Integrated Solutions for Infrastructure Development
Edited by Lau, H. H., Tang, F. E., Ng, C. K., and Singh, A.

ISBN: 978-0-9960437-3-1

IS PROJECT BASED LEARNING THE WAY TO GO?

INDUBHUSHAN PATNAIKUNI and HIMABINDU MYADARABOINA

School of Civil, Chemical & Environmental Engineering, RMIT University, Melbourne, Australia

Many educational institutions have moved or are moving to project-based learning (PBL) in Engineering. Project-based learning and problem-based learning have both advantages and also disadvantages. They are suitable for certain courses and may not be that helpful for certain other courses. In case of courses which require mathematical and analytical skills PBL does not seem to be very useful. As a matter of fact, many students do not seem to learn the basics/fundamentals if PBL method is used. Courses like statics, Mechanics, and structural analysis are the type of courses which can produce graduates without a proper fundamental understanding of the subject matter if PBL is used for the entire course.

Keywords: PBL, Statics, Structural analysis, Problem based learning.

1 INTRODUCTION

Project Based Learning (PBL) had emerged 40 years ago in the medical faculty at McMaster University in Canada and spread rapidly, predominantly in medical education, and also in the fields of law and engineering (Barret 2005, Ahern 2008).

Many universities are using project-based learning in the Engineering education programs (Bennet and Kelly 2010). Researchers around the world have investigated and suggested PBL as a major learning tool in civil engineering with some challenges in implementation (Gavin 2011, de Urena *et al.* 2003). Research by Nepal and Jenking (2011), suggested implementing a blended system which is a mixture of traditional and PBL which may give better results. But, there was not much research information shown on the individual student's performance.

The authors tried to study the advantages or disadvantages of using project-based learning. The course was designed to challenge the students to learn through problem-based learning and project based learning. The assessments were designed such that the students try to learn from the method of assessments like the quizzes which require the student to prepare well and understand the subject matter and assignments which require understanding the subject matter for completing the assignments. The students were given written quizzes once in every two weeks and the corrected answer sheets were usually returned the following week. For the students to know where they have gone wrong the quiz questions were answered by the academic when the answer scripts were returned. Despite too much time consumption for the Academic, especially for large classes and utilizing many resources the PBL is found to be either neutral or slightly beneficial only to a certain percentage of students who already have a sound basic knowledge and who are keen to learn and see the practical aspect of the theory. But, the rest of the students are likely to just take advantage of the teamwork and graduate without proper fundamental knowledge of the subject. Again it probably depends on the type of course. From the research, the authors believe that PBL may be useful for certain courses like design courses but may not be

very useful for other mathematical/ analytical type of courses which need the student to understand the fundamentals and be able to apply these fundamentals to problem solving. At the same time, PBL can be very useful for student learning if only a small percentage of credit is given to this component in the assessment of the course. It is also important to design the PBL part in such a manner that each individual contributes to the group and has understood the parts of the project contributed by the other students in the group. This requires considerable time to be spent by the academic in designing the course such as interviewing the student and also varying the assessment from time to time so that the students do not have the possibility of copying from other students or from the past year student projects. But the resources put in may not justify the marginal benefit which may result finally. The aim of this paper is to bring out what is the best way of assessing the student learning.

2 RESEARCH METHOD

The first author taught courses in structural engineering area, mainly in statics, mechanics, structural analysis, Analysis of complex structures, finite element analysis, the theory of elasticity, plates and shells, plastic analysis etc. for several years. Problem-based learning was used for several years without giving much credit (marks) for this component which seems to have worked very well. But during the past 8 or 9 years, the requirement in many universities is to use project-based learning with a significant percentage of credit (marks) given to this PBL component. It was found that this does not achieve what was the intention of this PBL. To examine the students' performance in the traditional tests (tests include written tests, written quizzes, and examination) as well as project-based assessments, a study is carried out on three different academic year (2008, 2009, and 2010) scores of a course in the structural engineering area of students in a reputed University in Melbourne. The research methodology included both written tests and PBL assessment. The course contains different components, some are project based and the others are test/examination/quiz type. Both types of components were assessed for the grading. PBL assessment was a significant part of the total assessment. Both project based assessment and written test based assessment had an equal credit of 50% each.

3 DATA ANALYSIS & RESULTS

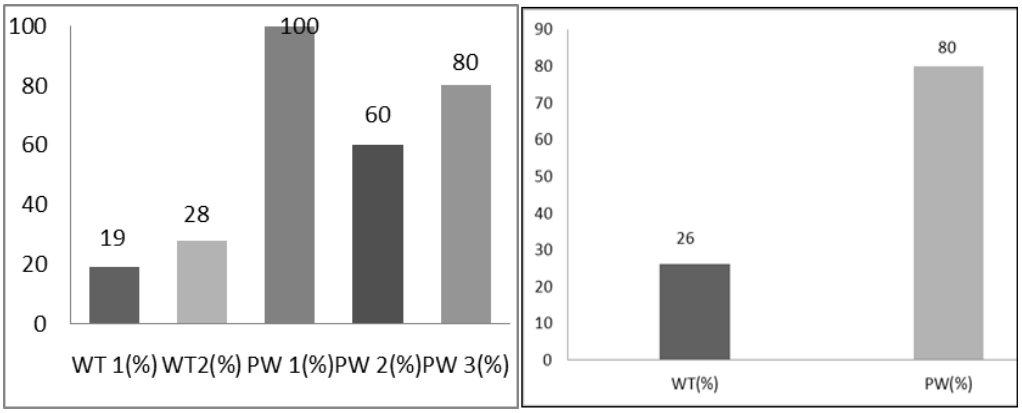
Though entire class of around 150 students is analyzed in three consecutive years as mentioned, this study mainly focuses on the percentage of marks obtained by 50 students from a class of around 150, who had poorly performed in written tests (WT) compared to their performance in the project work (PW). This was analyzed for three different academic years for the same course. The results for the entire 150 students also are shown in figures to get an idea of how the entire class performed.

Figure 1 shows an example of a student X, who scored different percentage marks in the five components of his/her course. Marks obtained in written tests & project works for student X from Class A in the year 2008 are also shown in Figure 1 and that the student scored very good percentage marks in Project Works, PW1, 2 & 3 though he/she got very less percentages marks in written tests, WT1, 2.

The cumulative percentages are shown in Figure 2, which also clearly show that the project-based learning fetches the student X high percentage even though the student is very weak in written examination/test which actually tests the student's basic understanding of the subject.

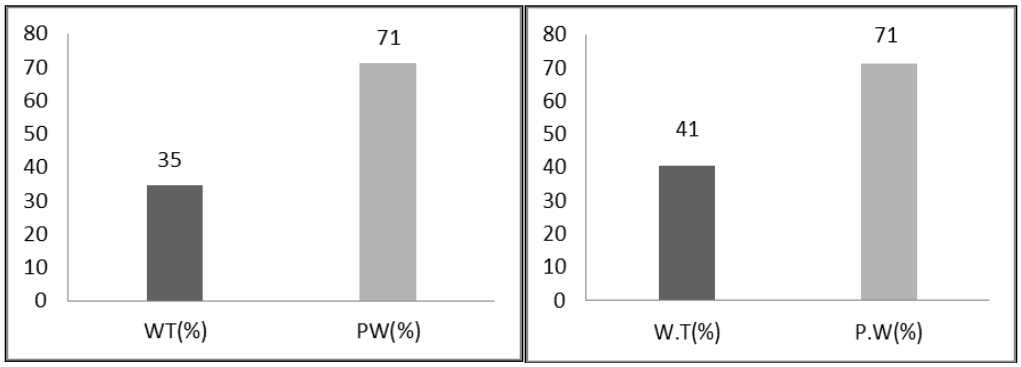
Hence, the analysis is carried out for 50 students in Class A of the year 2008 batch, and the average percentage marks of 50 poorly performed students in WT are calculated and are shown in

Figure 2. Also, the average % marks of PW and WT for 50 poorly performed (in WT) students are shown for academic years 2009 & 2010 in the Figures 2-b & 3-a respectively.



(a) (b)

Figure 1. a) Percentage of marks in all the components for student X in Class A -2008;
b) WT% Vs PW% marks for student X in Class A-2008.

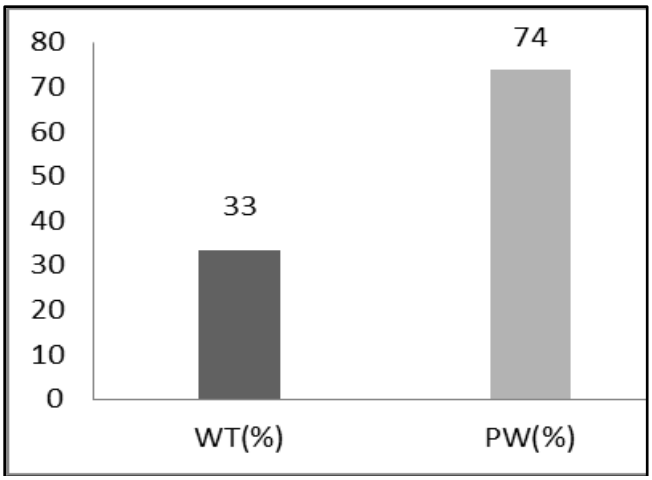


(a) (b)

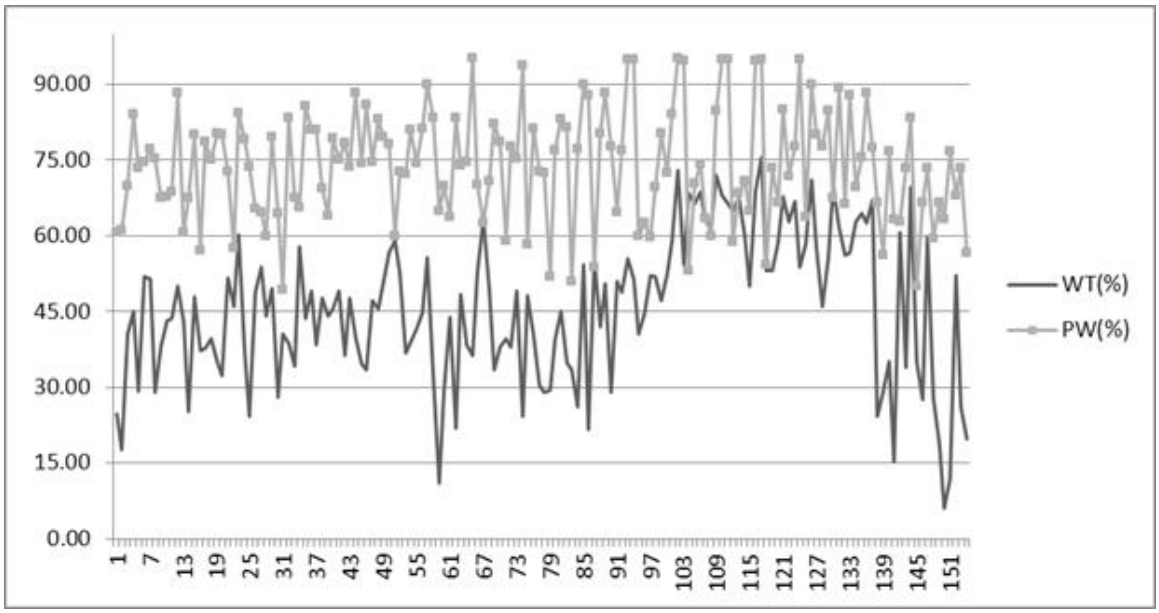
Figure 2. a) Average % marks of 50 students in Class A-2008;
b) in Class A-2009.

To show the entire picture of the majority of the students who have shown very good results in PW, irrespective of their performance in WT, an analysis was made for all the students in Class A for the year 2010 by showing their % marks in WT & PW and the graph is shown in Figure 3-b. The graph shows the PW% of the majority of the students always lies above the WT%. The WT% and PW% marks are calculated for all students for the same course in years 2008, 2009 and 2010 and the averages of each 25, 50, 100 and 150 students are shown in Table 1.

From Table 1, it can be seen that the % marks of WT was relatively higher in 2009 due to the fact that web-based quizzes instead of written quizzes were used as one of the components which could be attempted by the students in their own time and also the number of attempts allowed was more so that the students could learn the subject matter better if they fail to get the correct answer in the first or second attempt. It is possible that many students took the help of other students who had a better understanding of the subject matter.



(a)



(b)

Figure 3. a) Average % marks of 50 students in Class A-2010;
b) PW% vs WT% marks for all the students in Class A-2010.

Table 1. Average % marks of students in Class A for years 2008, 2009, and 2010.

	25 students		**50 students**		**100 students**		**150 students**	
	WT%	**PW%**	**WT%**	**PW%**	**WT%**	**PW%**	**WT%**	**PW%**
2008	25.5	67.9	34.6	71.2	47.3	72.5	56.3	72.6
2009	30.5	69.3	40.5	71.2	51.3	72.3	60.0	74.2
2010	23.1	70.1	29.2	72.1	37.5	73.0	45.0	73.6

Table 2. The ratio of PW% and WT% marks of students in Class A for years 2008, 2009, and 2010.

	25 students	**50 students**	**100 students**	**150 students**
2008	2.66	2.06	1.53	1.29
2009	2.27	1.76	1.41	1.24
2010	3.03	2.47	1.95	1.64

According to Table 2, it can be observed that in each year and for every set of students, the PW% is more than double that of the WT% for the first 50 students except in 2009. The group of students in the year 2010 has performed relatively worse compared to other two years. The first 25 students received 166%, 127% and 203% more marks in PW compared to WT in the year 2008, 2009 and 2010 respectively. Similarly, the first 50 students received 106%, 76% and 147% more marks in PW compared to WT in the year 2008, 2009 and 2010 respectively.

4 CONCLUSIONS

As mentioned earlier, this study is mainly focused on the performance of the students in Project Work who got very less percentage in conventional tests i.e. Written Tests (which include written test, written quizzes, and examination).

From all the above analysis the authors derive the following conclusions:

- Despite very less percentage marks in WT, many students were getting overall pass mark (50%) due to the high percentage of marks in PW which is not desirable in terms of development of basic knowledge for the future courses the student might undergo and the knowledge they require as engineers
- To avoid this problem, there is a need to reduce the weight of the PBL part of the courses in the overall assessment. PBL should be considered as a useful learning tool but should not be given higher weightage as given in current educational system in engineering as it is not actually measuring the student's performance as each individual contributes differently in a team.
- If project based learning is used as a main component, then the projects should be designed for each individual student which may not be practical and cost effective. The requirement of resources will be prohibitive.
- The authors believe that project based learning is not suitable for all types of courses. Especially so in the case of the mathematical and analytical type of courses. PBL may be useful for design type of courses. PBL can be very useful for learning if it is designed in such manner as not to distort the results.

5 RECOMMENDATIONS

- Credit for project-based components needs to be minimal to achieve better learning by the students. Also, the courses need to be designed in such a manner that the students are required to solve problems and attempt projects with minimum credit to these components.
- There should be a hurdle mark for the written test components to avoid students passing without proper learning.

- If web-based tests are conducted they should not be conducted by allowing the students to attempt the tests in their own time but should be conducted like other tests at a particular time.
- Project based learning may be used for courses like design courses with some written test component also. Though the results are not included here, the results of a structural design course where only PBL I used was compared.

References

Ahern, A., What are the perceptions of lecturers towards using cooperative learning in civil engineering? *European Journal of Engineering Education*, 32 (5), 517–526, 2008.

Bennett, Gareth J. and Kevin Kelly., Implementation of Project Based Learning in a Large Engineering Programme. *3rd International Symposium for Engineering Education*, University College Cork, Irland, 2010.

Barrett T., "*Understanding the Problem Based Learning (PBL)*. In: Barrett, T., Mac Labhrainn, I., Fallon, H. (Eds). Handbook of Enquiry & Problem Based Learning: Irish case studies and International Perspective, 2005.

de Urena, J. M., Menendez, J. M., and Coronado, J. M., Project/Problem Based Learning in Civil Engineering: the Ciudad Real (Spain) Experience. *International Conference on Engineering Education*, Valencia, Spain, 2003.

Gavin, K., Case Study of project-based learning course in civil engineering design, *European Journal of Engineering Design*, 36;6, 547-558, 2011.

Nepal, K. P. and Jenkins, G. A., Blending project-based learning and traditional lecture-tutorial-based teaching approaches in engineering design courses. *Proceedings of the 2011 AAEE Conference*, Western Australia, 2011.