

## The Effect of e-learning Approach on Students' Achievement in Biomedical Instrumentation Course at Palestine Polytechnic University

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### Abstract

*E-learning is widely used in universities and other organizations all over the world, either to support classroom learning or on its own. The Palestine Polytechnic University (PPU) is no exception. Usually, a special kind of web-based content management system is used for running e-learning courses. These systems hold all the course content and information of the students and also provide the interactive tools to support learning process. While using such systems makes the e-learning experience much easier, it also induces some problems like the heterogeneous previous knowledge of the students. The attitude of students towards e-learning or learning content management systems is also an important factor in e-learning. There have not been any major surveys in the PPU in that regard.*

*With newly developing multimedia technologies, incorporating simultaneous presentations of narration, images, and text, the possibilities for instruction are vast. Yet, how and when should educators use these technologies in the most effective ways to enhance learning? This is the driving question behind this research: What is the effectiveness and usefulness of using multimedia in e-learning approach in teaching the Biomedical Instrumentation course for students of Biomedical Engineering Program in the Palestine Polytechnic University?*

*In this study, an experimental group of (14) students was examined after studying a course using e-learning approach. The instructional design approach was used. I have used the El-Gazzar Instructional Design Model (2002) since it was proved to be simple and efficient. The course was implemented using MOODLE-LMS. The students' achievement was examined before and after the experiment. The research results proved that there is a significant increase in gain in achievement. The e-learning has achieved efficiency greater than (80%) in achievement. Also, the e-learning has achieved efficiency greater than (1.2) measured with respect to Black's Gain Ratio in achievement. Also, the e-learning has achieved efficiency greater than (0.6) measured with respect to McGugian's Gain Ratio in achievement. The e-learning has achieved larger effect size (more than 0.14) on achievement.*

**Keywords:** e-learning, Students' Achievement, pre-test, post-test, t-test

### 1. Introduction

No one can deny that advances in information technology coupled with the changes in society, are creating new paradigms for education and training. These changes will affect our education and training systems. Participants in this educational and training paradigm, require rich learning environment supported by well-designed resources (Khan, 1997). Therefore, there is a great demand for affordable, efficient, easily accessible, open, flexible, learner-centered and facilitated learning environment. Hall (2001) reports that "e-learning is the fastest growing and most promising in the educational industry".

Actually, there is a great debate about whether it is the use of a particular delivery technology or the design of the instruction that improves learning (Clark, 2001; Kozma, 2001). It has long been recognized that specialized delivery technologies can provide efficient and timely access to learning materials; however, Clark (1983) has claimed that technologies are vehicles that deliver instruction, but they do not influence student achievement. Similarly, Schramm (1977) suggested that learning is influenced more by the content and instructional strategy in the learning materials than by the type of technology used to deliver instruction.

E-learning is widely used in universities and other organizations all over the world, either to support classroom learning or on its own. The Palestine Polytechnic University (PPU) is no exception. Usually, a special kind of web-based content management system is used for running e-learning courses. These systems hold all the course content and information of the students and also provide the interactive tools to support learning process. While using such systems makes the e-learning experience much easier, it also induces some problems like the heterogeneous previous knowledge of the students. In many cases, this can be an obstacle, especially in such courses, where the students are from different faculties, or in adult learning situations. This is also a problem in the regular classroom education, but even more so in e-learning, where the participants can be from all over the world. The attitude of students towards e-learning or learning content management systems is also an important factor in e-learning. There have not been any major surveys in the PPU in that regard.

According to (Bonk and Reynolds, 1997), to encourage thinking on the e-learning, challenging

activities that enable learners to link new information to old, and acquire meaningful knowledge must be created; hence, it is the instructional strategy and not the technology that influences the quality of learning. Kozma (2001) argues that the particular attributes of the computer are needed to bring real-life models and simulations to the learner; thus, the medium does influence learning. However, it is not the computer per se that makes students learn, but the design of the real-life models and simulations, and the students' interaction with those models and simulations. The computer is merely the vehicle that provides the processing capability and delivers the instruction to learners (Clark, 2001).

In 1997 and after the Palestinian authority had been established, Palestine Polytechnic University (PPU) in Hebron-Palestine established a new engineering program called Biomedical Engineering to fill the wide gap and needs for this program in Palestinian hospitals and medical centers being previously controlled by the occupation authorities since 1967. The Biomedical program academic plan is developed by consulting experts from universities in Egypt, Jordan and Sweden. One of the important courses in the plan is the Biomedical Instrumentation course of 3-credit hours and two-lab sessions weekly, continuing for 16 week. This course describes the principles, applications and design of the medical instruments most commonly used in hospitals.

The course includes the following subjects:

- 1- Basic Concepts of Biomedical Instrumentations and Measurements.
- 2- Biomedical Sensors and Transducers.
- 3- Biomedical Electrodes.
- 4- Electrocardiograph (ECG) Amplifiers and Processing.
- 5- Blood Pressure Measurements.

It is well known that the biomedical engineering is an interdisciplinary field requiring a strong background in physics, chemistry, mathematics, electrical circuits, electronics, computer hardware and software. Also, the course treats signals of biological sources characterized by low frequency, low amplitudes; needs special and very expensive laboratory devices for studying. In lab, the experiments may be very dangerous if implemented really. Also, the bio signals may be corrupted by noises of different sources that need a special computer processing for feature extraction, especially, since one physiological system may affect the operation of other systems. (Webster, J.G.1995).

Also, these signals are taken from living organs in a system that can't be turned off, as an electrical device for repairing as an example. Sometimes, it is essential to follow the signal propagation in the human body and record the electric field that will appear on the body surface for diagnosis purposes.

These are impossible to achieve without computer technology, like recording of the heart electrical activity. Monitoring patient in an Intensive Care Unit needs computers, also. (Tompkins, W.J. 1993)

The biomedical technology development is very fast and hundreds of devices and systems have being used. Many biomedical companies have published important data concerning their devices on their sites on the internet. Service and operating manuals are essential for the biomedical engineer to conduct when needed, (Carr, Jacobson. & Brown M. 1993).

I have taught the biomedical instrumentation course in PPU many times, and I have noticed the difficulty for students to achieve good scores and to be interactive in the classroom during the lectures. As an example, some students can't imagine how are the heart valves movement, ECG signals and blood pressure be related. For answering, to draw, to show animation, to hear sounds in a systematic way using chalk and talk is impossible. What about abnormal situations, different waveform, different animation etc. I have consulted my colleagues in the Electrical and Computer Engineering department at PPU about this situation and explained for them my opinion to use the computer-based learning to overcome these problems. All of them agree that e-learning using computer tools, internet and, interactive multimedia based on instructional computer will enhance the education process and increase the efficiency especially if designed under the control of the Instructional System Design theory.

**The research problem may be defined in the following question:**

What is the effectiveness and usefulness of using multimedia in e-learning approach in teaching the Biomedical Instrumentation course for students of Biomedical Engineering program in the Palestine Polytechnic University?

**2.1. The Research Importance**

This study is an important contribution to the research of understanding how to use e-learning and web-based multimedia instruction. Colleges and universities are using the Internet and WWW more and more to deliver instruction, and instructors and courseware designers need to have valid information on what technologies are available and how to use them to improve student learning. Students of the "Net Generation" expect and demand high quality, fully accessible course materials available online. Decisions to purchase e-learning and multimedia software by university departments can be justified through this research. Software companies would gain feedback about the usefulness of their products in an educational setting.

The Biomedical Instrumentation course is one of the essential program requirements for the Biomedical Engineering Program. Using e-learning approach to teach this course is the first attempt to engage the internet facilities in PPU. The efficiency of the

suggested program will be determined. The student's attitudes toward this technology will be studied. Student's feedback will be analyzed to determine future plans concerning this type of learning. PPU technological facilities and educational development strategies may be changed according to the research results.

**2.2. The Research Hypothesis**

1-There are no significant differences at level of  $\alpha$  (0.05) between the mean scores of the achievement of pretest and posttest.

2-E-learning based on internet has efficiency in achievement not less than 80%.

3-E-learning based on internet has efficiency in achievement not less than 1.2 as measured with respect to the modified Black's Gain Ratio.

4-E-learning based on internet has efficiency in achievement not less than 0.6 as measured with respect to the McGugian Gain Ratio.

5-E-learning based on internet has an effect size on achievement not less than 0.14.

**2.3. The Research Methodology**

The research was carried out using the experimental methodology in which the 14 student were treated as an experimental group. This group had studied the course of biomedical instrumentation being programmed using the (MOODLE) platform Learning Management System.

**3. Experimental Design**

I have used a pretest- posttest experimental design. One experimental group with pretest-posttest were timed and taken on computers using the testing module of the course management system in Moodle. All students were experienced with the testing format of the Moodle. Test questions on pre- and post-tests were identical. Test answers were not revealed on the pre-test. The test questions were derived from a pool of questions bank designed by the researcher.

**3.1. Variables Calculations and Statistical Processing**

After completing the experiment, I have collected the data to be analyzed. The following relations were used in this research to measure the students' gain in achievement after studying the biomedical instrumentation course using the e-learning approach.

1. Gain = posttest grade – pretest grade

2. Modified Black's Gain Ratio:

$$\text{Modified Black's Gain Ratio} = \frac{(Y-X)}{(D-X)} + \frac{(Y-X)}{D}$$

Where: Y = grade of post-test  
X = grade of pre-test  
D = test maximum grade

This ratio interval is [0, 2] and the instructional program is considered acceptable if the computed ratio is not less than 1.2, (Roebuck, 1973, p 472-473).

3. McGugian Gain Ratio:

$$\text{McGugian Gain Ratio} = \frac{\text{Real Gain}}{\text{Expected Gain}}$$

$$\text{McGugian Gain Ratio} = \frac{(Y-X)}{(P-X)}$$

Where: Y = average of post-test grade

X = average of pre-test grade

P = test maximum grade

This ratio interval is [0, 1] and the instructional program is considered acceptable if the computed ratio is not less than 0.6, (Roebuck, 1973, p 472-473).

4. Effect Size: How much change the independent variable will affect the students' achievement and attitudes in studying a new program.

In this research I mean how much change the e-learning approach will affect the biomedical engineering students' achievement and attitudes in studying the biomedical instrumentation course.

Statistically, the square of eta ( $\eta^2$ ) will be used.  $D = t^2 / (t^2 + df)$ , t-value with degrees of freedom df. This factor should be greater than 0.14

5. Descriptive Statistics.

6. t-test: The t-distribution is a bell-shaped, symmetric about the mean distribution, used when the sample size is less than 30 and the variance is normally or approximately normally distributed. It is actually a family of curves based on the concept of degrees of freedom, which is related to sample size ( $df = n-1$ ). As the sample size increases, the t-distribution approaches the standard normal distribution.

**4. Results**

In order to apply parametric tests, the data was firstly investigated for normality distribution using Kolmogorov-Smirnov statistic. In Kolmogorov-Smirnov statistic, the data is assumed to be normal if the significance level is greater than (.05). As shown in table (1), the data was confirmed to be normally distributed. Therefore the t-test was used since the sample size is small ( $n=14$ , all the population) and the data was normally distributed.

Table 1: Data Normality tests

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Tests diff	.149	14	.200	.919	14	.213

When examining descriptive data concerning the pretest and posttest achievement scores (table 2), it was noticed that there is an increase in the mean of scores by (53.071) after the application of the elearning of the course. This value represents the gain in students' achievement. Also, it is well-known that the standard deviation is a measure of how well the mean represents the data. Small standard deviation (relative to the value of the mean) indicates that the data points are close to the mean. A large standard deviation (relative to the value of the mean) indicates that the data points are distant from the mean, or that the mean is not an accurate representation of the data. As seen in the table (4.2),

the standard deviation in the posttest (5.919) is reduced compared to the standard deviation in the pretest (9.153), which means less data variations and pointed out that the student's scores are around the mean (82.43).

Table 2: Descriptive Statistics for Achievements

Test	N	Mean	Standard deviation
Pretest	14	29.36	9.153
Posttest	14	82.43	5.919

**4.1. Paired Samples Statistics**

To check the validity of the first hypothesis that stated (There are no significant differences at level of  $\alpha$  (0.05) between the mean scores of the achievement of pretest and posttest), the paired samples (dependent) t-test was run on the SPSS-15 program to determine any significant differences between post- and pre- test scores. The results are shown in table (3). It is clear from this table and table (2) that the mean in the scores is increased from (29.36) to (82.43) by a difference of (53.071).The computed t-value equals (6.127) at degree of freedom equals (13) with statistical significance less than (0.001). This is less than the claimed level of significance  $\alpha$  (0.05), therefore the null hypothesis is rejected and the alternative hypothesis is accepted i.e. there is significant differences at level of  $\alpha$  (0.05) between the mean scores of the achievement of pretest and posttest, favoring the posttest).

Table 3: Achievement Dependent Samples t- test

Achievement	N	Mean	Std. deviation	t-value	df	p-value
Pretest	14	29.36	9.153	6.127	13	0.001
Posttest	14	82.43	5.919			

**4.2. One-Sample t-test**

To check the validity of the second hypothesis that stated (e-learning based on internet has efficiency in achievement not less than 80%), the one-sample t-test was run to determine whether a difference

Test Value = 80						
Achievement	N	Mean	Standard deviation	t-value	df	p-value
Posttest	14	82.43	5.919	1.535	13	0.149

exists between the posttest scores after application of elearning on the course and the test value of (80%). The results are shown in table (4).The computed t-value equals (1.535) at degree of freedom equals (13) with statistical significance (0.149). It is clear that there is no significant difference between the posttest scores and the degree 80% (posttest mean = 82.43).Therefore the null hypothesis is accepted i.e. e-learning based on internet has efficiency in achievement not less than 80%.

Table 4: Achievement One Sample t- test

**4.3. Achievement Black's Gain Ratio**

To check the validity of the third hypothesis that stated (e-learning based on internet has efficiency in achievement not less than 1.2 as measured with respect to the modified Black's Gain Ratio), the gain is calculated for each student based on the equation specified in section (3.1). The mean and standard deviation of this gain is calculated and shown in table (5). It is clear from this table that the calculated mean of Black's Gain Ratio equals (1.2878) which is greater than the reference value (1.2). This implies that e-learning achieves efficiency greater than Black's Gain Ratio.i.e. Accepting the null hypothesis.

Table 5: Achievement Black's Gain Ratio

	N	Minimum	Maximum	Mean	Std. Deviation
Black's Gain	14	1.22	1.41	1.2878	.05771

**4.4. Achievement McGugian Gain Ratio**

To check the validity of the fourth hypothesis that stated (e-learning based on internet has efficiency in achievement not less than 0.6 as measured with respect to the McGugian Gain Ratio), the gain is calculated for each student based on the equation specified in section (3.1). The mean and standard deviation of this gain is calculated and shown in table (6). It is clear from this table that the calculated mean of McGugian Gain Ratio equals (0.7571) which is greater than the reference value (0.6). This implies that e-learning achieves efficiency greater than McGugian Gain Ratio.i.e.accepting the null hypothesis.

Table 6: Achievement McGugian Gain Ratio

	N	Minimum	Maximum	Mean	Std. Deviation
McGugian Gain	14	.69	.89	.7571	.05934

**4.5. Effect Size of e-learning on Achievement**

To check the validity of the fifth hypothesis that stated (e-learning based on internet has an effect size on achievement not less than 0.14). The square of ( $\eta$ ) is calculated and summarized in table (7). The square of ( $\eta$ ) equals 0.743 which is greater than the reference value (0.14). This implies acceptance of the claimed hypothesis.

Table 7: Effect Size of e-learning on Achievement

N	t-value	df	$\eta^2$	Effect Size
14	6.127	13	0.743	large

## 5. Conclusions

The goal of any learning activity is for learning to take place. A common way to measure the effectiveness of instruction is to measure learner achievement. Measuring learner achievement in e-learning environments requires special attention. In fact, traditional methods for measuring learner achievement can be applied to e-learning courses with some forethought and modification. Quizzes, exams, team and individual projects, as well as written assignments, can all be used in e-learning courses. The use of electronic mediums can even make grading of tests and quizzes easier because scores can be tabulated immediately following the completion of a quiz or test, providing quick and accurate feedback to learners.

When examining the descriptive data concerning the achievement pretest and posttest scores, it was found that there is an increase in the mean of scores by a gain value (53.071) after the application of the e-learning of the course. Also, the standard deviation in the posttest is reduced compared to the standard deviation in the pretest which means less data variations and pointed out that the student's scores are around the mean (82.43). Therefore the first hypothesis stated that (There are no significant differences at level of  $\alpha$  (0.05) between the mean scores of the achievement of pretest and posttest) is rejected. The validity of the second hypothesis stated that (e-learning based on internet has efficiency in achievement not less than 80%) was accepted after the application of one-sample t-test between the posttest scores after application of e-learning on the course and the test value of (80%). The validity of the third hypothesis stated that (e-learning based on internet has efficiency in achievement not less than 1.2 as measured with respect to the modified Black's Gain Ratio) was accepted since the calculated Black's Gain Ratio equals (1.2878) is larger than the reference value (1.2).

The validity of the fourth hypothesis stated that (e-learning based on internet has efficiency in achievement not less than 0.6 as measured with respect to the McGugian Gain Ratio) was accepted since the calculated McGugian Gain Ratio equals (0.7571) is larger than the reference value (0.6). The validity of the fifth hypothesis stated that (e-learning based on internet has an effect size on achievement not less than 0.14) was accepted since the calculated effect size equals (0.743) is larger than the reference value (0.14).

From this discussion, it is clear that e-learning approach has good efficiency in learning and improves the students' achievement and attitudes toward this new systematic way of learning using the new technology based on computer and multimedia tools. After the results of the research have been lighted, the researcher would like to suggest the following points:

- The e-learning approach should be used in our Universities, especially occupation military barriers are usual.
- Execute practical sessions for students of all levels concerning use of LMS.
- Encourage instructors to practice the e-learning approach and use LMS.
- Establish an authoring unit for e-learning of different courses with different experts.

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