e-learning design a usability evaluation method was developed. The proposed questionnaire extends conventional web usability criteria and integrates them with criteria derived from pedagogical usability as well as universal usability so that to address specificities of e-learning motivational design and address the users as learners. The proposed method also extends the current practice in usability evaluation by measuring users' affective engagement and proposing *motivation to learn* as a new type of usability measurement. This new type of measurement has been tested for reliability: overall internal consistency of the questionnaire is very high.

Besides the accomplishments of this study there are still certain limitations that practitioners should be aware of. The first limitation has to do with the use of the questionnaire as a method to assess affective states. Questionnaires have been accused of being static methods that cannot easily detect more transient respondents' characteristics; further social-emotional expectations and awareness of the respondent can greatly influence what is reported.

6. Future studies

Firstly, future studies can be designed in order to address the above limitations. As already mentioned using a questionnaire as a method to assess an affective state has advantages and some weaknesses as well. Future research efforts can employ a combination with other methods so to gather other information about more transient characteristics and more qualitative usability data.

A combination of methods can give stronger results. Such methods could include the use expert systems and sentic modulation, which is about detecting affective states through sensors such as cameras, microphones, wearable devices etc. (Picard and Daily, 2005).Moreover, further consideration is needed to explore usability attributes and role of affect in e-learning environments.

Besides the confrontation of the limitations future research can focus on the following:-

- Use of the proposed questionnaire as a formative evaluation method. The proposed questionnaire can also provide useful design guidelines during the iterative design process as a formative evaluation method. Currently, the proposed questionnaire can point towards specific usability problems within an e-learning environment. A more systematic exploitation of using such method for formative evaluation can be realized through the development of a database where the results of a number of different usability studies can be stored so that the knowledge obtained can be reused.
- Benchmarking: The proposed questionnaire based can also provide benchmark information like other research-validated questionnaires (for example WAMMI) do so. This means practically that the usability of an e-learning could be tested against others. A

standardized database can be developed that contains the usability profiles of existing e-learning applications and, thus, can facilitate designers compare the usability of one application with a series of other e-learning applications.

- Focusing on other affective/ emotional states. Future research should seek a deeper understanding of the design issues that influence learners' affect and emotions. Emotions such as fear, anxiety, apprehension, enthusiasm and excitement as well as pride and embarrassment, (Ingleton and O'Regan, 1998, O'Regan, 2003) along with the flow experience (Csikszentmihalyi, 1975, 1990, Konradt and Sulz, 2001) can provide significant input to e-learning design and shed light in explaining learners' behaviour; such emotions and their assessment can also be taken into consideration in the next version of the questionnaire.

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