

The First International Conference of Engineering Education (1<sup>st</sup> ICEE 2019), Iraq, Baghdad,

9-10 January 2019

**Raed N. Hwayyin**

Petroleum Technology  
Department, University of  
Technology, Baghdad, Iraq.  
[10596@outtechnology.edu.iq](mailto:10596@outtechnology.edu.iq)

**Azhar S. Ameer**

Electromechanical  
Engineering Department,  
University of Technology,  
Baghdad, Iraq.

Received on: 15/11/2018  
Accepted on: 10/01/2019  
Published online: 25/12/2019

## Study the Effect of Apply the Problem Based Learning in Engineering Education

**Abstract-** The study examined the effect of application of the problem-based learning method of teaching engineering students in the Department of Petroleum Technology compared to traditional teaching methods (lecture). The problem-based learning method involved a number of assessments and exams that students individually and collectively performed. The study investigates the first class students of petroleum technology department of two subjects which are the calculus and engineering practice subjects. The study is use the statistical calculations to compare between applying the problem based learning and tradition method "lecture method" in engineering education, and taking into consideration the individual differences between students to communicate knowledge. The study use d statistical equations to calculate the standard deviation and variance using in determining the effectiveness of the application of the BPL method compared to the lecture method in the educational field. The results show the ratio of standard deviation in the lecture method compared to the PBL method is equal to (58.2%) in the theoretical exam, noting that the degree of evaluation of the theoretical exam in the lecture is (35%) while in the PBL method it is (20%), It means the error rate in the accuracy of the student's assessment be greater in traditional method.

**Keywords-** Problem based learning, Standard deviation, and variance.

**How to cite this article:** R.N. Hwayyin & A.S. Ameer, "Study the Effect of Apply the Problem Based Learning in Engineering Education," *Engineering and Technology Journal*, Vol. 37, Part C, No. 4, pp. 431-435, 2019.

### 1. Introduction

Modern educational methods are more capable of providing educational requirements in modern times because they have made practical reality a source of learning and knowledge acquisition. A number of researchers have studied this field. Hunt et al. [1] study of the PBL experience from a related category that included the concepts of the course, and enhanced intercourse communication and included realistic applications for students. Students considered the experience as useful, thus enhancing their understanding of the content and applications in each field of specialization. Brodeur, et al. [2], described several Problems-Based Learning experiences in aeronautical engineering at the Massachusetts Institute of Technology (MIT) where it included four levels of problem classification. The learning theories describe the elements that lead to the success of PBL, identify the basic features of PBL, the critical problems in designing the problems, and the methods that are effective in evaluating the PBL method. Barrow [3], the study aimed at learning based on solving the problem, which is to provide students with opportunities to apply

knowledge in the field of science and not to acquire it only. Problem-based learning depends on problem formulation as well as how to solve the problem. It looks up simulating research and development in the application of knowledge in real world engineering. Grolinger [4], the study considered the industry's interest in employing engineers primarily to solve workplace problems. Problem solving is an essential part of engineering education. However, problems in the industrial field, and in the work of environmental engineers, are often quite different from the experience of university engineering students. Yadav et al. [5], the study included the effect of applying problem-based learning method to electrical engineering students. The study focused on enhancing theoretical understanding and enhancing students' perceptions of learning by using PBL in comparison with the application of the lecture method. The results showed that the learning gains of participants in the PBL application were twice that of those who participated in traditional lectures. Masek and Yamin [6] they examined the theoretical relationship and reviewed the recent empirical evidence on the effect of the PBL method in enhancing students' ability to think critically. The

review was applied to the latest empirical studies from several different disciplines between 2000 and 2011. Dischino et al. [7], the study showed that the learning-based learning program improves student learning and retention, critical thinking, problem solving skills, teamwork to gain students the ability to apply knowledge to new attitudes in the real world - these skills are critical to success in the workplace in the 21st century. "Problem-Based Learning" in Sustainable Technologies: Increasing the STEM (PBM) pipeline by adopting the PBL principles for the development of innovative, standards-based curricula that focus on increasing student interest and willingness to pursue careers in different fields such as science, technology, engineering and mathematics. Simone [8] they are studying new and experienced teachers facing educational reform that requires them to meet the demanding career requirements. The research discusses the utility of implementing the PBL program in providing teachers with the necessary expertise to meet these requirements. The implementation of PBL, which focuses on moving away from the adoption of traditional medical models, is discussed and better response to the requirements of teacher education. Hitt [9] Studying problem-based learning is a curriculum for learning that focuses on the learner or student. Focus shifts from teacher-driven teaching to student-centered self-directed learning.

The objective of the current comparative analysis is the use of the statistical methods between the adoption of the traditional lecture method and the PBL method for two type subjects (Calculus and engineering practice) of the same lecturer. The PBL method has adopted the presentation of the problem as a scenario similar to the scenario that occurred in the working space and the description of the problem to analyze the data received during the description for use by the engineering students as input to solve the problem; usually this does not happen in traditional learning methods. The scenario of the educational problem is based on problems facing the society and meets its needs such as treatment of waste water, pollution and renewable energy. The application of the method to the students of the first stage has contributed to the expansion of the knowledge base of students through the search for scientific sources through the adoption of the Internet and reading the various sources in finding a scientific solution to the education problem.

### **Problem -Based Learning**

Problem-Based Education (PBL) is a problem-based teaching method that stimulates the

possibilities of engineering education to enhance student learning. The application of PBL in engineering education achieves the ability of students to bridge the gap between theory and practice. The two common problems when trying to integrate an application (PBL) into engineering classes [1]:

- 1) It takes a long time to accomplish a big and useful problem.
- 2) The possibility of determining its impact on students.

### **Objectives and characteristics of problem-based education**

Barrows described the main features of PBL in this way [3]:

- The student is the focus of the learning process, meaning that the students choose the ways of solving and how to know what they want.
- Learning takes place through science in teams that work together.
- Teachers are interpreters, mentors or trainers.
- Problems shaping organizational focus and motivation for learning.
- Problems are a tool to develop students' skill acquisition to solve the real problem.
- Acquiring new information through self-directed learning.

### **Problem-based Learning in Engineering Education**

Studies conducted in the 1990s indicate that engineering curricula and graduates were generally deficient in addressing the concerns of modern society. Industry, accreditation councils, academia and students have reiterated these concerns. Some of the main concerns included the following [5]:

1. Engineering approaches greatly focus on the adoption of engineering sciences and technical courses without sufficient coordination of these topics.
2. Software does not provide sufficient realistic design experiences.
3. Graduates lack communication skills and work in a team.
4. Programs need to develop greater awareness among students in addressing social, environmental, economic and legal issues.
5. The college lacks practical experience that simulates solving the problem in the working space.
6. The adopted learning and learning strategies are outdated and require updating to make the student the focus of the learning process.

Recent engineering programs, which began in the 1990s, have recognized the need to change

curricula. The PBL program was adopted by many engineering programs as a curriculum to help graduates acquire the skills required by their employers and address many lack of expertise in the workplace. Most commonly, the PBL application at the course level is a traditional engineering program. Only a limited number of programs integrate the PBL program across the tutorial because it requires collaboration and integration among faculty members from multiple departments. In addition, it is not clear that an integrated and integrated approach based on the capacity-building program is the best approach to success in the above concerns.

### 2. Methodology

The mean and median are the arithmetic average of the data set. Their calculation is done by adding numbers in a data set and dividing the number of existing numbers. The median represents the middle number of the data set when the data is organized in ascending or descending order [10].

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

$\sum$ : represents the summation.

x: represent scores.

n: represent number of scores.

The formula for Standard Deviation is:

$$S.D. = \sqrt{\frac{\sum_{i=1}^n (x-x_i)^2}{n-1}} \tag{2}$$

Where,

$x_i$ = Terms given in the data.

$\bar{x}$  = mean

Where, the (standard deviation) is defined as the positive square root for (variance).

### Participants

The researchers adopted the PBL method, which achieves the knowledge transfer horizontally through the discussions among the students in the same group as well as the vertical transmission through the lecturer's explanations and interpretation to solve the problem specific to work by the students, as illustrated in Figure 1.

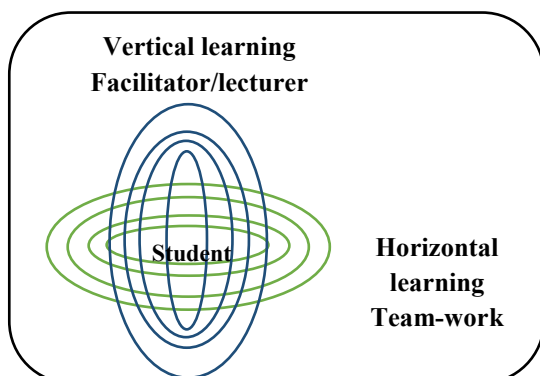


Figure 1: illustrate the knowledge transform in PBL method

The sample consisted of (32) students in the first stage in the University of Technology /Petroleum Department Technology. The study applied the PBL method and traditional methods of "lecture" to the same lecturer to focus on common assessment tools that affect the statistical results obtained from student assessment according to the approach of both methods. Students received a contact information and regular availability dates from the group mentors. Students receive contact information and regular availability dates from group routers. An additional office clock is available for the attendees on time. The work of students involved in teamwork contributes to solving the problem through research and information collection. The role of the lecturer is limited as an interpreter and directed to be the student center of the learning process.

### 3. Procedure

The PBL method is included variety evaluations of the students using of individual and group assessments as shown in the table (1). The table shows the mechanism of calculating students' grades to evaluate individual and group cognitive skills through team-work.

Table 1: Shows the mechanism for calculating students' grades according PBL method.

Grading	The distribution of assessments comprising your grad for this two credit course is as follows:
- Individual assignment	
Assignment 1: theoretical exam	10%
Assignment 2:Lab. Exam	10%
Assignment 3 :the daily Lab. Assessment	10%
Total	30%
- Group assignment	
the daily assessments	10%
discussion the report of project	10%
The report evaluation	20%
Total	70%

Semester includes a display problem of representing the needs of the community using the learning method based on the problem. The problem, which represents the needs of the community scenario, includes a description of the problem similar to the practical realities and

limitations of the data that can be obtained by the engineer to reach a solution based on the research and information collection presented. The other side included the use of the computer program (Auto Cad soft.) to build the student's skills in the field of engineering drawing and design. There was no required text book, however student would have to investigate online and library resources on the design process. Student attendance was mandatory for all lecture and laboratory periods. A portion of each student's grade is based on class attendance and participation. Class assessments was prepared according to the attached syllabus. All assessments were due at the beginning of class on the due date outlined on the syllabus where there were multiple individual and group assignment, an individual programming Quiz, individual attendance and participation, a group final report. Mathematics adopted traditional method "lecture method", which included the assessments of students through the exams with percentage (65%) of total grads, quizzes with percentage (25%) of total grads, daily assessments with percentage (5%) of total grads and home works with percentage (5%) of total grads.

Using statistical equations, the standard deviation, variance and consistency of the students' grades were calculated for all the methods of evaluation adopted by the two methods during the whole academic year. Statistical calculations were carry out using Excel 2013 and the interpretation of those statistics compared to the two methods that were applied for the same students by the same lecturer.

**4. The Results and Discussion**

The results in figures (2 and 3) are show that the ratio of standard deviation in the lecture method compared to the PBL method is equal to (58.2%) in the theoretical exam, noting that the degree of evaluation for the theoretical exam in the lecture is (35%) while in the PBL method it is (20%).

The standard deviation of the daily assessment in the lecture method compared with PBL is reduced by (40.4%) because the method of the lecture depends on the sudden answer question through the lecture in the evaluation while in the PBL method the students understand the problem of the project and suggesting solutions which are need more effective in using higher mental skills to get the answer.

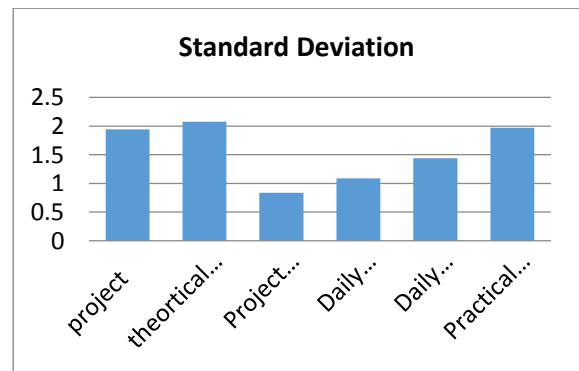


Figure 2: show the standard deviation of using PBL of different assessment

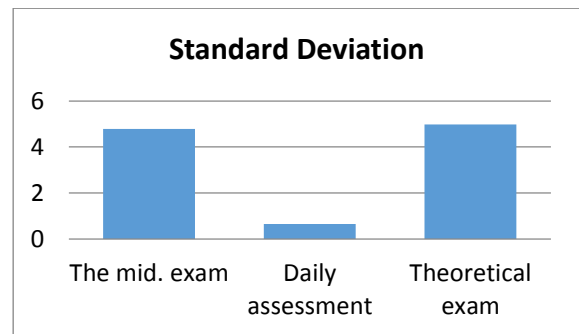


Figure 3: show the standard deviation of using tradition method of different assessments

Figures 4 and 5 show increasing the variance in the statistical equations of the lecture method compared to the PBL method of theoretical exam by ratio (82.5%) while decreasing the ratio of the daily assessment to be (64.6%). Note the decreasing of the variance rate refers to that the adopted educational method takes into consideration individual differences between the students.

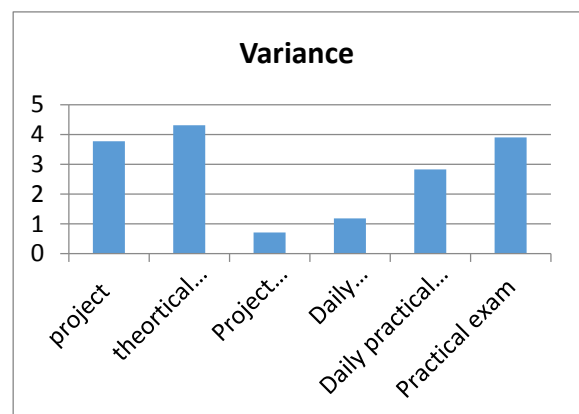
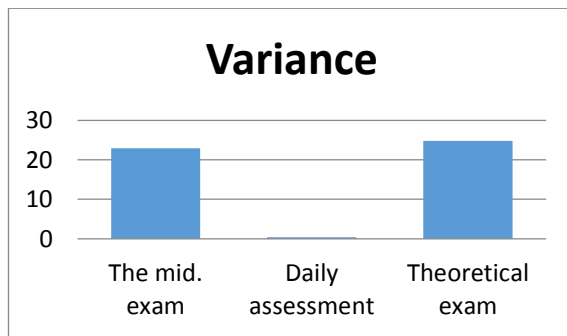


Figure 4: show the variance of using PBL of different assessments



**Figure 5: show the variance of using tradition method of different assessments**

## 5. Conclusions

The study determines the ratio of standard deviation in the lecture method is higher by (58.2%) in the theoretical exam compared with PBL method and it is higher by (40.4%) of the daily assessment which indicates that the PBL method takes into consideration the individual differences between the students' evaluations approximately ratio (50%). The higher variance rate in the traditional lecture method compared to the PBL method (82.5%) to evaluate the theoretical exam and (64.6%) for the daily assessment. The increasing the value of the variance of the assessment values for students indicates that the reliability of the grades is less because the high variance value indicates that the evaluation criteria and test tools are inaccurate, which caused dispersal in assessments for students.

The use of the PBL method of working as a team in the search for solutions to the problem according to the scientific theories which is gain the student the ability to discuss, work in team work and work in practical lab therefore it also includes reinforce personality of the student.

## Acknowledgment

We would like to thank the University of Technology, especially the Petroleum Technology and Electromechanical Engineering departments for their supports in completing the research to develop the educational process using modern learning methods that stimulate the higher mental abilities of the engineering students in finding suitable solutions in the workspace. I would also like to thank the President of the University Prof. Dr. Amin Daway Thamir and the Head of the Department of Petroleum Technology Dr. Aqeel Shakir Ghani Al-Adili and head of the Department of Electromechanical Engineering Asst. Prof. Dr. Hosham S. Anead.

## References

- [1] E.M. Hunt, P. Lockwood-Cooke and J. Kelley, "Linked-Class Problem-Based Learning in Engineering: Method and Evaluation," West Texas A&M University, USA, American Journal of Engineering Education, Vol.1, No.1, 2010.
- [2] D.R. Brodeur, P.W. Young and K.B. Blair, "Problem-Based Learning in Aerospace Engineering Education," American Society for Engineering Education Annual Conference & Exposition, Massachusetts Institute of Technology, 2002.
- [3] H.S. Barrows, "Problem-Based Learning in Medicine and Beyond: A Brief Overview," in Wilkerson, L., and W. H. Gijsselaers (Eds.), Bringing Problem-Based Learning to Higher Education: Theory and Practice, New Directions for Teaching and Learning, No. 68, Jossey-Bass, San Francisco, CA, 1996.
- [4] K. Grolinger, "Problem Based Learning in Engineering Education: Meeting the needs of industry", The University of Western Ontario, Teaching Innovation Projects, and Vol. 1: Issn. 2, Article 2, 2011.
- [5] A. Yadav, D. Subedi, M.A. Lundeberg, and C.F. Bunting, "Problem-based Learning: Influence on Students' Learning in an Electrical Engineering Course," Journal of Engineering Education, Vol. 100, No. 2, pp. 253–280, ASEE. <http://www.jee.org>, April 2011.
- [6] A. Masek and S. Yamin, "The Effect of Problem Based learning on Critical Thinking Ability: A Theoretical and Empirical Review," International Review of Social Sciences and Humanities, Vol.2, No.1, pp. 215-221, 2011.
- [7] M. Dischino, J.A. DeLaura, J.D.N.M. Massa and F. Hanes, "Increasing the STEM Pipeline through Problem-Based Learning," Proceedings of The IAJC-ASEE International Conference ISBN 978-1-60643-379-9, 2011.
- [8] C. De Simone, "Problem-Based Learning in Teacher Education: Trajectories of Change," International Journal of Humanities and Social Science, Vol. 4, No. 12, 2014.
- [9] J. Hitt, "Problem-Based Learning in Engineering," Fulfillment of the Master Teacher Program, United States Military Academy, West Point, NY, 2010.
- [10] C.A. Bellera, B.J. Foster and J.A. Hanley, "Calculating Sample Size in Anthropometry," Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease, DOI 10.1007/978-1-4419-1788-1\_1, Springer Science+Business Media, LLC 2012.