The Effect of Using the Interactive Electronic Models in Teaching Mathematical Concepts on Students Achievement in the University Level

Yahya Mizher Alzahrani
Ymzahrani@uqu.edu.sa
Umm Al-Qura University, Makkah, Makkah, SA

Summary
This study examines the effect of using interactive electronic models to teach mathematical concepts on students' achievement in the linear algebra course at university. The field sample consisted of 200 students divided into two equal groups, an experimental group of 100 students and a control group of 100 students. The researcher used an achievement test in some mathematical concepts related to linear algebra. The results of the study showed that there were statistically significant differences (0.05) between the average achievement scores of the experimental and control groups in the post application of the achievement test, in favor of the experimental group. The size of the influence of the independent factor on the results of the study, which is "interactive electronic forms", on the dependent factor, which is the students' academic achievement in the prepared test, had a very large effect. Also, the results of the study showed that there were statistically significant differences (0.05) between the mean scores of the experimental group in the pre and post applications of the achievement test, in favor of the post application. The researcher recommended the use of interactive electronic models in teaching mathematical concepts at the university level and diversifying the strategies of teaching mathematics, using technology to attract learners and raise their academic achievement.
Keywords:
Interactive electronics models, Mathematical concepts, Teaching strategies, Teaching mathematics.

1. Introduction

Interactive Electronic Models is one of the more recent approaches used in teaching mathematics at university, and it is also considered one of the most important teaching approaches to mathematical concepts based on investigation. The interactive electronic models aim to build reliable electronic experiences that use mathematical programs or a programming language, such as Java (Phycharis, 2013).

Therefore, the educational environment supported by technology, Enhanced Learning, such as the use of Dynamic Visualizations and Virtual Experiments, is a highly effective tool, and it has a role in providing teaching supports for undergraduate mathematics students while they acquire knowledge in new mathematical concepts and contribute to the creation of mental representations (Varma & Linn, 2011). Interactive models also play a clear role in providing learners with valuable scientific experiences that improve their acquisition of complex concepts and are presented to them at a simple and attractive cost (The Concord Consortium, 2018; Ari - Gur, 2015).

The consolidation of mathematical concepts among students of mathematics is a prerequisite for achieving the goals of teaching mathematics and scientific enlightenment in their minds. Duscle (2008). It also contributes to developing the students' communicative skills, in addition to supporting meaningful learning and critical thinking skills based on the comprehension of mathematical concepts (Cavagnetto, 2010; Jimenez-Aleixandre & Erduran, 2007).

Many studies have shown that there are difficulties in learning mathematical concepts. Wong et al. (2008) confirmed that mathematics students' learning difficulties range from 5% to 8%, and that 26% of students with learning difficulties have learning difficulties in mathematics, especially in understanding mathematical concepts.

Due to the difficulty of communicating mathematical concepts to learners, it was necessary to search for teaching approaches that contribute to arousing students' motivation, by engaging them in surveys that help develop a deep understanding of scientific mathematical concepts and scientific processes within the framework of their preservation of motivation to learn mathematics using interactive electronic models.

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2. Theoretical Consideration

1. Interactive Electronic Models: Representations of nature or other systems that are first expressed mathematically as models, and then used in the form of computer programs or programming languages. An interactive model can be seen as a representation of a function that produces output values when given input values. Interactive electronic models aim to build reliable electronic experiences that use mathematical software or a programming language such as Java (Concord Consortium, 2018; Psycharis, 2013).
2. Mathematical Concepts: A mathematical concept is knowledge of a mathematical necessity of a particular mathematical relationship (Simon, 2017:120).

Many studies focused on the use of certain teaching strategies to develop mathematical concepts. Prediger's study (2007) aimed to know the effect of constructivist models in treating the concepts of fractions, their wrong complications about fractions and their multiples. Her study showed clear and present individual differences in the students before and after the interviews, after applying the pilot study to them and the emergence of a greater depth of conceptual change.

Another study (Christou & Vosniadou, 2005) aimed to identify the conceptual change in the way students interpret algebraic symbols and the impact of this on their cognitive structures. Where the experimental method was used by the researchers on a sample of 57 male and female students in the eighth and ninth grade, and the researchers divided the students into two control and experimental groups.

A study by Vamvakoussi and Vosniadou (2004) examined the effect of using cognitive concepts as a strategy that focuses on intentional learning in bringing about the necessary change in students' understanding about relative numbers. The researchers used the experimental method and several tools, including a diagnostic test that was applied to 16 students from random schools in Athens. The results showed a significant effect, as a result of using conceptual change strategies based on intentional learning for the benefit of the experimental group students.

In view of the lack of scientific studies related to the use of electronic interactive models in teaching mathematical concepts, and measuring their impact on the achievement of university mathematics students, the need for this study emerged, and therefore the subject under investigation can be formulated in the following question:

What is the effect on students' academic achievement in the linear algebra course, by using electronic interactive models to teach mathematical concepts at Umm Al-Qura University, in the Kingdom of Saudi Arabia?
This question is divided into the following sub-questions:
1- Are there statistically significant differences between the mean scores of mathematics students for the experimental and control groups in the post application of the achievement test?
2- Are there statistically significant differences between the mean scores of the experimental group in the pre and post applications of the achievement test?

3. Experimental Consideration

Study Methodology: The researcher used the experimental method by dividing the sample members into two equal groups, one a control group, and the other an experimental group of mathematics students at Umm Al-Qura University.

Study community: The study population consists of all 240 students of mathematics studying linear algebra at Umm Al-Qura University for the first semester of 2021.
Study sample: The study sample consisted of 200 mathematics students studying the linear algebra course at Umm Al-Qura University for the first semester of 2021, where the teachers at Umm Al-Qura University were selected due to the researcher's work in the same university and the ease of application procedures so that the number was divided into two experimental and control groups with an average of 100 students. One of the two groups was randomly assigned to be an experimental group taught using interactive electronic forms, while the control group was taught using the normal method (lecture).

Preparing a list of some mathematical concepts in the linear algebra course:

Where a set of topics were selected that focus on some mathematical concepts in the linear algebra course. These topics are linear rates, matrices, mathematical induction, relationships, and vector spaces.

Study tool: The study tool was represented in a diagnostic test that was prepared in the light of its main objective: to determine the most important mathematical concepts that the test should address under each of the selected topics, and to measure the extent to which the students and teachers were able to acquire those mathematical concepts. The 60-item test was a multiple-choice test that measured the students' three higher levels of reasoning (analysis, synthesis, and evaluation).

4. Results:

To answer the first question, a t-test in Table (1) was used.

Table 1: The averages, standard deviations, the value of "t" and the level of significance to identify the differences between the mean scores of students in the control and experimental groups in the post application.

Variables Dimensions	Group	N	M	St	t	(α)
Analysis	Experimental	100	7.7	1.5	6.810	0.01
	Control	100	5.6	2.2		
Evaluating	Experimental	100	18.4	4.1	8.616	0.01
	Control	100	14.9	4.7		
Creating	Experimental	100	15.7	3.2	9.769	0.01
	Control	100	9.7	3.8		
Scale as Whole	Experimental	100	43.4	8.4	9.557	0.01
	Control	100	27.8	11.5		

N=200, α=0.01

It is clear from Table (1) that the calculated “t” value is greater than the tabular “t” value at all levels and the total score of the test at the level of significance ($\alpha \leq 0.01$). This clearly indicates that there are statistically significant differences between the mean scores of the experimental group and the mean scores of the control group in the test.

It also indicates that there are statistically significant differences between the average achievement scores of the experimental and control groups in the post application of the achievement test in favor of the experimental group. The researcher calculated the effect of the independent factor on the results of the study, which is "interactive electronic models" on the dependent factor, which is the students' academic achievement in the test prepared after applying the strategy followed, and Table (2) illustrates this.

Table 2: Shows the value of "t" and the square of eta (η)2 and the size of the total effect in the test

Variables' Dimension	T	(η)2	Value of Effect size	Effect size
Analysis	6.810	0.456	1.527	Large
Evaluating	8.923	0.842	1.861	Large
Creating	9.785	0.567	2.314	Large
Scale as Whole	9.676	0.531	2.257	Large

It is clear from Table (2) that the effect was very large, which indicates that there is an impact in the use of interactive electronic forms on the students’ achievement, to a high and noticeable degree if we compare their scores previously using the traditional method (the lecture).

To answer the second question, a t-test in Table (3) was used.

Table 3: Shows the averages, standard deviations, the value of "t" and the level of significance to identify the differences between the mean scores of students in the two applications, before and after.

Variables Dimensions	Group	N	M	St	t	(α)
Analysis	Pre-Experimental	100	3.7	1.6	13.21	0.01
	Post-Experimental	100	7.7	1.5		
Evaluating	Pre-Experimental	100	8.7	2.6	20.67	0.01
	Post-Experimental	100	18.4	4.0		
Creating	Pre-Experimental	100	5.6	2.3	20.73	0.01
	Post-Experimental	100	15.7	3.3		
Scale as Whole	Pre-Experimental	100	18.9	4.6	23.43	0.01
	Post-Experimental	100	43.4	8.5		

It is clear from Table (3) above that the calculated “t” value is greater than the tabular “t” value at all levels, and the total score of the test is significant at 0.01, and this indicates the existence of statistically significant differences between the experimental group before and after the application of the program. This is in favor of the post application, which indicates that the use of interactive electronic models has an impact on the students’ performance through the interaction that occurred within university lectures, as well as the high level of academic achievement of students in the post test.

In order to determine the effectiveness of the interactive electronic models, the researcher performed a statistical treatment of the results of applying the achievement test before and after the experimental group, and the Black Adjusted Gain equation was used as shown in the following table:

Table 4: shows the differences between the mean scores of the experimental group in the pre and post application of the achievement test.

Variables' Dimension	Pre-Average	Post-Average	(η)2	Black Modified gain Rate
Analysis	3.7	8.7	0.826	1.51
Evaluating	8.7	22.4	0.926	1.34
Creating	5.6	17.5	0.938	1.23
Scale as Whole	18.8	50.3	0.941	1.36

Table (4) shows that the adjusted gain values for mathematics students in the dimensional application were 1.36, and this value is greater than the value 1.2 that Black determined as an extent of the effectiveness of training programs in general.

4. Discussion:

The researcher attributes the results of the first question to the significant impact of the use of interactive electronic models in teaching, which led to raising students' achievement. This is in addition to several other factors, including that teaching with interactive electronic models is carefully planned and organized, with a logical gradation in explaining mathematical concepts. It is necessary to simplify it and try to embody it away from the abstraction that is often described by most mathematical concepts. Also, the use of educational techniques that accompanied the interactive electronic forms contributed to students overcoming many of the difficulties of acquiring mathematical concepts. Lecturing, however, could not, based on its previous results, achieve a high level of academic achievement for the same students. In addition to the foregoing, the use of interactive electronic models in teaching contributed to controlling mathematics students and teachers and drawing their attention to the lessons presented.

The researcher also attributes the results of the second question to the fact that the students who used interactive electronic models were more successful than their peers in the control group. General mathematical concepts are introduced in simple terms and later have sub-concepts added to them. Students who study these general subjects cannot must first learn the classifications of mathematical concepts as particles (associative concepts, relational concepts, abstract concepts, and so on). Therefore, the use of interactive electronic models in teaching contributes significantly to improving the knowledge structure about mathematical concepts and arriving at new concepts, as long as the general concept through which deeper details can be reached is clear.

5. Conclusion

This study focused on the effect of teaching mathematical concepts with interactive electronic models on academic achievement in the linear algebra course at Umm Al-Qura University. The results indicate that there are statistically significant differences between the average achievement scores of the experimental and control groups in the post application of the achievement test, in favor of the experimental group that studied using interactive electronic models. This indicates that the use of interactive electronic models had an impact on the performance of mathematics students through the interaction that occurred within university lectures, as well as the high level of academic achievement of students in the post-test.

The results of this study may encourage the use of interactive electronic models in teaching mathematics and open the way for further studies that focus on the use of interactive electronic models in teaching mathematics and benefiting from them as much as possible. Considering the results of the study, the researcher recommends diversifying the use of teaching methods when teaching mathematics and using technology in a useful way that reduces difficulties and helps mathematics students to understand mathematical concepts. Interesting and engaging that makes them spend more time using it and learning from it.

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Dr. Yahya Mizher Alzahrani received the M.A. degrees, in Mathematics Teaching in 2007 from Umm Al-Qura University in Saudi Arabia. He received the Ph.D. degree in Mathematics Teaching from Southampton University at the UK in 2014. He is working as a Assistant professor at Umm al-Qura University from 2014-2018. Moreover, he has been a Associate professor at UQU University from 2019 up to now. He occupied Vice Dean for Graduate Studies and Scientific Research at UQU university. from 2019-2021. His research interest includes Mathematics teaching, role of ICT for mathematics teaching. He is a member of BSRLM in the UK and EAME in Egypt.