

# The effect of problem-based learning on education and recall of medical students in a course of basic immunology in comparison with lecture-based learning

Davood Yadegarinia, MD<sup>1</sup>; Mostafa Alavi-Moghaddam, MD<sup>2</sup>; Reza Gholami-Khojin<sup>3</sup>; Hossein Ghofrani<sup>3</sup>; Alireza Arabnia<sup>3</sup> ;& Soha Rezai-Shiraz<sup>3</sup>

<sup>1</sup> Director of Educational Development Center, Shaheed Beheshti University of Medical Sciences and Health Services

<sup>2</sup> Director of Student Committee of Educational Development Center, Shaheed Beheshti University of Medical Sciences and Health Services

<sup>3</sup> Member of Student Committee of Educational Development Center, Shaheed Beheshti University of Medical Sciences and Health Services

## ABSTRACT

**Background** According to the available evidence and experiments, problem-based learning is one of the most successful methods to achieve higher educational objectives. In this method, the discussion about the medical subjects to be learned by the students is based on a real clinical case and participation of the students. Various advantages and disadvantages of this method have been addressed in different studies.

**Purpose** In order to evaluate the effect of this method in our educational framework, We compare two educational methods, problem-based learning and lecture-based learning, in terms of students' education and recall.

**Methods** It is an experimental study. Two topics of basic immunology were chosen after holding discussion meetings. The students were divided randomly into two groups. Each topic was taught to the two groups of students using both methods alternately. Students' educational achievement was evaluated with pre-test and post-test exams. Four weeks after these sessions, short-assay exams were used to evaluate the students' recall.

**Results** The difference of pre-test results between the two groups was not statistically significant, whereas the difference of post-test scores was statistically significant. There was no statistically significant difference in the students' recall between the two groups.

**Conclusion** Considering the exchange of two methods between the two groups, the effect of personal differences was eliminated in this study, and since there is no significant difference in the pre-test scores, the difference of post-test results could be related to the effect of PBL. According to the results of this study and with conducting additional experiments, the problem-based learning could be adjusted with the specific educational framework in our country.

**Keywords** PROBLEM-BASED LEARNING, LECTURE-BASED LEARNING, EDUCATION, RECALL

*Journal of Medical Education Summer 2002;1(4):165-8*

## Introduction

One of the major objectives of medical education is to train physicians who have a comprehensive view to the patients' problems and to integrate the theoretic subjects with professional medical needs and realities. Lecture-based learning (LBL) and using unilateral lecturing is the method that has

been used for many years in most of the universities around the world to achieve this goal. In this method, the mentor teaches all topics personally.

However, according to various evidence and experiments, one method which has been suggested to be more capable in achieving the above-mentioned goals than other methods, is

problem-based learning (PBL). PBL has been recommended as an educational goal and is now expanding worldwide (1). In this method, the discussion about the subjects that should be taught to the students is based upon a real clinical case and participation of the attending students.

Determining the superiority and dominance of one of these two methods is still controversial in the academic circles. Different studies have shown that PBL has more advantages than LBL (2-7). These advantages include increasing the motive and encouragement for personal studying, promoting self-learning skills, emphasizing on the importance of learning basic science in order to use them in clinical setting, and promoting the analysis capabilities and clinical competence of the students at the time of the professional medical practice (2-4).

In contrast, other researchers believe that not only PBL has no special dominance over LBL in at least achieving some of the educational criterion, but also using PBL could not be recommended because of the necessary preparations for applying PBL (such as educational space and staff), (5, 9, 10).

Since expansion and applying problem-based learning method in different medical classes requires certain changes in the educational system, it has to be modified first to match with each society's circumstances, opportunities and potentials, and its advantages and disadvantages should be recognized completely. Therefore, the Educational Development Center (EDC) of Shaheed Beheshti University of Medical Sciences and Health Services decided to perform a research, in the spring of 2000, to evaluate the effect of applying PBL and customizing it with the potentials of this university. The current study considers and compares the effect of two educational methods, PBL and LBL, on educational achievement and recall of medical students.

### **Materials and Methods**

This is an experimental study. Two educational methods, problem-based learning and lecture-based learning have been compared according to two specific variables: educational achievement level and recall level (the modified PBL and LBL methods which have been used in the study will be explained in this section).

In this regard, the researchers conducted a number of joint meetings with the cooperating mentors—a professor in immunology in the faculty

of medicine, Shaheed Beheshti University of Medical Sciences and Health Services, a dermatologist who is an authority in medical education and a clinical immunologist and two topics of basic immunology were selected for this study and the required preparations was done. These two topics were hypersensitivity reaction types III and IV, and transplantation.

The study group was the medical students of the 3rd semester in Shaheed Beheshti University of Medical Sciences and Health Services, faculty of medicine, in the second half of the 2000-2001 educational year.

One week before starting the project, a one-day educational workshop was conducted to familiarize the students more efficiently with this study and with problem-based learning method. First, the project's objectives and PBL method were explained for the students. Then, for more familiarization, one topic of microbiology (typhoid fever) was taught using PBL method.

To perform the study, the students were divided into two equal groups (A & B), randomly. Each topic was addressed in two separate 1-hour sessions so that the first topic was taught to group A using PBL method and the same topic was taught to group B using LBL. The remainder of this topic was given in the second session with a 2-day interval, so that PBL was continued for group A and LBL for group B.

At the beginning of the first session, pre-test exams and at the end of the second session, post-test exams were taken from the students to evaluate their education level. Each exam contained 10 short-assay questions. Consulting a number of medical education specialist, the teacher, prepared the questions of pre-test and post-test exams. At the end of each session, the teacher corrected the student's papers and the results were given to the project executives.

It must be noted that in order to alleviate the statistical bias and to prevent the decrease in the reliability of the results, the teacher for both groups was one person (the cooperating immunologist) and the sessions were held in a different place for each group to prevent the confrontation of the students and exchanging information about the topics.

For the second topic, the same program was performed but in reverse order so that groups A and B received LBL and PBL methods, respectively. Thus, each group received both PBL and LBL methods.

**TABLE 1** THE RESULTS OF PRE-TEST, POST-TEST AND RECALL EXAMS IN THE PBL AND LBL GROUPS

	PBL		LBL	
	Number	Mean	Number	Mean
Pre-test	72	15.38	67	20.76
Post-test	54	83.06	50	69.85
Recall	42	37.26	46	30.71

Four weeks after the last session, another exam was given to the students, consisting of 10 short-assay questions to evaluate their recall level. The process of preparing this exam was the same as pre-test and post-test and the teacher gave the results to the executives.

After collecting all data from the assessments, statistical analysis was performed using SPSS Version 10 and consulting with an expert in the field of medical statistics.

### Problem-Based Learning

This method emphasizes on a clinical problem as the axis of teaching and on participation of the students. Each topic was addressed in two sessions and in 7 steps.

*Step 1 Problem presentation* According to the educational objectives of each topic, the clinical problems of one or more patients were explained to the students. A committee consisting of the cooperating immunology professor and two clinicians designed the clinical cases. These cases were designed so that they would be coincided with the level of basic science students and to fulfill the educational objectives. The members of the committee passed a course of designing educational cases.

*Step 2 Terminology* In this step, the teacher gave the necessary explanation about the terminology and the concept of the specific words.

*Step 3 Defining the Problem* The students expressed their questions about the subject.

*Step 4 Brain Storming* The attending students were divided into 8-12 member groups and discussed the subject with each other under the supervision of the tutors (the executives of the study) and found probable answers for their own questions. The teacher supervised the discussion of all groups.

*Step 5 Assembling* A representative from each group explained the conclusion of the discussions in their group to all of the class. Then the teacher classified the subjects and questions expressed by

the representatives and the students were instructed to find the answers of those questions for the next session. The required references were presented at the end of the first session.

*Step 6 Presentation* At the beginning of the second session, the representative of each group presented the results of the group study to the class.

*Step 7 Final Conclusion* The teacher corrected and completed the given answers if necessary. At the end of the session, the resulting educational objectives were explained to the students.

### Lecture-Based Learning

It was the traditional method of explaining subject using unilateral lecturing by the teacher.

### Results

This study was performed on the students of the 3rd semester of Shaheed Beheshti University of Medical Science and Health Services, faculty of medicine. Altogether, 72 and 67 students gave the pretest exam in the PBL and LBL groups respectively, and the average score of the PBL and LBL groups were 15.38 and 20.76 (out of 100). The difference was not statistically significant ( $p=0.138$ ).

In the post-test exam, which was performed immediately after the 2nd session of each topic, the average score of the PBL group was 83.06 and that of LBL group was 69.85. This difference was statistically significant ( $p<0.001$ ).

In the recall exam, which was taken 4 weeks after the sessions, the average score of the PBL and LBL groups were 37.262 and 30.714, respectively ( $p=0.057$ ). The results of these three exams are summarized in the table. As could be seen, the number of students participating in the project has been declined, since attending the classes was not obligatory.

### Discussion

The results of this study showed that the students are more successful in learning selected topics of

immunology when PBL is used as the educational method. Since the students were randomly divided into two groups and two educational methods were exchanged between the groups for different topics, so that the effect of personal differences of the students was eliminated. Since the students were randomly divided into two groups and the pre-test scores of these groups showed no statistically significant difference, the difference of the post-test scores could be contributed to the effect of the educational method. The study that was performed in Glogne University in Germany and used short-essay questions to assess the effect of PBL, also showed significant difference in learning level between two groups, but neither dividing students in this study was random nor the crossover of the methods was performed (2).

In the recall exam that was taken four weeks after the sessions, the average score of the PBL and LBL groups was also different, although this difference was not statistically significant. This could be due to the decrease in the difference between the average score of two groups and also to the decrease in the number of samples in the recall exam. However, Doucet et al showed significant difference in the results of the recall exam, which was performed three months after the sessions using "key features problem" method (3).

Further studies, reveal the requirements for applying PBL in our medical educational system.

### Acknowledgments

The authors consider their duty to express their very special thanks to Dr. M. Sattari who was the immunology professor cooperating with this research and her interest and concern drove us to complete the study whenever we encountered a problem, Dr. F. Kamangar our medical statistic consultant whose friendly cooperation we will never forget, and Dr. F. Azizi without whose advice we were not able to perform this study.

We should also thank Dr. M. Jan-Ahmadi, Dr. R. Rezaipoor, Dr. M. Dejkam, M. Golfam and S. PourAlizadeh for their cooperation.

### References

1. Azizi F, Marandi A, Larijani B, Jamshidi HR. Problem-based learning: health in Islamic Republic of Iran. WHO & UNICEF; 1998. p. 841-2.
2. Antepohl W, Herzig S. Problem-based learning versus lecture-based learning in a course of basic pharmacology. *Med Edu* 1999;33: 106-13.
3. Doucet MD, Purdy RA, Kaufman DM, Langille DB. Comparison of problem-based learning and lecture format in continuing medical education on headache diagnosis and management. *Med Edu* 1998;32:590-6.
4. Dhapagain ML, Bhattacharya N, Jain BK, Kaini KR, Koirala S, Jayawickramarajah PT. Introducing problem-based learning into an organ system program. *Medical Teacher* 1998; 20(6):587-9.
5. Azizi F. Changing medical education programs according to the necessities of the community. *Journal of Shaheed Beheshti Medical University* 1999;9(4):229-44.
6. Jones GL, Margetson D, Bligh FG. Problem-based learning: A coat of many colors. *Med Edu* 1998;32:492-4.
7. Davis MH, Harden RM. Problem-based learning: A practical guide. *Med Edu* 1999;21 (2):130-4.
8. Georgiev G., Macpherson C., Rooney R.Z.: A novel extension of problem-based learning: Problem-based lecture presentation by students. *Med Edu* 1995;29(3):255-6.
9. Dolmans DHJM, Schmidt HG. What drives the students in problem-based learning? *Med Edu* 1994;28:372-80.
10. Shotliff K. Basic sciences in problem-based learning and conventional curricula: students' attitudes. *Med Edu* 1997;31(5):394.