

Comparison of the Effect of Behavioral-Based vs. Cognitive-Based Multimedia Instruction on the Rate of Learning and Retention in Students

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Abstract

The present study aimed to compare the effect of behavioral-based vs. cognitive-based multimedia instructions on the rate of learning and retention of the eighth grade female students in Social Education lesson. The method of the study was quasi-experimental and with regard to the objective it is an applied study. The study population consisted of all eighth grade female students who had enrolled in the academic year of 2014-2015 in Tehran, Iran. The statistical sample of the study included 30 female students in the eighth grade in Sana non-profit school who were selected through a convenient sampling method. The instrumentals of the study consisted of 3 researcher-made tests as well as 2 researcher-made multimedia software. Data analysis was performed using independent t-test and ANCOVA. The results of the study revealed that cognitive-based multimedia instruction had more effect on the rate of learning and retention of this students in Social Education lesson.

Keywords: Instruction, Behavioral-Based Multimedia, Cognitive-Based Multimedia, Learning, Retention

1. Introduction

Today, the advent of modern electronic technologies, such as computers, multimedia, hypermedia and the development of Information and Communication Technology (ICT), etc. have made broad and rapid changes in the world; hence the Iranian education system has also experiences such change (Amir Teimori, 2011). In Iran, one of the most important modern educational technologies is the entrance of instructional multimedia in the form of various courses into the market. The term Multimedia has been raised since 1950 onwards and it was tried to increase the quality of instruction through combining several media. These facilities allow the development, interaction, creativity, and better correlation between the user and software (Amir Teimori, 2004).

Multimedia is those computer software in which a combination of text, audio, still or moving images, fixed or moving two-dimensional or three-dimensional designs and visual effects have been employed (Amir Teimori, 2004). Multimedia computer applications can be produced in two forms of interactive- and non-interactive multimedia. In interactive multimedia applications, the programmer enables the user to establish a two-way and mutual communication with computer, while in non-interactive multimedia, the user is mainly passive in dealing with computer and is a mere receptor of the information provided (Ahmadi and Beigzadeh, 2002). Through an investigation of the effect of interactive multimedia on academic achievement of students in mathematics, Mendel (2000, quoted by Fazli, 2010) concluded that the students who used interactive multimedia rather than non-interactive multimedia were more active in the learning process and better learned too. Lewis and Miles (2001, cited by Ranjbar, 2009) conducted a research entitled “the effect of technology on student learning” and concluded that using interactive multimedia makes students very active and responsible for their learning and thus, experience a better learning. In comparison with other forms of instruction, the most important advantage of multimedia is flexibility in providing information and quick access to provide feedback.

The main objective of the use of multimedia is to help students learn and raise their literacy so that students enjoy multimedia hence, employ the materials of multimedia learning (Barati, 2005). Among the advantages of using multimedia in classroom (Milheim, 1996) are enhancing students' motivation to participate, combining various skills such as reading, listening, writing, and speaking, increasing cooperative skills, better interaction between the students and teacher, better analysis of resources, enhancing students' thinking in problem solving, changing the role of teacher from a mere narrator to the facilitator of learning, and using different teaching-learning styles. Of multimedia, interactive multimedia has more effect on learning.

The presence of computer all over the world is one of the most important factors which has played a large role in the creation and acceleration of today's change. The created changes have emerged in all aspects of human life that one of the most important one is teaching-learning dimension (Amir Taimori, 2011). The most popular definition of learning is that learning is the process of relatively stable changes in either behavior or behavioral potentiality which is the result of experience (Seif, 2004). Instruction should be used to help people learn and that the objective of any instruction is learning. Instruction is the active flow of the exchange of information and experience between the instructor and learner in the areas of knowledge, attitude, and ability to improve a new behavior in learner (Saberian and Salemi, 2004). Instruction helps the formation of structures and

active performance of learner which leads to their learning. Instruction does not aim at just learning; however, retention is another instructional objective (Shabani, 2006). Retention means that the information which has entered into the active memory, transfer to the long-term memory after connection to the previously learned information. Such information becomes organized and stays there for a long time and if necessary, it returns to the short-term memory and based on which the person responds (Seif, 2004). What is important is that in order to achieve the desired outcomes, designing should be done before the instruction (Saberian and Salemi, 2004). Studies on instructional multimedia aimed at teaching and learning suggest that the effectiveness of any type of multimedia depends on how to design instructional content message (Amir Teimori, 2011). Given that in our country, the production of instructional multimedia has an increasing development and in the field of subject areas and at different educational levels, their number is raising day to day, the need to determine appropriate standards and principle orientation in relation to designing is required more than ever. Investigations on the application of multimedia in teaching and learning point out that in order for instruction by multimedia, we should follow an appropriate designing pattern of instruction. So, instructional designing can be considered as a cause of proper influence of instructional multimedia on learning and retention (Shah Jafari, 2006). On the other hand, the question raised is that among various models of instructional design, which one is more appropriate in the effective learning and retention of students.

Behavioral approach: Behavioral approach was one of the most influential psychological pillars at the first half of the 20th century. Behaviorists interpreted learning based on Stimulus Response Theory (S-R) and believed that human reaction relies on environmental stimuli and through changes in them, the desired behaviors can be emitted or changed (Skinner, 1954). Stimulus-Response psychology deals with environmental stimuli, responses called by stimuli, and rewards and punishments along with such responses (Seif, 2008). From behavioral perspective, human is passive and has a machinery state controlled by environmental factors. Behavioral approach considers environmental stimuli as a major factor in the emergence of behavior and learning. This approach assigns no value for the active role of human in teaching and learning (Fardanesh, 1998).

Cognitive approach: Since the early 1920s, it was found that there were restrictions on behavioral approach to understanding individuals' learning. In the mid-20th century, along with developments occurred in the field of science and progresses in the area of cognitive sciences, murmurs were raised against behavioral approach and challenges to it (Shoari Nejad, 2003). Ignoring what is going on in mind by behaviorists and emphasizing on observable behavior suggested questions that some of the most important ones included: where does the process leading to behavioral change occur? In which part of this approach are students put? Where do behaviors that are not emerged go? cognition is the major issue of studies of cognitivists (Shabani, 2003). One of the points attracting the attention of cognitivists is their attention to the role of learner in learning. They consider learners as the active processors of information i.e. learners who are not only affected by environment but also actively choose and reflect multiple responses (Fardanesh, 1998). From cognitive perspective, teaching is done when learner actively involves in learning and extremely uses his thinking. Since the late 1970s, the science of cognition influenced instructional designing (Shabani, 2006). The table 1 compares the behavioral and cognitive approaches.

Some studies have some far been conducted with regard to the application of the principles of cognitive and behavioral approaches in education. In a study entitled instructional design from the perspective of behaviorism, cognitivist and constructivist approaches, Fardanesh (1998) considered cognitivist and constructivist approaches as learner-oriented approaches that are good models for instructional designing and have a greater impact on students' learning compared to behaviorism approach. He also concluded that constructivism was the most appropriate approach to change the attitude of students. In a study entitled the status of retention-learning approaches of behaviorism, cognitivist and humanistic schools in educational system, Mehr Mohammadi and Shabani Varaki (1998) concluded that these schools are different in terms of the sequence of activity of teacher-student and role and the relationship between teacher and student in the teaching-learning process. Each school observes special objectives. Therefore, the application of these approaches in education system should be done with regard to the objectives on which these approaches have been embedded.

Given what was said on two behavioral- and cognitive approaches, behavioral-based multimedia can be considered as multimedia that is similar to non-interactive multimedia in some ways such as the lack of attention to the active role of learner in learning and teaching and according to the active role of learner, cognitive-based multimedia can considered similar to interactive multimedia. The history of multimedia in our country shows that unfortunately, in the transmission of this critical technology, its hardware dimension has been emphasized and a little attention has been paid to instructional design and its quality (Shah Jafari, 2006). With regard to the issues such as the multimedia on the market have no necessary instructional quality and appropriate organization and instructional design and on the basis of the importance of instructional design in achieving desired learning outcomes and given that learning and retention are very important aims of instructional programs and the achievement is not possible without a good pattern of instructional design, hence, we attempt to choose the most appropriate approach in the field of effective learning and retention of students via investigation of two

behavioral and cognitive approaches in designing instructional multimedia and solve the problems in this area to some extent. The present study aimed to compare the effect of behavioral-based and cognitive-based multimedia instruction on the rate of learning and retention of the eighth grade female students in Social Education lesson. In this respect, hypotheses of the study are:

- 1) There is a significant difference between the learning rates of Social Education lesson through behavioral-based multimedia compared to that through cognitive-based multimedia in the eighth grade female students.
- 2) There is a significant difference between the rates of the retention of Social Education through behavioral-based multimedia compared to that through cognitive-based multimedia in the eighth grade female students.

2. Material and methods

In terms of the nature of the subject, objectives, and hypotheses as well as its use in the context of teaching and learning, the current study is an applied one. A quasi-experimental method was used in this study. The present study is quantitative and since the objective of the study was to compare two different forms of a variable, pre- and post-test were used (Table 2).

The study population consisted of all eighth grade female students enrolled in the academic year of 2014-2015 in Tehran. The statistical sample of the study included 30 eighth grade female students in Sana non-profit school who were selected by convenient sampling and randomly put into the two experimental groups, namely group 1 and group 2. In conducting the study, learning pre-test, learning post-test and retention test and two multimedia software were used which all were researcher-made. In the extraction and selection of pre- and post-test, the views of experts of teaching Social Education lesson were used to achieve the content validity which was resulted in high content validity. Kuder - Richardson formula was also used for reliability and the reliability of the tests was confirmed by the coefficient of 74%. The pre-test of the study included 20 questions related to Chapter 3 (Law and the youth) and Chapter 4 (Communication Era) of eighth grade Social Education book. 5 questions were allocated to each of these sections which were totally 20 questions. Learning post-test was prepared similar and parallel to the learning pre-test and retention test precisely was parallel to post-test questions in terms of numbers, concepts, and levels of learning. The questions of these tests were true- false and multiple choice questions. Scoring of the questions was based on the scores of zero and one. Zero indicated the incorrect answer and one the correct answer. In explaining the two researcher-made multimedia softwares, it should be said that these two softwares had colorful still or moving images, speech, music, and writing one of which was based on the principles of instructional design of behavioral approach and the other was based on the principles of instructional design of cognitive approach. In this study, for the preparation and construction of multimedia software, the information in the book about the basics of multimedia design, books on behavioral- and cognitive-based and views of the supervisor were applied. In this regard, two multimedia softwares with the same content including Chapters 3 and 4 of the eighth grade Social Education were designed and prepared by the researcher using Multimedia Builder software. In both experimental groups 1 and 2, a similar pre-test was conducted and after ensuring that the two groups were matched, teaching was done for experimental group 1 based on behavioral-based multimedia learning and for experimental group 2 based on cognitive-based multimedia learning. Because of the sufficient number of computers, a computer was dedicated to each experimental group 1 and group 2. The implementation of multimedia software was done in both experimental groups 1 and 2, by one of the teachers in the eighth grade. Within an explanatory session, in addition to an introduction with the two multimedia softwares in the study, he learned how to do it. Because the software was tutorial, no period of time was considered for the completion of the training. Training was conducted in two sessions. At the end of each session, after the completion of training, the same learning test of Social Education was performed in both groups. After 3 weeks of training implementation, without giving previous notice to students, a retention test of Social Education was done parallel to the questions of post-test in both groups.

3. Results and discussion

This part of the study can be divided into two parts. In the first part, the statistical sample and raw data from the study variables have been described in a way that by descriptive parameters (mean, standard deviation, and minimum and maximum scores), all data have been summarized, interpreted, and reported as well. In the next part, the study hypotheses and findings have been addressed. To examine the first hypothesis of the study, the analysis of covariance (ANCOVA) was used with the aim of the comparative study of the mean scores of students' learning in both groups, while independent t-test was used to test the second hypothesis.

- A) Descriptive findings (Table 3): According to the data given in Table 3, out of the total of 30 subjects, 15 individuals were put in the experimental group 1 (behavioral-based multimedia group) and 15 ones in the experimental group 2 (cognitive-based multimedia group).

Data description: after conducting the learning pre-test for both groups, the obtained results were descriptively presented in Table 4.

According to Table 4, the learning pre-test, the mean experimental group 1 with the standard deviation of 1.52

and group 2 with the standard deviation of 2.81 were 7.73 and 7.63, respectively.

After performing the learning post-test for both groups, the obtained results were descriptively presented in Table 5.

According to Table 5, the learning post-test, the mean experimental group 1 with the standard deviation of 2.06 and group 2 with the standard deviation of 2.42 were 9.1 and 2.43, respectively.

After performing the retention post-test for both groups, the obtained results were descriptively provided in Table 6.

According to Table 6, the retention post-test, the mean experimental group 1 with the standard deviation of 2.79 and group 2 with the standard deviation of 17.06 were 8.15 and 1.41, respectively.

B) The inferential analysis of the data

The first hypothesis: there is a significant difference between the learning rates of Social Education lesson through behavioral-based multimedia compared to that through cognitive-based multimedia in the eighth grade female students. Given that the pre-test was used before the implementation of pilot project, to investigate this hypothesis, the analysis of covariance was used to eliminate the effect of the pre-test. The results of the analysis of covariance are given in Table 7.

As it can be observed in Table 7, there is $f=131.38$ between the two experimental groups with the degrees of freedom of 1 and 27; therefore, the hypothesis that there is a significant difference between the rate of learning Social Education lesson through behavioral-based multimedia compared to that through cognitive-based multimedia in the eighth grade female students can be accepted.

($F(27, 1) = 131.38, P < 0/001$ Partial $\eta^2 = 0.83$)

The second hypothesis: there is a significant difference between the retention rates of Social Education lesson through behavioral-based multimedia compared to that through cognitive-based multimedia in the eighth grade female students.

To test this hypothesis, the retention of the two experimental groups and their means were compared. In so doing, independent t-test was used whose results are summarized in Table 8.

According to Table 8, considering that the calculated value ($T=11.1$) with the degree of freedom of 28 is larger than T in the table (2.763), it can be said that there is a significant difference between the two experimental groups in retention with 99% confidence level. Therefore, the hypothesis of the study in which there is a significant difference between the rates of retention in Social Education lesson through multimedia-based behavioral approach compared to that through multimedia-based cognitive approach in the eighth grade female students is accepted.

($P=0.0001, T=11.01, df=28$)

Also, according to the data in Table 5 (Scores of post-test for both groups in learning test) and data in Table 6 (Scores of post-test for both groups in retention test), it can be said that the cognitive-based multimedia instruction has more effect on the rate of learning and retention of the eighth grade female students in Social Education lesson compared to behavioral-based multimedia instruction.

The results of the study showed that there is a significant difference between behavioral-based multimedia and cognitive-based multimedia instructions. In other words, compared to the behavioral-based multimedia instruction, the cognitive-based multimedia instruction has more effect on the rate of learning and retention of the eighth grade female students in "Social Education lesson". If we consider the behavioral-based multimedia similar to non-interactive multimedia in some aspects such as the lack of attention to the active role of learner and cognitive-based multimedia similar to the interactive multimedia in terms of attention to the active role of learner, then the results of this study confirm the studies conducted by Mendel (2000) entitled "an investigation into the effect of interactive multimedia on the academic achievement of students in mathematics" which concluded that students using interactive multimedia rather than non-interactive multimedia were more active in the learning process and had better learning and the study by Lewis and Miles (2001) entitled "The effect of using technology on student learning" which concluded that the use of interactive multimedia caused students to be very active and experience better learning. Also, the results of this study are consistent with the studies including the study done by Fardanesh (1998) entitled "Instructional designing from the perspective of behaviorism, cognitive and constructivism approaches" in which the cognitive approach was considered as a learner-centered approach having more effect on students' learning than the behavioral approach, the study conducted by Mehr Mohammadi and Shabani varaki (1998) entitled "Status of teaching - learning approaches and behaviorism, cognitive, and humanism schools in educational system" which concluded that these approaches are different in the teaching-learning process in terms of the sequence of teacher-student activity and the role of and how to relate teacher and student.

Today, the advent of electronic technologies has caused their effects on educational system, especially in the learning-teaching process to be considered more. Nowadays, using facilities of new technologies and given its positive and negative aspects, the context has been provided for change and development in the development of education system from traditional to modern education. Therefore, many efforts have been done

on the development of instructional software. What is important is how to instructionally design such instructional software. Given the importance of instructional designing in achieving desired learning outcomes and results from the impact of new technologies on teaching and learning, the techniques, methods, practical practices and how to utilize the instructional design in new instructional tools should be quickly examined and select the most appropriate approach through comparing various approaches of instructional designing. According to the results of the present study, an emphasis on utilizing the designed multimedia based on the principles of instructional design of cognitive approach in comparison with multimedia based on the principles of instructional design of behavioral approach can provide new opportunities for education in order to achieve its objectives which are to promote learning and depth of knowledge and let students to experience better learning and retention. Thus, officials and others involved in education are offered the following advice and suggestions:

- Using the principles of cognitive instructional designing in providing and formulating instructional multimedia
- Using interactive multimedia in classrooms and schools
- Holding instructional workshops for teachers to enhance their skills in the use of multimedia
- Equipping schools with hardware devices to apply active and modern instructional methods such as multimedia

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Table 1- Comparison of behavioral and cognitive approaches

	Behavioral approach	Cognitive approach
Learning	Changing the external behavior at the effect of conditioning	Knowledge acquisition and change in mental structures
Types of learning	Recognition, generalization, association and chain	Short-term storage of sensory memory, short-term memory and long term memory
Factor affecting learning	Environmental factors: stimulus, reinforcements	Environmental factors: explains, views, offering examples and non-examples, exercises, information feedback
The role of memory in learning	Not discussed	Has an important role. What store in memory in different forms and how to organize it
Transmission of learning	Due to the extension and in situations with the common elements	Depends on how to keep information in mind, comprehensive learning, and leads to better and more transfer
What type of learning can be better done?	Relations between stimulus-response, diagnostics, and associations and chain	Problem-solving, reasoning and information processing
Principles and assumptions of designing	Emphasis on visible results and measurement, doing pre-test to determine the starting point of instruction, proficiency in proceeding before continuing to the next steps, use the boost to stabilize performance, using symbols, forming behavior and practice to establish relation between stimulus and response	Emphasis on the active involvement of students in the learning process, analysis of subjects to determine the relationship of prerequisites, emphasizing on the structure, organization and sequence of data, creating an environment for relation between old and new knowledge of students.
Macro instructional strategies	Providing training and possibility of practice and feedback	Planning for cognitive strategies, and learning
Objectives	pre-determined Behavioral objectives	Predetermined objectives and objective-oriented phrases
Media strategies	Variety of media, computer-assisted instruction	Computer-based instruction
Instructional organization	Providing a stimulus and creating an opportunity to provide a response with help, hints, strengthening	Instruction is based on prior knowledge of students.
Micro instructional strategies	The signaled exercises are enhanced by immediate feedback	Fragmentation, providing a map of concepts, pre-organizer, repeat and exercise, mental imagery, retention, allegories
Evaluation	Processes and product are evaluated	Evaluation is diagnosis and mental representation and process of students

Taken from Sells, B & Glasgow, and T. (1998)

Table 2- Pilot project of two pre- and post-test groups with experimental groups

Groups	Number	Pre-test	Independence variable	Post-test	Retention test
Experimental group 1	15	T1	X1	T2	T3
Experimental group 2	15	T1	X2	T2	T3

Table 3- Frequency of participations for the two groups

Group	Frequency	Percentage
Experimental group 1	15	50
Experimental group 2	15	50

Table 4- Pre-test scores of both groups in learning pre-test

Parameter of groups	Number	Mean	Standard deviation	Minimum	Maximum
Experimental group 1	15	7.73	1.52	5.5	11/5
Experimental group 2	15	7.63	2.81	2.5	13.5

Table 5- Post-test scores of both groups in the learning test

Parameter of groups	Number	Mean	Standard deviation	Minimum	Maximum
Experimental group 1	15	9.1	2.06	5.5	14/5
Experimental group 2	15	17.03	2.42	12	20

Table 6- Post-test scores of both groups in the retention test

Parameter of groups	Number	Mean	Standard deviation	Minimum	Maximum
Experimental group 1	15	8.15	2.79	2	12
Experimental group 2	15	17.06	1.41	15.5	20

Table 7- Results of ANCOVA to compare the post-test between the two groups with the control of the effect of pre-test

Source of change	Sum of squares	Degree of freedom	Mean of squares	F	Level of significant
Pre-test	43.53	1	43.53	11.95	0.002
Within group	478.35	1	478.35	131.38	0.001
Intergroup	98.3	27	3.64		
Modified total	613.86	29			

Table 8- Results of independent t-test for the comparison of retention in the two experimental groups

Group	Mean	SD	T	Degree of freedom	Level of significant
Experimental group 1	8.15	2.79	11.01	28	0.0001
Experimental group 2	17.06	1.41			