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The Effect of Computer Simulation on Al-Hussein Bin Talal University Student's Understanding of Electricity and Magnetism Concepts and their Attitudes towared Physics Learning

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ABSTRACT

This study aimed at investigating the impact of the integration (PhET- simulations) program in physics teaching to understand electricity and magnetism concepts, and to see the impact of the program at the students' attitudes toward physics learning amongst the undergraduate students at Al-Hussein Bin Talal University in Jordan. The sample was selected randomly from the students in course (Electricity and Magnetism). The sample consists of two groups; experimental (120 students) and control (115 students). The study used two instruments: Test for the electricity and magnetism concepts understanding prepared by The researcher and testing attitude towards Physics learning designed at the University of Colorado. Two sets of study were exposed to the two tests before and after the application of the experimental variable (teaching method), and calculate the averages and the significance of the differences between these averages by using analysis of covariance ANCOVA.

The study results showed a statistically significant difference of teaching accompanied by a computer simulation program to understanding the concepts of electricity and magnetism, while it did not affect to modify the students' attitudes toward physics learning.

Key word : (PhET- simulations) - Physics teaching - Attitudes - Al-Hussein Bin Talal University.

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INTRODUCTION

Learning physics concepts is certainly a complicated process, because it requires high level skills and multiple requirements (Jimoyiannis & Komis,2001) leading to students to have negative attitudes towards learning physics (Osborne, Simon, & Collins, 2003). Understanding physics concepts requires the practice of scientific processes ranging from observation and measurement until data collection skill then organizing, analyzing and interpreting them and finally experimentation (Zaytoon,1994). In addition to the need to have communication skills such as using charts, numbers and calculations.

Thus, specialists on teaching physics have developed strategies and tools to help increasing the desire of students to integrate into the process of physics learning and strengthening their attitudes towards it. These strategies based on the active roles of learners, through discovery, inquiry, and interpretation of the natural phenomena (knight,2002).

The technology and modern techniques have been used to serve the process of physics learning and developing it through the good use of sound and motion, colors, simulate phenomena and creating different educational and training programs (Ronen & Eliahu, 2000; Naps et al., 2003) to achieve the students' understanding of physical concepts. This would depend on the good use of learning strategies that make the student play a fundamental role and have self-responsibility (Jimoyiannis & Komis, 2001).

Teaching physics became easier through using software, modern techniques and equipment. Modern technology has also developed learners' ability to recognize many facts, practice experimentation, explore relationships and physical principles (Jimoyiannis & Komis, 2001).

However, teaching physics may be one of the most fields of knowledge that helped in using modern technology with multiple patterns and effective learn strategies (Jimoyiannis & Komis, 2001) such as spreadsheet programs, multimedia, computerized physics laboratories, educational software, computer simulations and intelligent tutoring programs (Schulze, Shelby, Treacy & Wintersgill, 2000).

In fact physics interests in studying phenomena ranging from the microscopic world, to the very complicated cosmic phenomena which are difficult to study and examine their effects directly (Bozkurta & Ilik, 2010). The importance of computer simulation programs as technique which helped significantly in this area appeared later(Finkelstein et al,2005; Adams et al, 2008) . Computer simulation provides

students with computing environment which allows them to discover the system and address variables (Campbell, Bourne, Mosterman, & Brodersen, 2002). It can be used as a means to help the teacher in clarifying concepts (Jensen, Self, Rhymer, Wood, & Bowe, 2002); it can also be used by students themselves (Colaso et al., 2002) so as to explain phenomena that cannot be understood in natural conditions (Lewis, Stern, & Linn, 1993; Luo, Stravers, & Duffin, 2005).

Organizers of teaching physics process can use computer simulation programs to increase students' ability to gain knowledge and information about scientific phenomena and concepts (Liu,2005). In addition, it is used for helping them to involve in science processes as imposing hypothesis, experimentation, interpreting data and organizing of learning process (Tomshaw,2006; Chang, Chen, Lin & Sung, 2008).

But we must realize that there are frequent cases of computer simulation usage in education which it did not result in the intended purpose (Bangert-Drowns, Kulik, & Kulik,1985; Regan & Sheppard, 1996; Reamon & Sheppard, 1997). So, this confirms the view that we should not completely believe in using computer technology in education. Today, we are in urgent need to emphasize on assessing methods and strategies which use computer technology in education. The first of these computer technologies is computer simulations and this should be done before making the decision to incorporate them in this process.

Study's Problem and Questions

Today, computer and technology have more influence on all areas of human life (Sharhan,2000) and education in the first place. Where there were many technological tools with different uses while education technology was marked as a branch of modern science education(Samara,2005).

As a result, institutions and educational organizations would like to develop technological tools and techniques in order to reduce difficulty facing learning process (Massoudi & almazroi,2012). Thus, physics concepts teaching was one of the educational institutions' priorities. At the same time, in line with recent trends in learning process, these institutions made sure of developing trends of research and discovery (Wieman and Perkins,2006).

It is no longer integrate computer technology in education is acceptable without thinking about how it is done. Today, there are necessary in relation to converting these technological tools to cognitive tools that help the learner to practice thinking through multiple cognitive processes.

Computer simulation programs are the most technological tools that operate in the same context. Thus, in this study, we tried to answer the following questions:

1- What is the effect of using computer simulations in teaching physics on undergraduate students' understanding concepts of electricity and magnetism?

2- What is the effect of using computer simulations in teaching physics on undergraduate students' attitude towards physics learning?

The importance of the study

This study is important because it includes the most influential factor in education process at the moment such as modern technology and patterns used in this process. However, this study focused on identifying the effect of computer simulations technology on teaching the most difficult science for students to understand its concepts, it is physics, which students usually have negative attitudes towards learning it. On the other hand, this study draws the attention of physics teachers towards using computer simulation software (e.g. PhET –simulations) used in the study and prepared in University of Colorado – USA.

Objectives of the Study

This study aims at recognizing the effect of merging computer simulation program used in teaching physics in the university stage in Jordan upon academic achieving of electricity and magnetic concepts and the effect of programs on the attitude of students in terms of physics learning.

STUDY PROCEDURES

Study Design:

Semi-experimental methodology was used in this study and was implemented in two academic years (2010 – 2011) and (2011-2012) in Hussein Bin Talal University south of Hashemite Kingdom of Jordan. Two sections of general physics (2) (electricity and magnetic) were selected randomly among all available sections in the first semester of the academic year (2010-2011). The two sections formed the control group which was taught through the traditional lecture. The experimental group was formed from the two sections of the same subject through random selection method in the first semester of the next academic year (2011-2012). Table (1) shows the distribution of the two groups. The two sections in experimental group were taught using computer simulation where the electronic links of the used software were connected for each targeted concept in the study plan which distributed at the beginning

of the semester. The lecturer of the course merged the targeted software in teaching process of the concepts of electricity and magnetic through presenting the electronic simulations and explaining the concepts through them. Such procedure was done through using worksheets designed based on the inquiry strategy. Answering will be done through using a software so that to deepen the understanding process. In addition, using educational ph-ET software was used in the process of structural evaluation during the semester.

Groups	Sections		Total		
	1	54			
Control	2	61	115		
	3	72			
Experimental	4	48	120		

Table (1) Study groups

Study Tools:

In order to answer the questions of the study, the researcher prepared and selected three researching tools as below:

1. Computer Simulation Software (PhET- simulation).

2. Colorado Learning Attitudes about Science Survey (CLASS-Phys)

3. Electricity and magnetic concepts test.

PhET- simulation:

PhET-simulation is considered a learning tool includes more than 80 educational experiments in different subjects of science. It is available through the internet (http://phet.colorado.edu). It is characterized with its widespread and being used too much globally. It is oriented mainly by students in the preliminary courses in university(McKagan et. al ,2008 ; Podolefsky ,N.S, Adams, W. K, Wieman,2009).

This software was designed in Colorado University based on the principals of informative education and a huge group of studies and researches. It provides the interactive opportunities between the student and the content through an exploring course and with minimal limits of guidance. All contents of the lessons in the software were connected with real-life phenomena (McKagan et. al ,2008).

Some physics lecturers in Al-hussien Bin Talal University reviewed the software by the presence of the researcher. All lecturers of general physics or introductory physics, which includes in the second part the concepts of electricity and magnetic agreed to select eight educational slides that in conformity with the content of the course. Figure (1) shows an example of one of these slides.



Figure (1) Ohms law

Ph-ET-simulation provides a group of hints and worksheets to the students. Also there are teaching plans the teachers can benefit from them. Also there is a group of tasks that will be implemented by the students. All these worksheets and tasks were planned on the basis of the inquiry strategy.

Colorado Learning Attitudes about Science Survey (CLASS-Phys):

Colorado Learning Attitudes about Science Survey (CLASS-Phys) Measure the students' attitude towards physics learning which was prepared in Colorado University. It consisted of 42 paragraphs. The localized (Arabized) version was used by the Distinguishing Research Center in developing teaching mathematics and science in King Saud University in the Kingdom of Saudi Arabia so that it will be the suitable

measurement for educational environment in the Arab World. The survey was subject to a group of tests of validity and stability (Perkins, Adams, Finkelstein, Wieman, 2004; Adams et. Al, 2008).

This survey was designed in Colorado University on the basis of a group of surveys that working in the same direction (Perkins, Adams, Finkelstein,& Wieman,2004), so that the student or the individual will answer a group of phrases through Likert scale answers style (Strongly disagree –Disagree – Don't know – Agree - Strongly agree). Here are examples of some phrases (I study the physics in order to get the knowledge that will help me in my life outside the university. I enjoy solving physics problems. --------.

Electricity and magnetic concepts test

After enumeration of the targeted electricity and magnetic concepts which were emphasized through simulation software, the researchers developed test for these concepts through specifications table and with the help of three lecturers of physics in Al Hussein Bin Talal University. Those concepts were (Electric charge – Electric current – Electric field – Electric voltage – Electric resistance – Ohm's Law – Electric capacitor – Magnetism – Electromagnetic Field). The questions of the test were diverse enough to simulate the different levels of thinking. Those who developed the test provided more than 45 paragraphs. In order to know the truth of the test, it was presented to five members of the faculty who are specialized in teaching the electricity and magnetic in the Jordanian universities in order to express their notes in terms of suitability, clarity, wording of the paragraphs and their relation to the targeted concepts. Upon receiving the opinions of the arbitrators, such opinions were considered, some amendments were conducted and the paragraphs that did not gain consensus concerning their validity were cancelled. Finally the test was including 27 paragraphs.

In order to calculate stability factor of the test, testing and re-testing method was used on a another sample consisting of 46 students (males and females) from the physics section in Hussein Bin Talal University who previously studied the course of electricity and magnetism. The test was applied on the sample and applied again after three weeks. The stability factor was calculated and found equals to 0.86

REVIEWING AND DISCUSSING THE STUDY'S OUTCOMES

Outcomes related to the first question:

At the beginning of the first semester of the academic years (2010 – 2011) and (2011 – 2012) all the areas were subjected to two groups; a control and an experimental group to test physics concepts and also after completion of teaching process (the experimental process). The arithmetic means standard deviations were calculated concerning the students' scores. Table 2 shows the results of the students regarding the academic achievement of concepts of electricity and magnetism :

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	Groups	Adjusted	Std.Error			
		Averages				
	Control	9.753ª	.386			
	Experimental	15.262ª	377			

Table. 2 Adjusted Averages of students achievement

a. Covariates appearing in the model are evaluated at the following values: achievement = 7.5319.

In order to know if there is an effect of statistical indication regarding the experimental process (the computer simulation software) on the academic achievement of the subjects of the concepts of electricity and magnetism at the indication level ($\alpha = 0.05$). The researchers used the Analysis of covariance (ANCOVA) at the dimensional test and after taking into consideration achievement differences on the pretest. Table 3 shows this fact:

Table. 3 Analysis of covariance						
Source	Sum of Square	df	Mean Square	F	Sig	
Corrected Model	2375.443ª	2	1187.722	75.240	0.000	
Intercept	3317.149	1	3317.149	210.136	0.000	
Achievement	1727.351	1	1727.351	109.425	0.000	
group	1533.207	1	1533.207	97.126	0.000	
Error	3662.284	232	15.786			
Total	43145.000	235				
Corrected Total	6037.728	234				

a. R Squared = .393 (Adjusted R Squared = .388)

The outcomes of statistical analysis show an effect of statistical indication of using computer simulation program regarding electricity and magnetism concepts with university students. The value was (f = 97.126) which has statistical indication where ($\alpha = 0.05$). This may attributed to what the used program provides such as specific additions to the learning process. It provides the opportunities of understanding physical concepts where students can see such concepts e.g. electric charge and electric current. The simulation software represents the physics concepts with multi-styles (figures, charts, movements, shapes...). This makes understanding concepts became more easily. As well as repeating implementation of the experiment with different values helps the student to recognize the relationships and principals organizing these concepts. Also, using that software by the student outside of the lecture, during memorization or implementing certain duties will reduce individual differences among students regarding understanding the concepts and solving the arithmetic problems as implementation of the physics principals and laws (Jimoyiannis & Komis,2001; Bozkurta & Ilik, 2010). The simulation software provides the chances to practice thinking at high levels. This is reflected positively on the academic achievement of physical concepts by the students (Chang, Chen, Lin & Sung, 2008).

The software provides the chances of verification, research, discovery and trial as thou the learner is a researcher in an actual laboratory of physics. This will increase learning motivation. Particularly, (Soyibo & Hudson, 2000; shonaq & bani domi ,2010) the student possesses great desires and positive attitude towards using the computer in learning process.

Outcomes related to the second question:

In order to measure the effect of merging simulation software in teaching physics in university on the attitude of the students towards learning physics and then measuring these attitudes using the direction measurement before and after the experimental treatment, the results are shown in the table (4):

ible .4 Aujusteu Averages of students attitud			
	group	Mean	Std. Error
	Control	12.773ª	.234
	Experimental	13.126ª	.229

Table .4 Adjusted Averages of students attitudes

a. Covariates appearing in the model are evaluated at the following values: attitude = 11.3787

In order to know if the apparent differences among the arithmetic means of the attitudes of the individuals of the experimental and control groups are differences of statistical indication, ANCOVA analysis has been used. Table (5) shows the outcomes of the analysis.

Table.5 Analysis of covariance						
Source	Type III Sum	df	Mean	F	Sig.	
	of Squares		Square			
Corrected	8487.502ª	2	4243.751	675.746	.000	
Model						
Intercept	190.433	1	190.433	30.323	.000	
Attitude	8485.927	1	8485.927	1351.240	.000	
Group	7.328	1	7.328	1.167	.281	
Error	1456.983	232	6.280			
Total	49374.000	235				
Corrected Total	9944.485	234				

a. R Squared = .853 (Adjusted R Squared = .852)

From table (5), it is clear that there are no differences of statistical indications regarding attitudes of the students in both the experimental and control groups as the value was (f = 1.167) which is not statistically significant at the indication level (α = 0.05). This outcome contrasts the results of the (Bozkurta & Ilik, 2010) study. The reason may be that changing the students' orientations towards learning physics needs long time because the students study most of their physics courses using the traditional method that do not help them to have positive attitudes towards learning physics. This fact has been asserted by the studies (Alhadlaq et. al, 2009) and (El Dik, 2010). Also students in Hussein Bin Talal University have studied physical concepts in school stage also with a method which does not give them pioneer roles and active participation on most cases. Hence, this study gives recommendations to

merge the computer simulation in teaching physics of education with a planned methods and training the teachers of physics for teaching through employing these programs and using methods depend on real roles for the students to understand and discover the physic concepts.

The process of building a positive attitudes towards learning physics may depend on other factors such as the teacher's characteristics and educational environment in addition to the nature of horizons and opportunities that were given by learning physics concerning the future of students. Also the prevailing impression in community about the physics may affect too much on the people who study this field.

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