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Learner Control Design vs. Program Control Design While Designing E-Learning Multimedia Educational Computer for 10th Grade Students in Oman Sultanate: Is There Any Effectiveness in Developing Their Informatics Competencies?

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Abstract

This research aimed at discovering the effectiveness of learner control design Vs. program control design when developing e-learning multimedia educational computer program of Information Technology subject matter in developing informatics competencies among 10th grade students in Oman Sultanate. The Developmental research method was implemented. Research hypotheses were formulated. Research sample size was (50) students selected two random classes from one purposefully selected school. Then, the sample was divided into two equal groups that were randomly assigned to a Quasi-Excremental design of two experimental groups with pretest and posttest. Two programs were designed using (Elgazzar, 2002) ISD Model: the 1st one Learner Control design (for Experimental group 1), and the 2nd one Program Control (for Experimental group 2). The two treatments of the instructional program were identical in everything but the control type. Two research tools were developed: an achievement test for the cognitive aspect of informatics competencies, and observation checklists for the performance (skills) aspect of informatics competencies, then these two tools were approved for validity and reliability. The 1st author conducted the research experiment according the experimental design Data of both research tools were processed and research hypotheses were tested with suitable statistical procedures. Research results revealed significant effect differences between Learner Control Design vs. Program Control Design showing superiority of Learner Control Design in both aspects of informatics competencies. Then the main research question has been answered as there is an effectiveness of the design types: Learner Control and Program Control in developing 10th graders' informatics competencies. Tables, Figures, References, and a list of recommendations are included in the research report.

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Keywords

Developing, Learner Control Design, Program Control Design, Designing Educational Multimedia Compute, E-Learning, Tenth Grade Students, Elgazzar (2002) ISD Model, Informatics Competencies, Oman Sultanate

1. Introduction

Educational technology is considered an applied science instructional design, which is an open system that utilizes both human and non-human resources, as it is based on the processes and their design to achieve learning outcomes, and that's what make it open to all the developments in information technology, computers, networks, e-content production, and multimedia technology in the form of an interactive instructional system to achieve learning outcomes, and that led to the emergence of innovations technologies such as distance learning, digital TV, interactive instructional video systems, learning across networks, interactive multimedia, and the concern to their design in an interactive e-learning environment that gives the learner more control over these interactions, and stimulating research in the design of the form of this control and its effectiveness on intended learning outcomes. The current research deals with the degree of control given to the learners and their relationship to the development of learners' competencies of informatics. Instructional technology is an instructional system that has inputs, processes, product, to achieve learning outcomes. This contention goes along with the American Association of Educational Communications and Technology definition of the field of instructional technology (1994) and Elgazzar [5] [6] that it is an integrated process based on the application of structured applied science and knowledge about human learning and utilizing human and non-human learning resources emphasizing learner activity and individuality through the methodology of systems approach to achieve instructional goals and reaching effective and meaningful learning. This means a more opportunities and potential of of utilizing instructional technology in solving the learning and training problems. Recently, as it has been mentioned, instructional technology innovations includes distance learning and e-learning. The interest is centered on developing e-learning environments that includes computer multimedia programs. Computer multimedia programs from this standpoint are considered electronic learning systems in the form of a multimedia computer program that is designed according to instructional design model to the level of instructional control of the learner control and is presented to the learner on CDs or a learning management systems (LMS) such as MOODLE (Modular Object Oriented Dynamic Learning Environment) or other such systems, or presented in the form of e-learning learning environments that allows learners to interact, communicate and collaborate and share [7], and then, can be used and employed flexibly adapted to the level of IT infrastructure and information technology in the school environment or distance learning. So, in order to use such e-learning environments and programs, there is a need to develop students' competencies as well as teachers in the form of curricula or training programs. For this, all countries worldwide are in a competition to teach informatics in their curricula.

Oman Sultanate pays a great concern to informatics in school curricula. Oman has its unique approach In developing Information Technology, this approach is special because it is linked to the digital revolution, which has become mainstay throughout the Omani society, as it is linked to the extent of adaptation and interaction of individuals, especially students positively with the resources and digital sources via the computer and Internet networks, as it is the specificity of this approach to informatics curriculum like all curricula that is based on providing students with knowledge, performance skills, and affective aspects-and in short-informatics competencies. So, developing these competencies among students, there is need to employ instructional technology through designing multimedia computer programs to learners at a level of control that facilitates positive activity during learning.

As a response to meet that need, the problem of this research came up as there is lack of students in their informatics competencies, and there was a need to develop informatics' competencies through e-learning based on multimedia educational computer technology, and to discover the effectiveness of the instructional Control on the development of those competencies. So, and in the following paragraphs, some theoretical the foundations will be discussed.

2. E-Learning Based Multimedia Educational Computer

Probably, the very early starting phase in e-learning technology evolution has been e-Learning Based Multimedia Educational Computer phase. In this sense, multimedia educational computer is an interactive learning program that combines integrated digital forms of media such as audios, pictures, graphics, videos, texts, animations, and simulations along with evaluation tools, computer workstations, that is systematically designed to achieve predetermined learning objectives. Hofestetter [11] defines it as the use of computer to display a integrated combination of written text, still images, graphics, video that allows the user to navigate them and interact with them. Sharp [13], in the sixties, has defined it as the integration of more than one medium that combines text, sound, graphics, animations, and video clips. Later, other scholars [8] defined educational multimedia programs as instructional/learning systems. So, e-learning that is based on multimedia educational computer is still among available solutions to implement e-learning at schools without Internet based information technology infrastructures. As a matter of fact, multimedia educational computers at schools have double purposes: they are instructional/learning delivery systems for e-learning, and they are a subject matter or content of informatics education. Actually, this is the case of multimedia educational computer in his research.

3. Instructional Control in E-Learning Multimedia Educational Programs

Instructional control is considered one of the many design variable e-Learning multimedia programs today. That instructional/learning control refers to the degree to which is given to the learner in a multi-media e-learning program content, navigation, sequence changing, choice of selection desirable learning objects, media element, or parts at that control might change the program sequence. This degree has at least three levels of control: full or higher learner control, medium learner control, or low learner control over the multimedia program sequence. Low learner control limits learner choices to linear navigation of forward navigation or backward navigation or program entering and exiting. This low level of instructional control is known as program control, this is because it is impossible to accept an educational program without at least this low level of learner control. So, instructional control in such type of e-Learning programs is a point in a continuum between two limits: the learner at the upper limit and the program at the other limit, the upper limit means learner full control and the lower limit means no learner control but program control/or lack of learner control. Azmy [5] says the intended learning outcomes such as achievement and learning time depends on the degree of learner control. So, according to this view, the more the learner control, the more the in learning outcomes. This means, in terms of the current research, that the learner control design of the multimedia educational program will result in more effectiveness in developing students' informatics competencies of both cognitive and skills component. In this sense, in terms of the current research of educational multimedia program design, there are two types of instructional control: learner control design and program control design. Sometimes, elsewhere in this paper, it may be mentioned as just instructional control (higher learner control) and program control/no instructional control for (normal learner control), *i.e.* higher instructional learner control vs. typical instructional learner control in e-Learning multimedia programs.

Learner control design, refers to the type of educational multimedia program design when the learner has a very high level of control over the program flow and sequence. That is learner (10th grader) can navigate within the program freely, to move forward, to move backward, to exit, to select branching from given list, to select from different paths, and to receive feedback. Also, Amein [4] adds that learners in the design can select his own way inquiries, search information, add or modify the basic knowledge, and paths in the multimedia program. In other words, this design gives the learner more freedom and interactions over this type of e-Learning program, there is no pre assigned paths or sequence. While in the other side program control design refers to the type of instructional control that limits the learner' choices, navigations, paths, and branching through multimedia elements and learning objects. In terms of the current research, the learner (10th grader) instructional control is limited to navigation within the program freely only to move forward and to move backward, to receive feedback, and to exit the program.

4. Informatics Competencies as Learning Outcomes

Competency in the field of education, refers to a learning outcome that has three aspects: knowledge aspect, skills aspect, and affective aspect. An Egyptian authority scholar, Al-Nakka [2] has defined it as the capability or capacity that includes a combination of knowledge, skills, and attitudes that is required for a job so as to be

carried out with ideal/model performance. Based on standards, Competency is a body of knowledge, skills, and attitudes/Interests that make a person capable of doing a certain performance or job at expected and acceptable specified level [12]. So, when one says that the learner has the competency of programming, he/she means that the learner has the required knowledge of programming, has the required skills of programming, and has the required interest, attitudes, and values of programming. In this regard, informatics competencies consists of required knowledge of informatics, skills, and values, attitudes (current research is limited to the first two). There are some agreed upon sources that can form basic inputs of competences, normally used in educational technology, training, and educational research: (1) the 1st source: performance analysis, job analysis, content analysis, needs, standards, and literature, (2) the 2nd source: human resource that includes experts, professionals, and scholars such as university professors/faculty in the field of specialization, and (3) the 3rd source: combination of two previous sources 1st and 2nd sources. Informatics competencies, in schools' curricula are dynamic and depend on school level. Informatics competencies that are required to 10th grade students are different than of those 9th grade or 11th grade, even though these competencies are suppose to be in a continuum to satisfy informatics curriculum continuity. So, authors of this research put those sources of competencies as theoretical procedural foundations to drive the list of required informatics competencies for 10th grade students.

5. ISD Model for E-Learning Multimedia Educational Programs' Designs

The Two e-Learning Multimedia Educational Programs' Designs are considered Instructional/learning Systems. So, there design, according to developmental research method adopted for this research, should follow the instructional systems design/development methodology through the implementation of an ISD model. Basically, ISD models guide instructional developers in the instructional developmental process that vary in their purposes, amount of detail provided, degree of linearity in which they are applied, and their operational tools [10]. Authors reviewed available ISD models that can be implement in this developmental research and they selected Elgazzar (2002) ISD model [3] [6] [7] [9] (see **Figure 1**) for developing the two designs: learner control design and program control design as defined in the previous fourth section in accordance of design standards. This model's procedures and implementation is found in several developmental researches [3]. The model as it is shown in **Figure 1** has five interrelated phases: Analysis, Design, Production/construction, Evaluation, Use, and Feedback. Implementation of this model, of course, ended at the formative evaluation phase as the two designs have met a derived list of standards (see research procedures section).

6. Research Problem Statement, Questions, and Research Hypotheses

Based on some initial field evidences, the research problem has been stated as "there are deficiencies in informatics competencies in Information Technology subject matter among 10th grade students in the Sultanate of Oman and an e-learning Multimedia Educational Computer solution is needed". A main question was the formulated: Is there any Effectiveness of Learner Control Design vs. Program Control Design in Developing their Informatics Competencies? Four sub-questions have been derived:

1. What are appropriate informatics competencies to 10th grade students in Omani schools?
2. What are the design standards of these two designs for the development of those informatics competencies?
3. What are the two designs of the e-Learning programs according to those standards using Elgazzar ISD model (2002) to develop students informatics competencies?
4. How effective is the implementation of these two designs instructional control in developing informatics competencies among tenth graders in Omani schools?

Then the following two Hypotheses are formulated to answer the 4th sub-question:

Hypothesis (1): There is a significant difference at level ($\alpha \leq 0.05$) between the two means of the learner control design and the program control design of e-Learning Multimedia Educational Computer program in posttest of knowledge achievement test of informatics competencies for the learner control design.

Hypothesis (2): There is a significant difference at level ($\alpha \leq 0.05$) between the two means of the learner control design and the program control design of e-Learning Multimedia Educational Computer program in posttest of skills' checklists of informatics competencies for the learner control design.

7. Research Method

The Developmental Research Method as described [7] was used in this research. This research method com-

Figure 1. Elgazzar (2002) ISD model [3] [6] [7] [9] for e-Learning multimedia educational computer program design.

bined three integrated research methods were used:

1) Descriptive research method implemented in students' characteristic analysis, course content analysis, resources analysis, and establishing design standards list of the e-Games designs,
2) Systems Development Method in terms of implementing Elgazzar ISD Model [3] [6] [7] [9] in developing the two e-Learning Multimedia Educational Computer program designs, and
3) Experimental research method in the research experiment to investigate the comparative effects of the two e-Learning Multimedia Educational Computer program in developing knowledge and skills of informatics competencies.

8. Research Procedures

8.1. Driving the List of Informatics Competencies

To drive this list, authors started with the 1st source of informatics competencies (as it was stated in Section 4) through conducting content analysis of the Information Technology Subject Matter for the 10th grade students. And then, the 2nd source while refereeing the content analysis outputs. They came up with four basic competencies of VISUAL BASIC and (24) sub-competencies of both knowledge and skills. These final list of competencies is required to Elgazzar ISD model (2002). The derived list of informatics competencies was used to derive instructional needs, instructional objectives, the cognitive achievement test, and observation checklists of skills.

So, the first sub-question has been answered.

8.2. Deriving E-Learning Multimedia Program Instructional Design Standards

An Initial list of instructional design standards of the two e-Learning Multimedia Educational Computer program Instructional designs were derived. This initial list was subjected for refereeing from experts. The final most agreed upon list of standards and their indicators became (15) standards and (104) of their indicators of performance. So, the second sub-question has been answered.

8.3. Developing the Two E-Learning Multimedia Program Designs

The Elgazzar (2002) ISD model was selected for developing the two e-Learning Multimedia Program Designs: learner control and program control. A very lengthy detail of developmental tasks were done on applying Elgazzar ISD Model (2002) in **Figure 1** until the two e-Learning Multimedia Program Designs: learner control and program control approved by the list of ISD design standards. These detailed developmental tasks have been described in Al-Husainy [1]. The phases of the ISD model were applied by the 1st author till the formative evaluation and the approval of the two of e-Learning Multimedia Program Designs: learner control and program control were meeting the ISD design standards. Then the two programs were put on CDs. A student' work book was developed too. So, the third sub-question has been answered and the two designs were ready to be implemented in the research experiment.

8.4. Participants and Experimental Design

Research sample of this research was a purposive clustered sample from two classrooms. It was consisted of (50) 10^{th} grade school from Saud Ben Azan School, Basic Education, Cycle 2, Oman Sultanate. The two classes of this sample were assigned randomly into two groups of (25) students in each of two experimental groups. The two experimental groups Quasi-Experimental Design was used with pretest–posttest. The first experimental group was assigned to the e-Learning program with learner control design, while the second experimental group was assigned to the e-Learning program with program control design.

8.5. Developing Research Tools

Authors developed two research tools since informatics competencies were delimited to knowledge and skills only. These two research tools were: (1) Test of Knowledge Achievement (TKA) of Informatics, and (2) Observation Checklists of Skills (OCS). The (TKA) test was built on learning objectives and was consisted of (23) items in the form of varied forms of objective test items on informatics. TKA validity was done by specialists in the field of educational technology and information technology. The reliability of the test carried out on its pretest data, the calculated Cronbach's Alpha (α) coefficient was ($\alpha = 0.89$). The OCS consisted of (24) sub skills for the (4) basic informatics skills. OCS validity was done by specialists in the field of educational technology and information technology. The reliability of the OCS was carried out on its pretest data, the calculated Cronbach's Alpha (α) coefficient was ($\alpha = 0.91$). So, the two research tools were valid and reliable tools for the purpose of this research.

Table 1. Means and standard deviations for the two e-Learning Multimedia program designs of research variables.

Research variables	e-Learning Program designs			
	Learner Control Design (25)		**Program Control Design (25)**	
	M	**SD**	**M**	**SD**
Pretest of TKA	6.1	1.60	6.24	1.36
Posttest of TKA	28.04	1.77	21.96	2.23
Pretest of OCS	1.12	0.60	1.12	0.60
Posttest of OCS	23.16	0.80	18.88	2.37

8.6. Experiment of the Research

The 1st author (Omani) carried out the implementation of the two e-Learning programs: learner control design and program control design during the year 2012 according to the experimental design. The first experimental group was taught through the e-Learning program with learner control design, while the second experimental group was taught through the e-Learning program with program control design. Experiment started on Saturday, February 25, 2012 extensively. The two research tools (TKA and OCS) were administered pre and post on the two experimental groups at the beginning and at the end of implementations of the two e-Learning designs. Data from the two research tools were collected and coded to SPSS Package.

9. Results and Discussions

Descriptive Statistics: Authors applied descriptive statistics procedures using SPSS statistical procedures to compute means and standard deviations for the two learner control and program control designs as in **Table 1**. It is so clear from **Table 1** that the two mean scores of TKA and OCS posttests are noticeably greater than the two mean scores of TKA and OCS pretests to give indications that both the designs e-Learning multimedia are effective in developing both aspects of informatics competencies. Comparatively, the two mean scores of both TKA and OCS posttests in learner control design are greater than those of TKA and OCS of program control design (28.04 > 21.96, 23.16 > 18.88) respectively. Testing research hypotheses will show if these differences are significant or not.

Hypotheses tests: To answer the fourth sub-question, these two hypotheses were tested as follows.

Hypothesis (1): There is a significant difference at level ($\alpha \leq 0.05$) between the two means of the learner control design and the program control design of e-Learning Multimedia Educational Computer program in posttest of knowledge achievement test (TKA)of informatics competencies for the learner control design.

To test this hypothesis, the independent samples t-test was applied to test the significance of the differences between means of the posttest of TKA scores. So for the posttest TKA in the upper half of **Table 2**, the t-value (10.70) of the two means' difference of TKA (28.04, 21.96) at df (48) is significant at (0.05) since the computed significance (0.00 < 0.05). So, Hypothesis (1) is retained to mean that the difference between the two means of posttests of TKA of the two designs is significant and the Learner control design is superior to program control design. This supports the contention that the more the learner control the more learning outcomes.

Hypothesis (2): There is a significant difference at level ($\alpha \leq 0.05$) between the two means the learner control design and the program control design of e-Learning Multimedia Educational Computer program in posttest of skills' checklists of informatics competencies for the learner control design.

To test hypothesis (2), the independent samples t-test was applied to test the significance of the differences between means of the posttest of OCS scores. So for the posttest OCS in the lower half of **Table 2**, the t-value (8.56) of the two means' difference of OCS (23.16, 18.88) at df (48) is significant at (0.05) since the computed significance (0.00 < 0.05). So, Hypothesis (2) is retained to mean that the difference between the two means of posttests of OCS of the two designs is significant and the Learner control design is superior to program control design. This supports the contention that the more the learner control the more learning outcomes.

Moreover, when dependent t-tests were carried out to test the significance of differences of the two mean scores of TKA and OCS posttests and the two mean scores of TKA and OCS pretests in both designs, all tests of dependent t-tests showed their significance at level of ($\alpha \leq 0.05$). These results indicates that both designs are effective in developing informatics competencies. This general result is also expected since it was allowed some typical learner in program control design. This is confirming that both the designs of e-Learning multimedia are

Table 2. Independent t-tests results of the means' differences of TKA and OCS posttests between Learner Control and Program Control designs.

Test scores	Group	N	Mean	SD	t	df	significance
Posttest TKA	Learner Control	25	28.04	1.77	10.70	48	0.00
	Program Control	25	21.96	2.23			
Posttest OCS	Learner Control	25	23.16	0.80	8.56	48	0.00
	Program Control	25	18.88	2.37			

effective in developing both aspects of informatics competencies.

So the final conclusion, based on the results of testing the two hypotheses, is that the answer to the main research question: Is there any Effectiveness of Learner Control Design vs. Program Control Design in Developing their Informatics Competencies? Is yes there is a comparative effectiveness of Learner Control Design vs. Program Control Design in Developing their Informatics Competencies. Moreover, both designs are effective in developing informatics competencies. This final conclusion is supported by many researches on instructional control [4] [5]. On the other hand, it supports the contention that the more the learner control in designing e-Learning in general the more the learning outcomes.

10. Research Recommendations

Based on these findings of the research, the following practical recommendations can be driven:

1) These two developed e-Learning Multimedia Educational Computer program: learner control design and program control design are to be used in developing informatics competencies in 10th grade, Basic Education, the Sultanate of Oman.
2) The list of instructional design standards of e-Learning Multimedia Educational Computer program: learner control design and program control design which was developed in this research should be adopted by researchers and e-Learning. Developers and researchers in e-Learning and distance learning centers.
3) The instructional design model of Elgazzar (2002) should be used in developing e-Learning and other e-Learning resources.

11. Future Researches

The following future researches are suggested:

1) Studying the effects of designing e-Learning Multimedia Educational Computer program: learner control design and program control design on developing higher cognitive skills such as problem solving skills.
2) Using developmental research method as defined by Elgazzar [7] in research of educational technology, e-Learning, and distance learning.
3) Studying the effects of the interaction between these two e-learning educational multimedia designs and cognitive styles on developing informatics competencies.

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