Towards An Online Individualized Multimedia Instruction Model for Engineering Education

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Abstract: The quest for effective teaching learning strategies and instructional approach in Engineering Education has been one among the challenges that continue to be of interest to educators in Jordan and throughout the world. The advancement of computers and communication technologies throughout the past decade has had major effects on our daily life. Although computers and their applications have enhanced the quality of many classroom lectures and played crucial role within the improvement of Engineering Education, providing both teachers and students with a lot of options and flexibility in their learning teaching process, with the Internet and computer technology available to most teachers and students, educational technology becomes more and more necessary in the field of Engineering Education [19]. The purpose of this paper is to develop a model of learning that caters for engineering learners with diverse pace of learning and backgrounds. The most challenge will be to implement this model on the engineering program. This study proposed an individualized multimedia instruction model for engineering education.

Key words: Individualized learning; Online learning; Multimedia instructions

INTRODUCTION

The field of E-learning has reached a new high in popularity due to the Web and a variety of different products trying to meet the needs and supporting of Web and the electronic learning teaching process in the electronic world with its challenges like virtual universities or virtual classrooms. Just introducing technology into teaching and learning process does not make them more effective and more efficient. The technology must be used as a cognitive tool to facilitate creativity, problem-solving, analysis and evaluation (Dietinger et al 1998).

Continual advancements in information and communication technology (ICT) such as virtual reality, fast speed access, networked communities, advanced computer graphics, rich and relevant online resources will constantly change learning environments and provide for different ways humans of learning (Phillips 2001). McKeachie (1994) states that “in the twenty-first century distance learning and teaching are technology revolutions which will make a transition from traditional classroom to Distance education”. Mainly, the online learning is based on computer technology, where teaching and learning have developed positively in a dramatic way. Online course delivery has become an attractive option for expanding the educational opportunities available to students. These opportunity and flexibility of online course delivery change roles on the learning and teaching process and give more options for taking into consideration of many factors to be well defined and treated in the design of online courses (McKeachie 1994).

Knowing the learner is the first stage of the effective learning and teaching design process, in order to set an objective which he will be able to achieve, there must be a teaching style that is compatible to his learning style, which facilitate class preparation, design the class delivery methods, choosing educational technologies, and developing sensitivity to differ student learning preferences within the distance education environment (Duffy et .2003; Felder, Silverman 1988). A study from the British Audiovisual Association showed that people retain 10 per cent of what they see, 20 per cent of what they hear, 50 per cent of what they see and hear and 80 per cent of what they see, hear and do (Omar et 2002). They emphasized the use of multimedia in online environment can increase the level of student's participation and information retention.

Statement Of The Problem:

Students need more interactive teaching learning approach to provide them with the opportunity to expand their knowledge and to have enough time and possibilities to practice what they learned so as to achieve their learning goals (Duffy et .2003). Deliberation or intention to govern pace, method and contents will insure the knowledge acquisition. Learning styles and backgrounds of student are the pace; the method includes the instruction design to base on specific learner characteristics which implies alternative instruction methods for student with different learning styles and backgrounds. Whereas for the content includes the material to be learned. These three variables define the individualized instruction approach to instruction (Snyder 2003; Felder, Silverman 1988).

The Information Technology integrates the learning environments for instruction and learning process which can greatly increase the information horizons of students in terms of both access and structuring. This
allows effective interactions across both time and distance (Duffy et al. 2003). The utilization of multimedia instruction systems in teaching and learning is growing rapidly. The integration of various media assists educational reform and is important to the improvement of education. Multimedia Instruction is quick rising as a basic skill that university graduates must possess within the 21st century (University of Texas 1995). Online multimedia Instruction has the ability to increase learner motivation by providing both greater learner autonomy and increased options for support. Its benefits may vary from simple e-mail lists, through multifunctional virtual learning environments to totally adaptive learning environments enabling individual courses to be created and delivered in step with learning objects and on demand based on learner preference and performance.

This research will develop an individualized multimedia instruction model for engineering education.

Individualized instruction is student-centered. It focuses all activity on the needs of each student in his efforts to achieve predetermined specific objectives. It responds to individual student abilities in three ways: (i) Multiple sensory approach to teaching; (ii) increased student activity, that helps him internalize his learning; and (iii) sufficient time to overcome student weaknesses (Snyder 2003). Snyder emphasis is on the student, the teacher’s role is more demanding. Individual learning activity must be prescribed for each student in line with his pace. The teacher becomes more professional and assumes the role of learning guide and consultant. The teaching staff is responsible for the creative development and effective use of the instructional media. The individual teacher manages the learning process of diagnosis, prescription, and evaluation. Snyder explore that student is doing more than he did in conventional systems. Experience is the best teacher, and student activity is the experience by which he learns. Individualized instruction is attained through the Instructional System Development process (Snyder 2003).

Many studies on online learning have focused on Internet and Web features, designing Web-based instruction, and student attitudes and participation in Web-based courses. Many of reports describe the purpose, content, and structure of online courses, as well as the pedagogical aspects of online course delivery (Alabama Center for Research on Online Learning 2001). However, despite the large volume of research published at this time, most reports include little discussion of the way to develop a model using the multimedia instructions and online learning to individualized the engineering learning.

With the flexibility of online individualizes multimedia instruction model it is hoped to solve the engineering programs problems described above. By firstly minimizing the problem of students’ number compared to the teachers’ number by the delivery method, secondly the mismatch between student and teachers learning style by giving the possibility to each student to learn according to his learning style and also by giving the teacher the possibility to teach every student according to his learning style. He chooses the teaching techniques according to student pace and multimedia instruction to assist the teaching strategy that best solve the mismatch problem then he uses the online method to deliver the individualized course. This can result in an effective outcome of the learning and teaching process. Also with the online multimedia instruction engineering education can address all the acceleration changes within the field of engineering science smoothly and instantly with minimum cost and efficient ways (Snyder 2003; Felder, Silverman 1988; Duffy et al. 2003; Alabama Center for Research on Online Learning 2001).

For all of the above this research is needed to develop and validate an online individualized multimedia instruction model and investigate its effectiveness on engineering students.

System Conceptual Framework:

Within this needs this research proposed a conceptual framework for Individualizing the engineering education under the name of Online Individualized Multimedia Instruction Model (OIMI). This conceptual framework will be used as a framework to deliver the Communications Skill course in 2012-2013.

The proposed model consists of multi stages corresponding to student, instructor and administration. The student is within the center of this cycle. The first stage before student registration deals with detecting the paces of their learning in the form of learning styles and backgrounds. For detecting learning styles, the Index of Learning Styles (ILS) questionnaire will be used (Felder, Silverman 1988). Also during this stage to know learners background demographic information request sheet will be used. The second stage deals with the authoring courses activities, this can be done using backboard course management system and multimedia software’s corresponding to learners’ paces. Performance objectives to identify the specific knowledge, skill, or attitude the learner should gain and show as a result of instructional activity will be used to determine different forms of courses activities (e.g., lectures, assignments, examples, exercises, self-assessment tests, feedback, discussion forms, course outline, calendar, useful link, and questionnaire). Finally is the dynamic stage to produce and generate courses that match the learner's paces. This can be done by assigning the authorized activities from the instructor stage to individualized online course as recommended by literatures mainly by Felder-Silverman learning style model in Engineering Education (FSLSM) (Felder, Silverman 1988). At the end of this stage the individual courses will be presented to the learners via the interface of the blackboard course management system.
Purpose Of The Study:
The purpose of this research is to investigate the effectiveness of Communications Skills Course delivered in Online Individualized Multimedia Instruction Model orientation.

Research Questions:

RQ1. Is the measurement scale for individualized learning (IL) construct-valid?
RQ2. Is the measurement scale for Multimedia instructions (MI) construct-valid?
RQ3. Is the measurement scale for online learning (OL) construct-valid?
RQ4:   Is the measurement scales for the developed theoretical model of OIMI construct-valid?
RQ5.   Does the multimedia instructions (MI) influence individualized learning (IL)?
RQ6.   Does online learning (OL) influence individualized learning (IL)?
RQ7.   Does a relationship exists among individualized learning (IL), multimedia instructions (MI) and online learning (OL)?

The Research Framework:
As illustrated in Figure 1.2, there are three unobserved variables also known as latent or dependent variables. All of them – Individualized learning (IL), Multimedia instruction (MI) and Online learning (OL) are indicated by orange circle. The first dependent variable, IL, is assumed to cause variation and co-variation between the three observed variables or indicators represented by green boxes on its left, indicated by arrows from the dependent IL variable. The three indicators or observed variables are pace, method and contents. The second unobserved dependent variable is MI. As a latent or observed variable, MI is also assumed to cause variation and co-variation between the six observed variables or indicators represented by another six green boxes on the right side, indicated by arrows coming from the dependent MI variable. The observed variables for MI are Modality, Contiguity, Personalization, Coherence, Redundancy and Signaling. The third unobserved dependent variable is OL. As a latent or observed variable, OL is also assumed to cause variation and co-variation between the two variables, the model consisting of one first order factor with one measured indicator variable and another one 2nd order factor with three measured indicator variable as shown in Figure 1.2. This model indicates the latent variable, online learning (OL), to be measured by one observed variables, which is Autonomy of the Learner and one unobserved variables which is Dialogue. The unobserved variable namely the Dialogue is measured by three observed variables; Students Instructor Interaction; Students Content Interaction and Students interaction.

The observed or indicators represented by green boxes on the bottom side, indicated by arrows coming from the unobserved OL variable.

The three unobserved dependent variables later will make up the hypothesized confirmatory factor models. The survey study will comprised a two-phase analysis. The first phase involved the analysis of the unobserved dependent variables which acted as exogenous variables that influenced the formation of endogenous variables. The endogenous variables are respective indicators or observed variables for each of the dependent variables.
The proposed research framework comprised the following aspects: (i) the formation of IL, MI and OL, (ii) the relationships between MI and IL, OL and IL, MI and OL and (iii) the overall relationship among IL, MI and OL.

Fig. 1.2: Research frameworks

The first-phase analysis will attempt to investigate the confirmation of factors which were assumed to influence the formation of IL. The factors are pace, method and contents. Secondly, the study attempted to investigate the confirmation of factors which were assumed to influence the formation of MI. These factors are Modality, Contiguity, Personalization, Coherence, Redundancy and Signaling. The last investigation in the first-phase analysis will attempt to investigate the confirmation of factors which were assumed to influence the formation of OL. The factors involved in this investigation are Instructional Dialogue and Autonomy of the Learner. The second-phase of the analysis will attempt to investigate the influence of MI on IL, OL on IL and the effects of OL on MI. To determine the overall effectiveness of the (OIMI) model the three measurement models - IL measurement model, MI measurement model, OL measurement model- will be integrated into a structural equation model to find out if a relationship exist among them.

To conclude, the proposed research framework, as illustrated in Figure 1.2, describes the narrative part of the research novelty, the research objectives and also the scope of the research.

Method:

The research will comprised both the quantitative and qualitative research methods in collecting and analyzing data. The triangulation of both methods will be intended to enhance the balance of data collection and analysis in this research. Neumen said “it is better to look at something from several angles than to look at it in only one way” (Neumen 2003). Using the triangulation of measurement on OIMI model will facilitate seeing all the aspects of the interactions within the learning environments.

To develop the OIMI model that caters for learners pace it is necessary to involve as many users as possible in the development process to increase their influence on tasks that should be supported by the model and to make sure that user acceptance is high. Therefore Rosseni’s theoretical empirical based design and development approach which consist of six main phases: feasibility study needs Analysis, system Design, system development, Training and Implementation, System Maintenance and Model (Din 2010). Development will be adopted in this study to develop the OIMI model. According to Rosseni this method is named as “the iterative triangulation participatory design and validation method or in short the Participatory Design (PD) method” (Din 2010).

Knowing and learning take place in a dynamic system of people, practices, artifacts, communities, and institutional practices. Participatory design allows end users to become part of a design team as well as to test the usability of a system. Therefore, when they are actively involved within the design process, the system requirements and system design can be refined iteratively. In this session, the end users will sit together with the developers and designers to discuss their requirements (Osman, et al. 2009).

Butler & Fitzgerald as cited in Osman and Baharin mentioned that participatory design activities have indeed contributed to the development of systems that adequately captured user requirements and hence satisfied user informational desires (Learning Solutions Magazine 2011). Baek and Cagiltay (2010) clarified that participatory design is a “user-centered design approach in which users are actively involved in the design process of a system or product that addresses their specific needs.”
As suggested by Rossen’s theoretical empirical based design and development approach, before getting to the model developmental process, the study will design various types testing and evaluation instruments(Din 2010), beside selecting and developing various types of instructional media and interface for the engineering communications skills course for the OIMI implementation. Before the implementation process took place, the validation of the instrument that will be used to measure the variables will be conducted. This will be done in order to provide evidence on the efficacy of the OIMI model that cater for learners needs. This study will adopt mainly a quantitative research approach although in some parts throughout the early and final phases of the study, the qualitative approach will be adopted to analysis electronics forms from blackboard course interface and emails. According to the adopted approach the research design will follow six phases.

**Phase 1: Feasibility Study:**
Feasibility Study is an organismist way of looking at particular problem, its possible solution, and most importantly, whether the solution will work. Reviewing the strengths, weaknesses, opportunities, and threats faced by a project helps developer target the large image. In some organizations, leaders might not need to approach a brand new trained unless they grasp they will dominate it. They believe that the challenges faced ought to be clearly outlined, at the side of the implications of failure (Hoagland and Williamson 2000).

The purpose of the Feasibility Study for this research is to investigate the technical, operational and economical feasibility of developing OIMI model as an alternative way to conduct course for engineering student at Al Al Bayt University in Jordan. A small-scale quantitative research using the open ended questioner instrument to address three types of feasibility studies will be used.

**Phase 2: Needs Analysis:**
Online Learning enables, evaluates and empowers everyone to acquire essential knowledge at a pace and time that fits their working or personal schedules. At the same time, online learning has shifted the emphasis from teacher-centered to learner-centered approaches to learning (Learning Solutions Magazine 2011). Learning needs analyses are undertaken in industry and business to determine the gap between the existing skills, knowledge and abilities of staff and those that are needed for the organization to function at the desired level. Once this gap is determined, decisions can be taken as to the type of training required and the form of delivery. As well, in an educational setting, a learning needs analysis helps students identify knowledge needed, skills and competencies, learning goals (Wynne 2011). It is intended to spot skills, data the learners already have, and that has to be developed. Conjointly goals they wish to realize to spot the content and resources that most accurately fits students’ needs. Learning needs analysis help to realize a correct fit between the instructors and learners, i.e., the course matches learners’ needs and expectations(Wynne 2011).

The need analysis study will be conducted as an early sub study involving a small-scale quantitative research using the open ended questioner instrument. The goal of the need analysis study is to identify significant contents importance included in an communication skill course. In addition, to identify the proposed time and method of delivery. Moreover to rate the subtopics in terms of the consequences of incompetence in certain areas and the importance of each subtopic. Next, a task analysis for blackboard interfaces and media use will be conducted to ensure if what will be used is fit to learner needs and to make sure, if what will be used is suitable to individual learner pace. The respondents will be 25 students who attended the communication skill course in the year 2011-2012.

**Phase 3 & 4: System Design and Development:**
Design stage for this research will focus on instructional goals and objectives within the concept of individualized learning (paces, methods and contents).Which included three major stages of design and development, namely, (i) designing and developing the course handbook based on the task analysis results. The handbook will be presented to experts. The course structure and contents especially the learning matrix, will be developed and redeveloped based on experts’ agreement on overall comments and suggestions. (ii) authoring and developing the courses activities, this will be done using blackboard course management system corresponding to learners’ paces(e.g., lectures, assignments, examples, exercises, self-assessment tests, feedback, discussion forms, course outline, calendar, useful link, and questionnaires) also during this stage a number of media file will selected and develop based on learners pace. and (iii) designing and developing the individualized engineering education blog on backboard course management system.

This research will use two approaches for evaluation; formative and summative evaluation. The formative evaluation throughout the instructional development process will be used to ensure that the model achieves its stated goals and objectives. One evaluation method for online educator to consider as suggested by Willis is to give students number of assignments and self-assessment test and exercises and a feedback (Willis 1992). Summative evaluation will be addressed using a survey study to collect necessary information about confirmation factors which are assumed to influence the formation of; Individualized learning( IL), Multimedia
instruction (MI) and Online learning (OL). In addition, the survey study attempted to investigate the influence of MI on IL, OL on IL and the relationship between them and to validate the model.

**Stage 1 of Phases 3 & 4: Development of the Course Handbook:**

The first stage of the system design and development phase according to the adopted approach was to come up with learning matrix based on previous course evaluation, course synopsis, course structure. This was followed by the development of the course structure and a complete course handbook.

The course handbook essentially was designed based on the task analysis results. According to the adopted approach Triangulation of data was made with data from document analysis and interaction analysis of the electronic forums. The course handbook was presented to nine experts in three stages; formative evaluations to rounds and summative evaluation one continues round. The course structure and contents in particular the learning matrix, as described in greater detail in the handbook, were developed and redeveloped based on experts agreement on overall notes and suggestions.

**Stage 2 of Phases 3 & 4: Development of the Course Blog:**

The second stage of the system design and development phase involved Authoring and developing the courses activities, this will be done using blackboard course management system corresponding to learners’ paces(e.g., lectures, assignments, examples, exercises, self-assessment tests, feedback, idea share, discussion forms, course outline, calendar, useful link, and questionnaires) also during this stage a number of media file will selected and developed based on learners pace.

**Stage 3 of Phases 3 & 4: Development of the Engineering Education Blog:**

The third stage of phases the system design and development phase involved designing and developing the course blog, named Engineering Education. The full version of the Engineering education blog can be accessed at https://www.ateffaresm.coursesites.com.

**Phase 5: Training and Implementation:**

Before the start of this phase, one usability tests will be conducted. The international standard defines usability as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”(ISO 9241-11, 1998). The first usability test according to the adopted approach will be done “for technical errors at the end of the development stage on three experts and five end-users”. The purpose is to find bugs and to improve on various aspects of the engineering course Interfaces on blackboard course management system. The second usability test will be conducted during the implementation phase .the purpose of this test is “to consider whether or not learner recognizes and accesses instructional elements as intended by the designer” (Din 2010).

Before actual implementation two blackboard workshops will be administrated one for engineering learners and one for instructors to help them know and practice all the necessary skills they will need in the online individualized multimedia instructions environment.

**Phase 6: System Maintenance and Model Development:**

The last phase of the study, involves maintenance and model development. Maintenance is iterative. It is an unending phase as more defects are discovered and new ideas arise. The engineering course Interfaces on blackboard course management system will be accessed every now and then by previous learners and the researcher. After several iterations to achieve a gradually better system, the real implementation will be conducted. Then data will be collected and analyzed using SPSS.

Finally as suggested by Rosseni’s theoretical empirical based design and development approach “these scores for all person measures will be plucked into the hypothesized measurement and structural models of the study using AMOS 7.0 software for Structural Equation Modeling. Confirmatory factor analysis and structural equation modeling analysis will be applied to come back up with models that the majority fit the data” (Din 2010).

**Evaluation For This Study:**

1. Content validation of the items and schema used to measure apparent direction towards Online Individualized Multimedia Instruction Model (OIMI) pedagogy (Section B of (I-OIMI)) to achieve apparent Individualized Learning (Section C of (I-OIMI)) to achieve apparent Multimedia instructions (section D of (I-OIMI)) to achieve apparent Online learning.


3. Expert review Checklist of the Engineering Education Blog to give an interface rating to the instructional media used for a online delivery of the course.

5. Subjective Record Form to note any unique observation during field study.

Along with heuristics evaluations and expert review, an evaluation of the Communications Skills Course using the Online Individualized Multimedia Instruction environment will be conducted in November 2012 throughout January of 2013. Findings from these testing and evaluations will be used to further improve the system while data collected from the questionnaire will be analyzed quantitatively using SPSS 15 software. Structural equation modeling will be used to verify a model for effectiveness of Communications Skills Course delivered in Online Individualized Multimedia Instruction Model orientation.

**Audience:**

A number of different audiences are referred to in this study. Broadly speaking they are:

(i) Architecture Engineering students at Al al-bayt University,
(ii) Civil Engineering students at Al al-bayt University;
(iii) Surveying Engineering students at Al al-bayt University.

Despite their internal complexities, these communities will be referred to in this study simply as Engineering students/Learners.

**Sample:**

The population of this study is Al Al-Bayt University Engineering students/Learners who are registrant in the communications skills course in the first semester of the academic year 2012-2013.

**Limitations:**

Limitations to the analysis and generalization of the evaluation as well as potential threats to the reliability and validity of the design and instrumentation are strictly for this group when score are computerized using the classical test theory, however the researcher will convert all scores to logic score using the Rasch model, hence the result may be generalize for other Jordanian Engineering students. Because of time and financial constraints, factors such as learner diversity in terms of personality and intelligences, motivation, social economic status or self-directed learning readiness will not be considered.

**Conclusion:**

Allen and Seaman state that “Bad economic times have often been good for education, either because decreased availability of good jobs encourages more people to seek education instead, or because those currently employed seek to improve their chances for advancement by advancing their education” [18].

Online Individualized Multimedia instruction is attained through the Instructional System Development process. It is student-centered focusing all activity on the needs of each student in his efforts to achieve predetermined specific objectives. It responds to individual student abilities in order to maximize the output of the teaching and learning process. With multimedia instruction the method and the content can be designed to individualize the instruction. Also With online learning asynchronous as well as synchronous each student will have the chance to learn according his pace. Therefore, this study proposed a research framework which offers a plan for (i) knowledge creation and acquisition, (ii) knowledge storage and retrieval, and (iii) knowledge transfer and utilization using the Online Individualized Multimedia instruction model. The research framework investigated if the Online Individualized Multimedia instruction model is able to cater to the needs of learners with differentiated paces.

The findings would result in the success factors being integrated into the Online Individualized Multimedia instruction model. This is extremely crucial because to-date very few researchers have developed such a model to explain achievements via online learning in architectures engineering in Asian countries, particularly in Jordan.

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