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The Effectiveness of Problem Based Learning Method on Students' Achievement in An Analog Electronics Course at Palestine Polytechnic University

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ABSTRACT

This study, undertaken at the Palestine Polytechnic University in Palestine, describes how problem-based learning (PBL) affects the Students' Achievement in 'analog electronics course'. Problems were designed to match real-life situations. Data of the experimental group learning outcome effects, were compared.. It was found that students who followed the PBL method learned to do research, learned better how to work in groups and developed greater confidence. Also what they learned was more of a practical value and they had more positive attitudes and reflected more. This research is in response to the real need to address gaps between employer expectations and higher education outcomes in Palestine.

In this study, an experimental group of (16) students was examined after studying a course using PBL approach. 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 PBL has achieved efficiency greater than (80%) in achievement. Also, the PBL has achieved efficiency greater than (1.2) measured with respect to Black's Gain Ratio in achievement. Also, PBL has achieved efficiency greater than (0.6) measured with respect to McGugian's Gain Ratio in achievement. The PBL has achieved larger effect size (more than 0.14) on achievement.

Keywords: PBL, Students' Achievement, pre-test, post-test, t-test

1 Introduction

Usually, engineering students have to do laboratory experiments as part of the curriculum and they should be able to apply their knowledge. According to Kitogo (2011), "today's graduates have attractive curricula vitae, but practically, their performance is insufficient; it doesn't match with what they claim to have studied". According to Case (2011), students in the lecturing mode who followed the traditional instruction are graduating with a good knowledge of fundamental engineering science and computer literacy, but they do not know how to apply that in practice. Students tend to memorize new information instead of using it as a tool to solve problems when it is presented to them without meaning or relevance in the lecturing mode and this leads to inert knowledge.

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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.

Problem-based learning (PBL) is still in the developmental stage. There is not sufficient research or empirical data to be able to state with certainty that problem-based learning is a proven alternative to other forms of learning, especially in the Arab countries. Based on evidence gathered over the past years, problem-based learning appears to be an effective model for producing gains in academic achievement. However, only a few of them have focused on problem-based learning in Electrical Engineering. Analogue electronic components and circuits are building blocks for any electronic device used in industries or in daily life. It is therefore necessary for electronics engineers to understand clearly the principles and functioning of the basic analogue components and circuits. This course will enable the students to understand the basics of construction, working, and applications of various types of electronic components such as Diodes, BJT, JFET, MOSJFET and circuits such as Small Signal amplifier, oscillators, power amplifiers, operational amplifier, and timers using linear ICs. Practical exercises of this course would enable students to maintain such circuits and in turn maintain equipment having such circuits. This course is therefore one of the basic core courses which is a must for every electronic engineer and hence should be taken very sincerely by students.

The need for this study arises from three main things: the personal experience of the researcher in teaching field, the literature review on problem-based approach and the roles of the teacher and real needs of teachers of Electronics. First, the researcher noticed that students' achievement level in Electronics courses is decreasing as they practice learning Electronics almost only inside the class or to study for the exams. As a result, the researcher tried to find a useful strategy to facilitate learning Electronics. Second, having reviewed the current literature, the researcher has figured out that the field of Electronics teaching and learning is poor in studies concerning the roles of the teacher and learners in light of the problem-based learning approach to teaching Electronics in Arab countries. Third, the unexpected low rate of success in these courses is a problem which deserves to be studied.

Employers expect more from local graduates, especially when it comes to the application of knowledge (Griesel & Parker, 2009). According to Erasmus, Loedolff, Mda, and Nel (2006), young people are unemployed or lack entrepreneurship due to a lack of specialized skills. Some of those skills are identified by Bethlehem (1997) as 'communication skills', 'decision-making skills', 'analytical skills', teamwork skills, 'well-practised leadership skills' and 'good interpersonal skills'. Many students at PPU University struggle to design an electronic project of reasonable proportion in a final year program under the label 'Design of Graduation Projects' due to a lack of application of knowledge.

Problem-Based Learning (PBL), an alternative to the traditional lecture-based approach, is built on the principle of constructivism in which learners are confronted with a meaningful authentic context. PBL originated from the McMasters University in Canada in the late sixties, using a problem-based approach

in medicine (Kolmos, de Graaff, & DU, 2009). Some European universities such as Aalborg in Denmark also implemented problem orientated, project organised PBL (Kolmos, Fink, & Krogh, 2006).

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

What is the effectiveness and usefulness of using problem-based learning (PBL) approach in teaching 'analog electronics course' for students of Electrical Engineering programs in the Palestine Polytechnic University (PPU)?

2.1 The Research Hypothesis

1- Problem-based learning (PBL) approach has efficiency in achievement not less than 80%.
2- Problem-based learning (PBL) approach has efficiency in achievement not less than 1.2 as measured with respect to the modified Black's Gain Ratio.
3- Problem-based learning (PBL) approach in achievement not less than 0.6 as measured with respect to the McGugian Gain Ratio.
4- Problem-based learning (PBL) approach has an effect size on achievement not less than 0.14.

2.2 The Research Methodology

The research was carried out using the experimental methodology in which the 16 student were treated as an experimental group.

3 Experimental Design

The process and purpose of the research study was explained to the students. The 16 students were randomly grouped in pairs All students were satisfied with the allocations made and no one requested to change partner. PBL requires students to work much harder than traditional lecture method.

The students were requested to solve the problem, following the operational definition of PBL according to Barrett, Mac Labhrainn, and Fallon (2005):

1. First students are presented with a problem.
2. Students discuss the problem in a small group PBL tutorial. They clarify the facts of the case. They define what the problem is. They brainstorm ideas based on their prior knowledge. They identify what they need to learn to work on the problem, i.e. what they do not know (learning issues). They reason through the problem. They specify an action plan for working on the problem.
3. Students engage in independent study on their learning issues outside the tutorial. This can include: library, databases, the web, resource people and observations.
4. They come back to the PBL tutorial(s) sharing information, peer teaching and working together on the problem.
5. They present their solution to the problem.
6. They review what they have learned from working on the problem. All who participated in the process engage in self, peer and tutor review of the PBL process and reflections on each person's contribution to that process.

The problem was stated as: assume that you are working for an Electronics company. They have asked you to design, develop and test a suitable regulated DC power supply of 9 volt , 100 mA. The line voltage 220VAC can go as low as 200VAC and as high as 240VAC from time to time, usually for small periods. Large

quantities of these power supplies are expected to be sold and you are requested to make the system as cheap as possible.

1st Small group meeting - PBL students met in their respective pairs and discussed the problem. Each student in the group had to use his/her own knowledge and experience and presume that they were personally asked to solve the problem/s. They needed to come up with a small number of hypotheses that were likely to explain and solve the problem and then divide the work to be done amongst the group members.

Individuals – They worked separately over the next 3 days to allow each member to independently carry out the research on how to design, develop, and test a suitable power supply.

2nd Small meeting - The pairs met again and drew conclusions on the nature of the problem and the best fit solutions given the information known.

Finally, each pair of students implemented the solutions, demonstrated the operation of the power supply, and submitted a report as to the solution and its consequences.

. All students had done a post-test after the experiment.

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 analog electronics course using the PBL approach.

1. Gain = posttest grade – pretest grade

2. Modified Black's Gain Ratio:

Modified Black's Gain Ratio = (Y-X)/(D-X) + (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:

McGugian Gain Ratio = Real Gain/Expected Gain

McGugian Gain Ratio = (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 PBL approach will affect the students' achievement in studying the course.

Statistically, the square of eita (ŋ2) will be used. Ŋ = t2/(t2 +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

When examining descriptive data concerning the pretest and posttest achievement scores (table 1), it was noticed that there is an increase in the mean of scores by (55.2) after the application of the PBL method. This value represents the gain in students' achievement.

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4.1 Paired Samples Statistics

To check the validity of the first hypothesis, 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 (1). It is clear from this table that the mean in the scores is increased from (30.30) to (85.50) by a difference of (55.20).The computed t-value equals (6.127) at degree of freedom equals (15) with statistical significance less than (0.001). This is less than the claimed level of significance α (0.05), therefore the null hypothesis is rejected and the alternative hypothesis is accepted i.e. there is significant differences at level of α (0.05) between the mean scores of the achievement of pretest and posttest, favoring the posttest).

Table 1: Achievement Dependent Samples t- test

Achievement	N	Mean	Std. deviation	t-value	df	p-value
Pretest	16	30.30	9.66	6.127	15	0.001
Posttest	16	85.50	4.91			

4.2 One-Sample t-test

To check the validity of the second hypothesis the one-sample t-test was run to determine whether a difference exists between the posttest scores after application of PBL on the course and the test value of (80%). The results are shown in table (2).The computed t-value equals (1.535) at degree of freedom equals (15) with statistical significance (0.149). It is clear that there is no significant difference between the

posttest scores and the degree 80% (posttest mean = 85.5).Therefore the null hypothesis is accepted i.e. PBL has efficiency in achievement not less than 80%.

4.3 Achievement Black's Gain Ratio

To check the validity of the third hypothesis ,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 (3). It is clear from this table that the calculated mean of Black's Gain Ratio equals (1.29) which is greater than the reference value (1.2). This implies that PBL achieves efficiency greater than Black's Gain Ratio.i.e. Accepting the null hypothesis.

Table2:One Sample test

	Test Value = 80					
Achievement	**N**	**Mean**	**Standard deviation**	**t-value**	**df**	**p-value**
Posttest	16	85.5	4.91	1.535	15	0.149

Table 3: Achievement Black's Gain Ratio

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Black's Gain	16	1.22	1.41	1.29	.05771

4.4 Achievement McGugian Gain Ratio

To check the validity of the forth hypothesis ,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 (4). It is clear from this table that the calculated mean of McGugian Gain Ratio equals (0.76) which is greater than the reference value (0.6). This implies that PBL achieves efficiency greater than McGugian Gain Ratio.i.e.accepting the null hypothesis.

Table4: Achievement McGugian Gain Ratio

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
McGugian Gain	16	.69	.89	.76	.05934

4.5 Effect Size of e-learning on Achievement

To check the validity of the fifth hypothesis The square of (η) is calculated and summarized in table (5). The square of (η) equals 0.65 which is greater than the reference value (0.14). This implies acceptance of the claimed hypothesis.

Table5: Effect Size of e-learning on Achievement

N	t-value	df	η^2	Effect Size
16	6.127	15	0.65	large

5 Conclusions

From this discussion, it is clear that PBL improves the students' achievement. It was found that students who followed the PBL method learned to do research, learned better how to work in groups and developed greater confidence. Also what they learned was more of a practical value and they had more positive attitudes and reflected more.

After the results of the research have been lighted, the researcher would like to suggest the following points:

- The PBL approach should be used in our Universities. Engineering departments who still offer engineering courses in the traditional way

should consider promoting the use of the PBL method in at least one experiment for each of the major subjects across the engineering spectrum. Participating lecturers can then be trained in the use of PBL before implementation and dedicated facilitators could also be considered. The library and internet facilities will be used more frequently when PBL is used as a learning method and future library planning should included addressing this

opportunity..

- Execute practical sessions for students of all levels concerning use of PBL.

- Encourage instructors to practice PBL approach.

REFERENCES

[1] Barrett, T., Mac Labhrainn, M., I, & Fallon, H. (2005). Handbook of Enquiry & Problem Based Learning.

[2] Bethlehem, P. A. (1997). National Association of Colleges and Employers. Job Outlook 98

[3] Case, J. M. (2011). Knowledge matters: interrogating the curriculum debate in engineering using the sociology of knowledge. Journal of Education, 51, 73-92.

[4] Clark, R. E. (2001). A summary of disagreements with the "mere vehicles" argument. In R. E. Clark (Ed.), Learning from media: Arguments, analysis, and evidence (pp. 125-136). Greenwich, CT: Information Age Publishing Inc, http://homepages.hvu.nl/ilya.zitter/References.htm.

[5] Clark,R E. (1983). Reconsiderig research on learning from media Review of Educational Research 53(4), 445-459

[6] Erasmus, B. J., Loedolff, P. v. Z., Mda, T. V., & Nel, P. S. (2006). Managing training and development inSouth Africa (5 ed.). Southern Africa: Oxford University Press

[7] Griesel, H., & Parker, B. (2009). A baseline study on South African graduates from the perspective ofemployers - Graduate Attributes. South Africa: Higher Education South Africa & The South African Qualifications Authority Retrieved FROMhttp://www.saqa.org.za/docs/pubs/general/graduate_attributes.pdf.

[8] Kitogo, A. S. (2011). How competent are Tanzanian graduates? . Retrieved 28/11/2011, from http://varsitycollegetz.ning.com/profiles/blogs/how-competent-are-tanzanian-graduates.

[9] Kolmos, A., de Graaff, E., & DU, X. (2009). Diversity of PBL - PBL Learning Principles and Modules. In X. DU, E. de Graaff & A. Kolmos (Eds.), Research on PBL Practice in Engineering Education (pp. 9-21).Rotterdam: Sense Publishers.

[10] .Kozma, R. B. (2001). Counterpoint theory of "learning with media." In R. E. Clark (Ed.), Learning from media: Arguments, analysis, and evidence, ISBN: 1930608772, (pp. 137-178). Greenwich, CT: Information Age Publishing Inc

[11] Kolmos, A., Fink, K. F., & Krogh, L. (2006). The Aalborg PBL model - Progress, Diversity and Challenges Vol. 1. (pp. 393). Retrieved from http://www.bog-ide.dk/productsamples/9788773079119.