Teaching reform of the *Engineering Project Valuation* course based on the PBL method

Yong Li

Huanghuai University
Zhumadian, People's Republic of China

ABSTRACT: In view of the inadequacy of the practical application and innovative ability of students with an engineering project management major who are studying the *Engineering Project Valuation* course, the PBL (problem-based learning) teaching method of the course was explored. Taking practical engineering project problems as examples, an experiment-based design was set up for the course, which is taught at Huanghuai University of Technology. Glodon project cost software was used, with the project cost network forum as the platform. The results of the PBL group were higher than those of the traditional LBL (lecture-based learning) group. The statistics on the interaction frequency of the PBL platform showed that it gave full play to the initiative, teamwork and responsibility of group members. According to a questionnaire and discussion surveys, the PBL teaching method greatly enhanced students' confidence and ability to solve the problems of actual engineering projects, improved their practical and innovative ability and emphasised the cultivation of high-quality talent that relates to engineering applications.

INTRODUCTION

The PBL (problem-based learning) teaching method was developed by Howard Barrows, an American neurological professor, on the basis of information processing psychology and cognitive psychology [1]. This method emphasises the student-centred, problem-based, teacher-guided, group discussion and self-teaching approach [2].

Compared with the traditional LBL (lecture-based learning) teaching method, PBL enhances the ability to analyse and solve problems and enables students to self-teach, work together and develop their practical and innovative abilities [3-5].

The PBL teaching method is currently one of the mainstream teaching methods for medical education in the world and has been quickly applied to various disciplines, such as computer, engineering and psychology [6][7]. Nowadays, PBL is still considered by some a new teaching method suitable for the development of higher education [8-10].

SUBJECT AND METHOD

The *Engineering Project Valuation* course at Huanghuai University of Technology is a regional, technical, professional, practical and policy-oriented course that covers a wide range of knowledge [9][10]. It is a main course for the engineering management major.

The course covers engineering economics, the impact of technology, management and law. In order to improve students' practical and innovative ability, on the basis of experience in teaching reform over recent years, the PBL method was proposed for this course.

The main thrust is theoretical teaching, but there is also a practical engineering project. Glodon project cost software (from Glodon Software Company Limited) is used and the project cost network forum serves as a platform. This method was piloted in 2013 to explore the new teaching of the *Engineering Project Valuation* course and proved to be effective.

Research Subjects

Research subjects in the study were selected from 61 students in the engineering project management major at Huanghuai University of Technology. These students were randomly classified according to academic results and had a similar percentage of males and females. The test samples were divided into the PBL group and the LBL group (see Table 1).

Table 1: The two test groups.

Class	Gender		Total
	Male	Female	
Class 1 (PBL group)	24	7	31
Class 2 (LBL group)	24	6	30

Experimental Design

PBL Group

Grouping of students: the PBL group was divided into four subgroups. Each of these consisted of seven to eight members and one was appointed leader of the group, and was responsible for organising discussion and recording discussions. Two teachers were assigned, who were associate professors with excellent teaching credentials. The teachers instructed the group leaders in the PBL teaching method in advance.

The problems: guided by the syllabus of the *Engineering Project Valuation* course, two problems were designed, viz. the budgeting for a project construction drawing and the determination of the tender offer for a construction enterprise. Each problem has more than one solution and overall consideration should be given to the civil engineering budget, construction technology and organisation, reinforced concrete structures, engineering economics, project management and other related professional matters. The budgeting for the construction drawing should have an accuracy of ±5%. The strategies for bid quotation should reflect competitiveness and there should be more than one competitor.

Independent learning and communication within subgroups: each subgroup collected materials from multiple sources. The members studied independently, tested and interacted through engineering budget forums and QQ (messaging service from Tencent Holdings Limited) groups so as to smoothly exchange information. Then, two-to-three discussions were held during which members of a subgroup stated problems and solutions one by one. The members solved problems together and sought help from the teachers. Finally, the results were transformed into PowerPoint presentations.

Classroom discussion: the teachers organised the leader of each subgroup to report the respective problem and solution, commented on the solutions, advised on the focuses discussed by students and, finally, obtained satisfactory solutions.

Summarisation: the teachers assessed the students and determined the first and second places in a civil engineering budget problem, while pointing out disadvantages and offering suggestions for improvement.

Experiment assessment: students completed the experiment reports. Scores were awarded based upon a student's answer to each question and also for the results of the experiment. The students' final results included the budget construction drawing (50%), the tender offer (35%) and the oral report (15%).

LBL Group

The traditional teaching method; namely, the model, *the teacher explains the experiment instructions - each student works independently - the teacher examines* was adopted. The teachers and the syllabus were the same as those of the PBL group.

ASSESSMENT OF THE TEACHING

Comparison of Results

The performance of the PBL and LBL groups, in the experiment, are shown in Figure 1; the values on the Y-axis relate to the number of students.

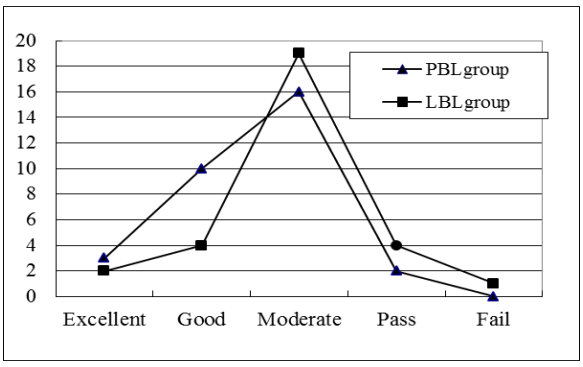

Figure 1: The comparison of experimental performances between the PBL and LBL groups.

The comparison between the experimental results of the PBL group and the LBL group (see Table 3) shows that excellent and good results of the PBL group are higher than those of the LBL group; the medium, pass and fail results of the PBL group are lower than those of the LBL group. The experimental results of the PBL teaching method are higher than those of the traditional LBL teaching method.

Interaction Frequency Using PBL

The PBL teaching method enabled students and teachers to communicate closely, work co-operatively and discuss the methods for solving problems together. The types of the interactive information of the PBL network platform based on the project cost forum are shown in Table 2. The classification and frequencies are shown in Table 3, where A1 to A8 is cross-referenced to Table 2.

Table 2: The types of the interactive information on the PBL network platform.

No.	Type	Description	Example
A1	Problem	Provided some problems and clarified them	How to price the water stops in kitchens and bathrooms? Should they be included in plates? Whether plates are priced as plate beam slabs or slabs?
A2	Organisation of opinions	Groups obtained opinions from books, Web sites or other members	http://wenku.baidu.com/view/eef8c35d3b3567ec102d8ab6.html for the case analysis of the unbalanced bidding strategy of construction enterprises' bidding.
A3	General explanation and feedback	Attention was focused on general discussion. The content of dialogues did not reflect the entire process *organise, analyse, react, solve problems and think*	Now we cannot solve the component attribute and drawing input problems of YP vertical plates and have to learn as soon as possible; have a try using fences; have a try using orthogonal offset dimensions.
A4	Analysis	Students proposed related or contrasted opinions	I think our bid quotation strategy should adopt the lowest quotation because this project does not have too big a risk for enterprises' construction.
A5	Problem solving	Provided solutions and the methods for solving problems and explained, tested, validated and corrected any error	Test the calculation of Z1ϕ10@200/100 (4) stirrup: three-dimensional display, consolidated calculation and review with the planar integrated representation method of reinforcement are combined from the aspects of the number, length and stirrup densified zone.
A6	Detailed explanation	Attention was focused on the explanation and analysis of complicated problems	The function of *single component's identification of beams' in situ marking* enables the identification of all extracted beams in situ marking. The first step: …; the second step …; the third step …
A7	Unique opinions	Introduced a new idea or attempt in order to solve this problem or thought about how to apply a widely used method	The probability method was used to calculate the possibility for the scoring of the bid quotation under multiple circumstances. The optimal bid quotation was selected.
A8	Rethink	Rethought members' dialogues through teaching content and PBL problems	I think our group did not co-operate very well. PBL problems call for more incentive.

Table 3: Classification and frequencies of the interactive information on the PBL network platform.

Group	Classification								Total
	A1	A2	A3	A4	A5	A6	A7	A8	
Group 1	19	16	38	8	7	3	3	6	100
Group 2	21	26	40	7	11	5	4	11	125
Group 3	11	9	37	3	6	2	1	4	73
Group 4	13	8	51	5	9	2	0	5	93
Total	64	59	166	23	33	11	8	26	390
Percentage	16%	15%	43%	6%	8%	3%	2%	7%	100%

According to the statistics in Table 3, in the interaction on the PBL network platform, the groups focused most on general explanations and feedback (43%), questions (16%) and the organisation of opinions (15%). The interaction gave full play to group members' initiative, teamwork and responsibility, as well as motivating the group's analysis, problem

solving, detailed explanation, understanding and rethink of PBL problems (26% which is the sum A4 to A8 in Table 3). With the constant improvement in the PBL teaching method, this last result can be expected to increase.

Investigation and Analysis of the Teaching Effect of PBL

Questionnaire and discussion surveys were conducted into the teaching effect of PBL from three aspects, viz. the PBL teaching method, PBL interactivity and the PBL platform. The statistics are shown Table 4. Scores are out of five.

Table 4: The teaching effect of PBL.

Item name	Average (scores)	Standard deviation σ
PBL teaching method		
Exercise language skills	4.15	0.698
Promote the motivation for independent learning	4.28	0.649
Improve the ability of logical analysis	4.30	0.701
Reflect the methods for solving practical problems	3.97	0.711
PBL interactivity		
Willing to share opinions in order to solve PBL problems	4.54	0.729
Enhance the teamwork spirit	4.50	0.793
Obtain timely help from teachers	4.42	0.763
Like to solve problems through PBL activities and co-operation	4.58	0.791
PBL platform		
Fast speed of the platform system	4.42	0.766
Friendly platform for human-computer interaction	4.36	1.062
Can provide multiple forms of learning	4.52	0.832

The standard deviation of the statistical results, σ, ranges from 0.649 to 1.062 indicating that the dispersion degree of the statistical data are low and the statistical values are close to the average. The statistical results show that the PBL teaching method greatly enhances students' confidence and ability to solve problems, and improved students' ability for logical thinking and information retrieval. Students like to solve problems through PBL activities and co-operation, and are willing to share their opinions to better solve PBL problems. The PBL platform provides students with multiple forms of learning and is a frequently used platform that can transmit information rapidly.

CONCLUSIONS

To sum up, in the teaching of the *Engineering Project Valuation* course, the PBL teaching method broke down complicated engineering problems to assist their solution. It gave full play to students' initiative, creativity and responsibility, and improved students' language skills. It integrated the knowledge of multiple disciplines and pooled information from rich Web platforms, greatly motivated students' confidence and ability to solve practical engineering problems, and expanded the development of students' horizontal skills and abilities so as to enable students to *learn to study new knowledge*.

The PBL teaching method incorporated industry engineering and professional elements into the *Engineering Project Valuation* course, which facilitated the solving of practical engineering project problems, realised the effective coupling of learning and employment, as well as improving students' employability and innovative ability. Hence, this has highlighted universities' ability to cultivate practical talent and helped the country deepen reform in higher engineering education and improved the quality of engineering education.

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