Assessment of E-learning Systems: A Systems Engineering Approach System

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Abstract-*This paper is on the issue of assessment of E-Learning systems. The originality of the work is to identify main drawbacks mentioned in the literature and propose a systems engineering framework approach.*
E-learning is more and more used and mainly in developing countries. A large number of E-learning systems have been developed in the institution around the world. These systems can be assessed using multiple dimensions and criteria. KSA started implementing the E-Learning since 2002. Although of this evolution up to our knowledge, limited research work have been carried out on assessing such system. In response to this limitation this paper is a preliminary research study that attempts to propose the requirements list needed to develop a reliable technique or methodology to evaluate an E- learning system. The contribution of this position paper proposition of a framework for future research as seeing ELearning as a system as any other system, and hence the assessment becomes a partial validation of the systems with respect to requirements. Requirements can be criteria of ABET accreditation. The methodology will be based on best practices of systems engineering approach.

Keywords: ELearning, systems engineering, modelling, Assessment, Evaluation Criteria

1 Introduction

Technology affects all the fields of our life. Learning is a critical field; so the impact of technology should improve the learning process [1]. All institution strive to achieve high education outcomes. In a suitable way for every course separately and within the whole program curriculum.

Electronic learning is simply to apply the use of electronic devices to improve and facilitate the learning process [2]. The development of electronic learning tools and web technology lead to start the distance learning which allow synchronous, asynchronous, and self-learning. For all of that many Learning Management Systems were developed and used in many institutions.

E-Learning must go through evaluation process to check its capability for achieving the outcomes expected from using it. Such outcomes can be requirements set by an accreditation body as ABET or specific to the education body.

"ABET, Inc.", formerly named Accreditation Board for Engineering and Technology, developed a system for accreditation of engineering programs that includes 8 criteria [3]. The criteria are: Students, Program Educational Objectives, Student Outcomes, Continuous Improvement, Curriculum, Faculty, Facilities and Institutional Support. "ABET accreditation provides assurance that a college or university program meets the quality standards of the profession for which that program prepares graduates" [4].

Till now there is no approved and accepted evaluation system of E-Learning [5]. To have a good E-Learning that fulfills the needs for high quality learning environment, E-Learning requirements should be defined first.

The expected outcome of this paper is a preliminary work on state of the art and propose a system engineering approach. By proposing a categorization of selected criteria for designing and assessing the E-Learning system. These criteria based on leaning quality standards and technology standards.

2 Background

Interest in E-Learning has increased after its evolution in higher education in KSA, the reason of that its ability to overcome the obstacles of delivering the education services to all population. Some of these obstacles are: First, KSA Islamic culture and isolation education campus for both male and female with limitation of the human resources and other facilities. Second, the large number of people who tried to apply for higher education. Third, personal reasons

which prevent individuals from enrolling in the higher education. After this growth of applying E-Learning it's the time to investigate if E-Learning is a good solution for overcoming these limitation of spreading the education. Actually a very little researches had been done in the field and further contribution is a need [6].

Ministry of Higher Education launched a National Center of E-Learning in 2008, to deliver the E-Learning in KSA universities [6]. On 10/8/2011 the Saudi Electronic University (SEU) was launched as a first government educational institution which for graduate and undergraduate degree programs. It aims to support the lifelong and self-learning [7].

3 Related work

The rapid development in technology and communication methodologies affects positively the improvement of the learning process [1]. Systems need to be checked to ensure that they meet the learning objectives. A relevant researches, performed around the world for this purpose. Interested way was established by number of researchers, their approaches were attempting to evaluate the E-Learning from different aspect by defining the main criteria for evaluation for every aspect.

3.1 Stakeholders

As in the literature, E-Learning system has number of stakeholders, understanding of various stakeholder‘s needs and expectation with having all information about the level of restriction will help in developing a good requirements list for E-Learning evaluation. Students and instructors are key entity in the learning process, their role will be E-learning instead of learning, as E-teaching for teachers, number of challenges arise from both side's students and teachers [1]. Students and faculty are one of the ABET accreditation criteria. Number of questions should be answered:

- Who are the leaner?
- Is this first E-Learning program to be conducted?
- Is there a need to change their performance?
- Do all learners have same chance of learning availability?

Student and program outcomes should be met by the E-Learning system by enforcing the procedures to ensure that.

In [1] authors see that the students are very critical factor for initiating ELearning, the learning success depend on the students acceptance and enjoyment of the learning process, a good researches have been done to check the students attitude regarding the EL education and its impact on them. Taking in consideration different factors affect their attitude such as gender, self-efficiency in using computer. This result will help the designer of E-Learning and LMCS to make their designs more effective [8].

Others who affected by E-Learning and who will affect the success of it, are not only these two item but also Employers, Educational Institutions, Content Providers, Technology Providers and Accreditation Bodies [9] [10].

All system stakeholders should be analyzed, to identify everything that may has influence on the learning process through the ELearning Systems. Even within each stakeholder you will have different characteristics that will influence the acceptance of E-Learning systems.

3.2 Design and usability

Design and usability of the E-Learning system have a good weight in the system quality evaluation [8]. Quality means meeting the user expectation. Different dimensions of quality should be defined and appropriate evaluation should be conducted to each dimension [11].

Software engineers always attempts to have a best implementation of the E-Learning systems before design them [12]. Institutions should has appropriate infra-structure, the courses should be redesigned to keep the learning process effective as possible, and Instructors and students must have the needed skills for using E-learning system. An evaluation technique was implemented on public universities in Kenya also concentrated on usability of Moodle E-Learning. The usability evaluation based on number of factors: learnability, user-friendliness, technological infrastructure, usability policy, culture and gender. The finding of that study was the learnability and friendliness highly affects the usability [13].

Different categories are integrated to evaluate the design and usability of the system: user experience, accessibility, hardware and software, layout, and other system details [14].

3.3 Effectiveness

Other researcher suggested a framework to evaluate the effectiveness of E-Learning process which focused on four dimensions: readiness, course delivery strategies, quality of E-Learning and effectiveness blended ELearning each of these four dimensions has components and number of items for every component [10] [15].

In [15] an investigation was conducted to find the factors that has impact on the E-Learning effectiveness. The finding of that investigation the ten different dimensions of the E-Learning effectiveness: technology, pedagogy, motivation, usability, content and material, support for

learners, assessment, future- direction, collaborative and interactivity.

3.4 Multi criteria evaluation

There are number of learning system adopted at many universities WebCT, Blackboard, Moodle and other systems. Some researchers consider number of factors affect E-Learning in addition to stakeholder as: material and capability of learner [2].

A survey was applied at SMCS (School of mathematics and computer science) for student who enrolled in ELearning system in programming, analysis and design, and object oriented programming courses. In years (2009-2011) for three different systems Edunet, Moodle, Canvas [12]. The survey used four different aspects: Learner interface, Teaching community, System Content, and Personalization. Each of these four aspect has different criteria used to check the quality.

It was implemented to evaluate the E-Learning course by applying 73 items according to number of characteristics. The study concentrated on the course design, they found that evaluating usability is part of quality which concentrates on the design of different part of the E-Learning system and the authors mentioned that a lot of usability problems still unsolved.

4 Drawbacks

Despite all these effort no approved international quality standards defined for E-Learning. The main limitations of the previous research is that they concentrate on the technical issues, and very few studies concentrate on the knowledge side. In addition to that not all evaluation characteristics have been analyzed which are: flexibility of the system, can be used to evaluate different types of courses, Simple, Reliable and Economical.

Any systems can be assessed only performance criteria set at the requirements levels. Such requirements are traced forward and backwards as to satisfy such criteria. We believe, in that context, that such requirements are not well set with respect to all stakeholders being high level stakeholders as managers, ABET authorities and low level stakeholders as students and teachers.

“TAFE means Technical and Further Education. TAFE in New South Wales comprises 10 institutes which cover different geographic areas of the state. Each Institute has more than one campus. TAFE NSW is Australia's largest training provider, with over 500,000 enrolments every year” [16] . Below are some criteria proposed by TAFE NSW.

-The ability to transfer skills to different training environments and learner groups

-Evidence of the preparation of a minimum of two delivery plans:

-One of these delivery plans must address a learning program that is linked to competency standards

-One delivery plan should address the whole or substantial part of a learning program and contain session plans for a series of training sessions

Assessment must also include evidence of both developing and contextualizing learning activities for the delivery plan and of developing new learning materials such as handouts, overheads etc and organizing the material and physical requirements for delivery.

5 Proposed methodology

To investigate the characteristics and requirement of a high quality E-Learning system with respect to all stakeholder point of view, a deep reading of relevant literature had been conducted. After investigating and searching good repositories as IEEE, IGI, Google Scholar, and Electronic world library using related key words. With the search result mind mapping process was conducted to classify the E-Learning evaluation criteria and hierarchal framework according to the importance of each category was developed. At this stage we are trying what suitable approach can be carried out and we believe that systems engineering approach can be beneficial as first step towards such methodology

5.1 Towards a Systems Engineering Framework for E-learning

In previous researches all agree on the need of evaluation approach for E-Learning system. The tools and techniques which were used in these researches were used several criteria and items [13]. Like any technology system E-Learning systems should fulfill the relevant overall learning and teaching requirements [17]. To have such integrated evaluation system, all different E-Learning aspect’s criteria need to be checked and evaluated. These criteria should be defined.

5.2 Systems engineering:

System engineering is an art to develop a system that satisfies the needs, concerned of building effective and efficient system which satisfy the requirements of stakeholders. System engineering discipline consist of: product development, (V&V) methods to assess system quality, and cost. In system engineering the requirements collected for every part of the software then these requirements integrated to understand the whole system [18].

5.3 Towards a systems engineering approach

Many work have been developed by systems engineering community on assessment and validation of education systems. Up to our knowledge, this approach has never been extended and deployed for E-Learning systems. In that respect, we can see dual complementary approach. The first is to make assessment of an education system as ABET accreditation type for a specific course and then the second is to build the associated E-Learning systems and make sure that objectives are met by using E-Learning systems. Hence such systems engineering approach will have in the next research goals to have a computer aided systems for E-Learning improvement; this is will be refined in the sequel.

5.4 Requirements and validation

As suggested earlier in the 5th part, we consider E-Learning systems and associated requirement and show that assessment is partial validation. Complete validation can of course be done only through formal validation and of course experimentally validation

5.4.1. E-Learning requirements

We can set requirements for any systems to be developed. The question is to go back to the basic: what were the objective of E-Learning. Possible requirements:

- were the objectives same as learning objective of ABET
- Were they different and hence why E-Learning just as distance learning
- E-Learning can it be a lecturer support
- Can be mean to cover the need for lecturer
- Are they addressed to any level, any discipline, any context

So we need to overcome the requirement issue for any E-Learning systems before embarking into its evaluation.

5.4.2. Assessment as a partial validation

We present here the main items related to the V & V process, its complexity and main related techniques. There is a large influence from the software engineering technology. Our aim is therefore clear, we must work on procedures to reduce the V &V efforts or to reduce its complexity. This is achieved in this work by developing a framework.

In V & V , we have many views and aspects. We give the sequel the various views, each view is as important as the other. These views do correspond to the steps/phases encountered in DoD 2167A and the ED-79/ARP 4754 of the european organisation for civil aviation equipment (EUROCAE) IEEE-P1220 . We are interested by consistency relationships; the following types of consistency relationships

Requirements <-> Requirements : The challenge for consistency verification is to use standard approaches that have been experimented with the integration of automated V & V. In our work , we are more concerned with such specific phase;. Other following phases are more mature in their respective domain. General objectives and requirements at this stage in system development are the most keen to errors and inconsistencies. Our approach is to translate informal requirements into semi-formal or formal requirements. Candidate methods are statecharts/activitycharts for the semi-formal specification and VDM for formal specification. Tool support is available for both software specification in particular and for system specification in general; we make use of extensions and interfaces of support tools through exchange format as STEP.

Requirements <-> Design : Requirements define the functional behavior of a system while design models define the internal structure of a system. Consistency between design models and requirements is concerned with whether the design model exhibits the required behavior and satisfies all the constraints.

Design <-> Implementation : During the development, the system must not only implement behavior as implemented by the design model, but models themselves may need to change based on discovered limitations of an implementation environment.

Inconsistency management : The framework is method independent. Approaches used in the software industry and developed at NASA (IV&V lab) are based on the viewpoints paradigm. Global consistency is achieved though a series of pair-wise consistency checks between viewpoints.

State of the art in SE standards : We look here at the V&V issue through SE standard views. The definition concerning validation and verification varies from standards to another; we will not consider the terminology aspect in this paper.

Requirements validation in IEEE : Validation consists of two types of activities: (1) evaluation of the requirements baseline to ensure that it represents identified customer expectations and project, enterprise, and external constraints and (2) assessment of the requirements baseline to determine whether the full spectrum of possible system

operations and system life-cycle support concepts has been adequately addressed.

We believe that Assessment can be considered as partial validation for any system design and implementation. In this respect we will be using standard EIA 632 where we have seven items of validation and verification; we mention briefly these validations

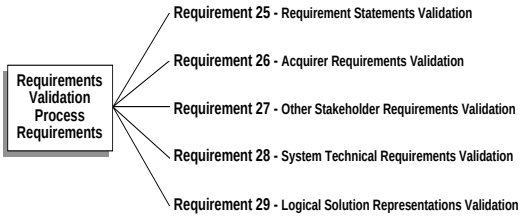

Figure 1. Validation Process Requirements

5.5 The proposed framework

The proposed framework of E-Learning evaluation criteria attempts to combine the effort of several researcher. And the criteria representation was merged with ABET criteria. The main aspects of the proposed framework criteria shown in Table 1.

5.6 Modelling dynamic lifecycle

The lifecycle of E-Learning systems can be modelled in the next research with Petri nets, colored version; and the tool being used on CPN developed at Aarhus University [19].

6 Conclusion and future work

It's very important to have an evaluation technique for E-Learning systems, to make sure that the learning process give a high quality learning outcome according to the market demand and comparing with the quality of the accredited curriculum.

Developing of professional technique require a detailed requirement list, to know which criteria should be checked to ensure the quality of the E-Learning systems. We proposed a list of criteria which need improvement and also for each criteria all items should be defined. And that will help to develop different models to evaluate every aspect of the E-Learning process. Considering the discipline of system engineering while developing any EL system or tools, with a very deep analysis of the EL environment will lead to a strong system. Then the system will be able to undergo the evaluation process.

We gave in this paper a possible direction of research on assessment of E-Learning systems. We will use V& V approach pruned in systems engineering and modelling the dynamics of such model with UML for information model and dynamic model with Petri nets.

Dimension	Factors	Items
Stakeholders	Instructors	Teaching Effectiveness
		interaction Level
		Satisfaction Level
		Teaching Effectiveness
		interaction Level
		Satisfaction Level
	Students	Student Characteristics Level of attainment Familiarity with technology interaction Level
	Contents Providers	Learning Resources Multimedia Comply with standards Appropriate Content
	Technology providers	Training Technical Support (Hardware & Software)
	Employees	
	Developer	Services design Website Utilization Communication tools Tools Website usability
	Accreditation Bodies	Guidelines for requirements

Table 1. E-Learning Assessment Factors

Dimension	Factors	Items
Organization	Department	Academic Affair Administrative Affair Assessment Virtual Class Learning Outcome
	Student Learning Management	Student tracking Time management Learning tracking Use of e-portfolios
	Technological infrastructure Policies on e-learning staff representatives E-learning special funds	
Technology	Infrastructure Readiness Support Cost	Hardware Software
Environment	geographic Location	
	Social Factors	Ethics Information Access Culture
	Learning Style	Asynchronous Synchronous Self-Learning
	Culture Awareness	Learning culture Change in study habits
Pedagogic and curricular	Match to the curriculum Effective learning	
Quality E-learning Systems	E-learning Management System Design	Adaptability of course module platform
		Ease of navigation
		Consistency of course module platform
		User-friendliness
		Multi-culturally appealing
		Accessibility of course module content
		Event management
		User management
		Security of user data
		Collaborative learning
		Interactive learning
Effective Blended E-Learning	Impact on E-learning Readiness, Quality of E-learning Systems and E-learning Course Module Delivery Strategies	Student retention
		Student access to learning
		Cost effectiveness
		Performance and quality of lecturers
		Academic achievement
		Improvement of research and education

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