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A Framework for Combined Evaluation by Usability and User Experience in E-learning Systems

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Abstract—*E-learning has been a major disruptive change in the traditional education. The E-Learning packages not only have to be usable by the users but they should also lead to constructive learning. The motivation for a learner to learn involves the moment to moment experience that he/she undergoes with any learning system. In context of E-Learning therefore, it is important to identify these usability and user experience challenges which lead to effective learning. There is a need to assess the usability and user experience of an e-learning system along with the actual learning contribution of the e-learning system. This paper suggest a framework for combined evaluation of usability and user experience in e-learning systems while evaluating learning outcomes form a e-learning system.*

1. INTRODUCTION

The education system requires three entities, learning material, learner and teacher. Several theoretical models have been developed to understand and enhance these relationships [7]. The theoretical models have evolved over periods of time and have influenced the pedagogy of education system. The schemes and models of educational system have been introduced to improve education system [8]. Since advent of e-learning, these models of learning have been used to create and improve the e-learning systems as well.

In context of e-learning the use of these learning models can be used to understand the learning behavior of the learner, however unlike the traditional methods of learning the e-learning is mediated by technology and technology has its own layers of issues. The need to evaluate an e-learning system not only needs the effectiveness of the learning content and the method teaching to be evaluated but the influence of technology also needs to be evaluated both in tandem as well in isolation of the content. Usability of the interaction and the experience an interactive systems generates have been two concepts prevalent in human computer interaction community. Broadly speaking, while usability measures the cognitive aspect of the interactive system the user experience measures the affective aspect. The learning happens by application of both, the cognitive and affective faculties of the learner [2]. While the aim of the e-learning system is to impart learning, the evaluation of the e-learning system needs to also evaluate the usability and user experience of the interaction design along with the learning generated by the system. This paper proposes a framework for combined measure of the usability, user experience and leaning efficiency of the system.

2. E-LEARNING

E-learning can be defined as the effective learning process created by combining digital delivered content with learning support and services [8]. Long before when internet being launched, communication with the remote sources can be done and identification, monitoring and control over objects can be possible. This achievement has a great role in education technology, which provide distance/online learning feasible. Due to its digital content, one of the technologies that have fostered the most has been the internet, which provides many communication capabilities allowing students and learners to have a ubiquitous access to the contents of e-learning applications.

In 1924, first testing machine was invented by B F Skinner, Harvard professor. This computer based program (CBT) test the skills of a student in a particular subject. It is known as PLATO-Programmed Logic for Automated Teaching Operations. Today learning comes under World Wide Web (www). Every learning material is available in the educational web sites and other commercial and non-commercial web portals. Educational blogs, articles journal research papers and other electronic media. E-learning is being envisaged as major learning system in educational spaces. E-learning has a wide set of applications and processes which use all available electronic media to deliver vocational education and training [11]. The term covers computer based learning, web based learning and the use of mobile technologies; it includes virtual classrooms and digital collaboration. There are many techniques reported in the past research and their effects over education system these are online e-learning, m-learning, traditional learning and blend learning techniques[5][11][12].

Everything is now online and easily available on internet but still there is immense gap for evaluation of skill of the learner. Some specific online learning systems were evaluating based on human behavior and some are analyzing the performance based on total errors, reaction time and task completion time [9]. These factors will be no longer to test the ability of the learner and the learning system/module for future learning system. This paper proposed a framework to measure the specific skill through physiological parameters, like EEG, GSR, HRV and pupil size variation (using Eye Track device)[15][21]. These physiological parameters will be able to measure the learner's attention, arousal, engagement and cognitive load [16] [18] [20]. Also map the performance of the learner and help to re-design e-learning module. [21] By measuring physiological parameters during learning from e-learning module in real time environment can be able evaluate the skill of the learner and like this good e-learning module design will reduce the mental load and increase the performance.

3. MODELS OF LEARNING SYSTEMS

In traditional education system, two people were required, one who teaches and another who learns [7]. The way of learning started with small classes, less study materials and no technological support. The era was more focused about the educational relationship between a teacher and a student. The assessment of learning was based on teacher's sensitivity towards learners' learning related improvements.

Globalization and commercialization, changed the scenario of education system where the teacher and student relationship altered from personal level guidance to mass teaching [3]. Teachers were associated with their students at interpersonal and social bases in the past which has change to very formal and business oriented ecosystem in the present scenario. Moral values and ethics were the part of curriculum along with the regular pattern of education both provided by the teacher in classical ways of teaching [3]. The present model for education system has a confined approach towards teaching and learning methodology. The intervention of expert's written contents, communication media and computer based evaluation methods [1], all combine gives efficient learning system.

4. FIGURE AND TABLE CAPTIONS

The bloom's taxonomy [2] was a way to differentiate the basic learning of the education system. The bloom's taxonomy refer, educational objectives of a learning system in three sections i.e. cognitive, affective and psychomotor. Bloom's taxonomy as shown in figure1 details out the components of the triads of learning in a pyramidal structure.

Cognitive: skills in the cognitive domain consist of knowledge, comprehension, application, analysis, synthesis and evaluation.

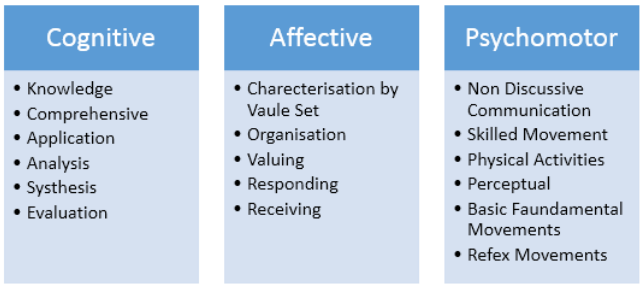

Fig. 1: Bloom's Taxonomy model diagram [2]

Traditional education tends to emphasize the skills in this domain, particularly the lower-order objectives. These set of skills were measured for assessment of learner's efficiency.

Affective: explains the importance of emotion in learning system. The ability to feel other's feeling and get connected with it. The factors involve in this domain were receiving, responding, valuing, characterizing and organizing.

Psychomotor: this domain involves with the ability to use sensory cues to guide motor activity. The perception and action on learning tasks. Set automata schemas for reading writing skills.

All the above explained domains were used for assessment of learner's ability.

5. EXISTING MODEL IN LEARNING SYSTEM

Kort's learning spiral model, [10] was proposed four quadrant learning spiral model shown in figure 2, in which emotion change while the learner moves through quadrants and set up the spiral. In quadrant 1 learner experiences the positive affect and constructive learning, quadrant 2, consist of constructive learning and negative affect which means due to puzzlement, confusion learning affect negatively. Quadrant 3, as earner try to solve the problem but fails, quadrant shows the discard and frustration in learning. In quadrant 4 anticipation lead to increase the positive affect towards constructive learning.

The Kort's also tried this model for evaluation of emotional processing during learning process. Some other learning models were also reported in the past research like Russell's circumplex model of affect [11].

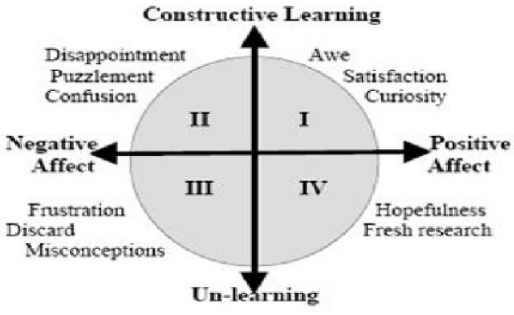

Fig. 2: Kort's spiral model, [10]

6. USER EXPERIENCES IN LEARNING SYSTEMS

Learning in a computer or web based environment was not simple, it need abundance effort in various domain [13] [14]. These learning environment was associated to human psychology, pedagogy, communication media and the evaluation methods for learners [7]. All these were attribute to one entity that was efficient e-learning system.

User experiences [4] in learning system involved the user mental modal towards the working pattern of the system. The user experience design for learning system requires the following capability in the system.

1. Strong communicate strengths of the system.
2. Create guided features and information.
3. Make the interface intuitive by building affordance.
4. Maintain consistency throughout the system.

All the capability of the system improves learnability, ease to use, memorability, effectiveness and efficiency [9].

7. USABILITY OF LEARNING SYSTEM

Usability terminology involves two thing one a user and object, object could be any book, application, hardware, software etc. To test usability of any learning system requires ease to use, efficiency, effectiveness, learnability and memorability, these are the principle components of usability engineering. These factors were used to evaluate moment to moment efficiency of the learner in a learning system. Usability of any system defines as making sure that something works well; and easy to use; an average person with average ability can use it [9]. Usability test the learner performance during given tasks of learning. The markers for the testing were counts of errors in task, time of task, Success/ failure rates and total number of mouse clicks etc. Also perform some behavior analysis of the learner during interaction with the learning system [14].

8. PROPOSED MODEL TO EVALUATE THE LEARNER EFFICIENCY AND LEARNING SYSTEMS EFFICIENCY

An e-learning system needs to be evaluated before it is put to use. The need is to assess the efficiency and effectiveness of the system in providing the learning to the learners. Here is the 'human' in human computer interaction of e-learning system has two roles to play. One is that of the user, the human that 'uses' the system for learning and that of the 'learner', the human that learns using the system. Evaluation of the e-learning system has to evaluate both the usage and learning provided by the system. The framework for evaluation proposed in this paper involves the theoretical model of learning provided in learning theories and the usability and UX models of evaluation provided in HCI literature.

This paper proposes that the combined measure for evaluation of learning system can be based on cognitive, affective and psychomotor dimensions of the blooms taxonomy. The usability and user experience measures can be combined along with the learning outcome measure on the other dimension. The tools to measure usability, user experience and learning efficiency can be combined by using combination of behavior analysis tool and physiological tool as shown in table1. The cognitive and psychomotor can be measures by usability testing protocols. The affective domain can be measured by physiological measurement systems like EEG and GSR devices [21].

Table 1: Combine measure for dimensions of the blooms taxonomy

	Cognitive	**Affective**	**Psychomotor**
Learning	Knowledge, Comprehension, Analysis, Synthesis and evaluation	Emotions, Receiving, Recording and Valuing	Perception, Skilled, Movement and Physical activity
Usability	Ease of use, Memorability and Learnability	Satisfaction	Efficiency and Effectiveness
User Experience	Intuitive, Information, Presentation and Thinking	Engagement, Frustration, Stress, Fun and Disappointment	Attention/ Alertness

The proposed framework for evaluation methods in e- learning based on usability and user experiences a combine measure, as shown in table 2.

Table 2: Proposed evaluation methods based on extension of bloom's taxonomy classification model: for evaluation of e-learning system

	Cognitive	**Evaluation Methods**
Learning	Knowledge, comprehension, analysis, synthesis and evaluation	Post Learning Test
Usability	Ease of use, Memorability and Learnability	Completion Time of Tasks, No. of Mouse Click and Post Use Questionnaire on Interaction [8][9]
User Experience	Intuitive, information presentation, Fun and Thinking	EEG and GSR [16]
	Affective	
Learning	Emotions- receiving, responding and valuing	EEG & GSR
Usability	Satisfaction	Post questionnaire
User Experience	Engagement, Frustration, Stress, fun and disappointment	Eye track, EEG and GSR [16]
	Psychomotor	

Learning	Perception, Skilled movement and physical activity	EEG [16] [18]
Usability	Efficiency and Effectiveness	Total Error on Task and Success and failure Rate[7]
User Experience	Attention/ Alertness and arousal	Eye track, EEG and GSR[17][18][20]

9. CONCLUSION

It is assumed that the e-learning involved with both cognitive and emotional learning models both are important for constructive learning. E-learning technology consist of three major blocks such as internet, machine/computer and user. E-learning emerged as human computer interaction domain. In e-learning, measurement of learning efficiency or assessment of learner are playing important role. For this learning, usability and user experiences attribute was introduced in the blooms taxonomy to evaluate the E-learning system. The behavioral and physiological data both provide the measurement of learning efficiency. Therefore, framework for combined evaluation of usability and user experience in e-learning system was proposed.

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