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Comparing the long-term retention of a physiology course for medical students with the traditional and problem-based learning

A. A. Pourshanazari · A. Roohbakhsh · M. Khazaei · H. Tajadini

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Abstract The rapid improvements in medical sciences and the ever-increasing related data, however, require novel methods of instruction. One such method, which has been given less than due attention in Iran, is problem-based learning (PBL). In this study, we aimed to evaluate the impact of study skills and the PBL methods on short and long-term retention of information provided for medical students in the course of respiratory physiology and compare it with traditional learning method. In this study, 39 medical students from Medical School of Kerman University of Medical Sciences, Kerman, Iran (2006–2010) were enrolled in the study and allocated randomly in three equal groups (13 in each group). All groups underwent a pre-test to be assessed for their basic information regarding respiratory physiology. Two groups were instructed using the traditional method, and one group used PBL. Among the two groups of the traditional method, one was instructed about study skills and the other was not. Once the PBL group took the study skill workshop, they were aided by tutors for their education. In the final term test, those students who had learned study skills and were instructed with the traditional method scored higher compared to other groups ($p < 0.05$). However, in the 1 year ($p < 0.05$) and 4 year ($p < 0.01$) interval examinations, the PBL group achieved significantly higher scores. Despite the fact that PBL had no positive effect on the final term exam of our students, it yielded a more profound and retained understanding of the subject course. Moreover, considering the positive effect of study skills on long-term student scores, we recommend students to receive instructions regarding the appropriate study skills when initiated into universities.

A. A. Pourshanazari
Department of Physiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

A. Roohbakhsh · M. Khazaei
Department of Physiology and Pharmacology, School of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

H. Tajadini (✉)
Kerman University of Medical Sciences, Kerman, Iran
e-mail: H_tajadini@kmu.ac.ir

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Introduction

The rapid changes in modern medical science require the provision of more efficient educational methods. Furthermore, considering the current challenges of educational systems, including the passivity of students during the teaching process and their lack of practical abilities, necessitate changes in educational systems in order to keep up with the pace of medical advances. One method devised to improve medical education is the problem-based learning (PBL) to serve as an alternative for the conventional methods. Numerous studies have been conducted to disclose the advantages of PBL over the traditional methods. One study by Abraham et al. indicated better results in physiology course with PBL (Abraham et al. 2008; Chou and Chin 2009). Another study by Mehdizadeh et al. reported that students who learned anatomy with PBL scored higher in tests and were more satisfied with their education compared to those who had used traditional methods (Mahdizadeh et al. 2008). Physiology has been instructed traditionally in Iran during the last three decades. Its objectives are focused on theoretical knowledge of the course and practical concepts are rarely instructed and evaluated. The practical concepts of physiology are introduced in clinical wards during the clerkship and internship stages. For the medicine program, it consists of 8 theoretical units and 1 practical unit, presented during the second year of the program. The subject of respiratory physiology is covered in 7 weekly sessions, each with duration of 2 hours. The entire program for general medicine in Iran consists of three stages of Basic Sciences, Physiopathology and Clinical Training, which altogether take 7 years to complete. Due to lack of enough investigations about PBL in medical subjects and topics in Iran, we conducted this study to appraise the PBL method and the role of tutor in teaching physiology.

Furthermore, considering the fact that most students are not familiar with the appropriate study skills and this may probably have a negative bearing on their education and their motivations, we conducted this study to evaluate the impact of study skills and the PBL method on short and long-term retention of information provided for medical students in the course of respiratory physiology and compare it with traditional learning method.

Method

Thirty nine medical students (consisting of 19 boys and 20 girls) from Medical School of Kerman Uniersity of Medical Sciences, Kerman, Iran (2006–2010) enrolled in this prospective interventional study.

The study protocol was approved in Research ethics committee of Kerman University of Medical Sciences and all participants gave written informed consent prior to enrollment.

To assess basic information of participants regarding respiratory physiology, all groups underwent a pre-test. Then participants were randomly assigned in three groups equally (13 students in each group) for the purpose of matching; one PBL group and two traditional LBL groups. One of the traditional education groups attended a workshop for study skills while the other did not. The PBL group participated in the workshop for study skill, as well.

In PBL, the educational material of the subsequent session would be presented as a series of questions to be answered the next session with the participation of students and a conclusion and correction of the opinions by the tutor. The PBL group used a tutor for facilitating and reinforcing the learning process. Thus, they were divided into groups of 4 or 5 students and each group had a one-hour discussion with their tutor per week. A briefing workshop was held for tutors who consisted of successful students from previous years.

At the end of the semester, all students took the same test and their scores were compared. Prior to the test, a questionnaire, checked for its reliability and validity, was completed by all students. In order to assess the durability of the course, tests of the same level were repeated 1 year and 4 years later, without prior notification, and the results were compared.

Sample size

Considering standard deviation = 2.3, $\alpha = 0.05$, and power = 80%, the sample size for each group was calculated to be 11 persons. It is noteworthy that previous studies have recommended few students to be assigned to each group with PBL; however, traditional methods do not have any limitation regarding the number of attendees.

Data analysis

The test scores are based on a full score of 20. The ANOVA test was utilized to compare the average scores among the groups. Moreover, the final semester and final study scores of students in each group were compared using the independent sample t- test, assuming $p < 0.05$ as significant.

The survey on tutor's role was performed with 5 questions. Likert's scale was used for the survey, with grading as Bad = 1, Average = 2, Good = 3, and Excellent = 4 and the mean of the scores were calculated.

We asked 8 questions from students to assess the role of study skills workshops. Likert's scale, ranging from Bad to Excellent was graded from 1 through 4.

Results

Comparing the scores of students instructed with the traditional method and PBL

The mean age of students in our study was 21.83 years, with 94.2% of them being single and 81% living in dormitories. The groups were not significantly different in terms of age, gender, marital status, place of residence, and grade averages of previous semesters.

The statistical analysis revealed no significant difference between traditional methods and PBL groups in the pretest before the study ($p > 0.05$).

The data in Table 1 demonstrate the fact that those students who had not participated in the workshop for study skills scored significantly higher compared to those who had taken part in the workshop on final semester exam ($p < 0.05$).

The final term exam scores of the students (Table 1) indicated no significant difference between the scores of traditional group with skills workshop and PBL group; however, the scores of the similar test after 1 year and 4 years were significantly higher for the PBL

Table 1 Comparing the scores of medical students for the course of respiratory physiology at the end of semester and at the end of their training in the groups of our study

Group		Final semester test score (out of 20)	Test score after 1 year (out of 20)	Test score after 4 years (out of 20)
Traditional education	With study skills workshop	13.07 ± 0.90	5.46 ± 0.96	3.32 ± 0.68
	Without study skills workshop	14.63 ± 0.82*	5.94 ± 0.81	4.74 ± 0.67*
PBL education	With tutor	13.58 ± 0.86	8.25 ± 0.79#	6.35 ± 0.68##

Asterisk (*) marks the significant difference between the groups as indicated by Kruskal–Wallis test. The sharp sign (#) marks the significant difference between the scores on final semester exam and the exam 1 year or four-year later in each group, as indicated by the Wilcoxon test

* Comparing the groups with or without study skills workshop ($p < 0.05$)

Comparing the traditional method and PBL ($p < 0.05$)

Comparing the traditional method and PBL ($p < 0.01$)

students compared to those who were instructed traditionally ($p < 0.05$). This difference was more punctuated in the final examination held 4 years later ($p < 0.01$), indicating the better retention of information in PBL students (Table 1).

Results of the survey concerning the role of tutor in educational improvement were obtained from 5 questions and are presented in Table 2. The mean score of all individuals equals 2.3 which lies in the Average zone.

Results of the survey concerning the role of workshop for study skills in educational improvement

The results of this 8-question survey are presented in Table 3. The mean score is 2.84 which falls in the Good zone.

Discussion and conclusion

In our study, the results obtained from medical students indicate that PBL failed to influence the final semester scores of the students significantly; however, the information

Table 2 Results of survey from students regarding the role of tutor in educational improvement

Question	Bad (%)	Average (%)	Good (%)	Excellent (%)
Satisfaction with tutors' role in better understanding of physiology	17.7	23.5	58.8	0
Tutors' ability in performing their duties	17.7	23.5	58.5	0
Worth of time spent in the tutors' sessions compared to the results achieved	18.7	75	6.3	0
Efficiency of tutors in teaching physiology compared to traditional methods	6.5	15.3	52.3	25.9
Potential of achieving higher scores with tutors compared to traditional methods	25.5	63.1	11.4	0

Table 3 Results of survey from students regarding the role of study skills workshop in educational improvement

Question	Bad (%)	Average (%)	Good (%)	Excellent (%)
Role of workshop in improvement in physiology	19.1	21.4	19	40.5
Role of workshop in time spent learning	11.9	19.1	23.8	45.2
Role of using study styles in educational improvement	11.9	14.3	47.6	26.2
Role of learning process in educational improvement	11.9	11.9	38.1	38.1
Role of rapid reading in educational improvement	4.8	14.3	45.2	35.37
Role of note taking workshop in educational improvement	11.9	28.6	33.3	26.2
Role of workshop in acquisition of test skills	16.7	31	33.3	19
Role of workshop in reducing test stress	14.3	33.3	31	21.4

short and long-term retention was improved. The higher scores achieved by the PBL group in examinations held one and 4 years later reflect the decreased rate of data loss for these students. In addition, comparing the two groups of traditional method revealed that participating in the workshop for study skills improves long-term retention (one and 4-year) but not short-term retention (final term exam) significantly compared to those who had not taken part in the workshop. Having no effect on short-term retension may be due to that, final exam mainly is based on reminding the subjects by reviewing them but not understanding and PBL is based on understanding. In fact, this workshop improved their status of understanding in the course of physiology. Of course, part of this improvement is due to their enhanced test skills while answering the questions.

Our result indicating a lack of advantage for PBL compared to traditional teaching contradicts some previous studies (Abraham et al. 2008; Mahdizadeh et al. 2008) while corroborating others (Grzeskowiak et al. 2009). Some studies have even reported PBL to worsen or even no beneficial in education for basic sciences (Antepohl and Herzig 1999).

In a descriptive study in England, it has been reported that PBL is not superior in the opinion of medical students (Tavakol et al. 2009). Furthermore, another systematic study recently published has reported no significant difference between PBL and classical systems of education in medical training (Polyzois et al. 2010). Nevertheless, it has been stated that making changes in the manner of presenting PBL according to the conditions and requirements of the university and students will improve the outcome: one study on nursing students in Taiwan reported that although PBL failed to make significant improvements in the first year of its application, the amendments made to it based on the conditions and requirements of the university ameliorated the results significantly (Chou and Chin 2009). Therefore, it is probable that certain amendments in this method may render physiology education more efficient. Despite the fact that the students' level of information diminishes naturally with time, as is observed in all three groups, comparing their scores after 1 year and 4 years revealed that those who were educated with PBL had significantly higher scores compared to those who were trained traditionally which in turn indicates the better durability of PBL. This finding is in line with some previous studies (Chou and Chin 2009). It may be concluded that retrieval of data from brain is easier with PBL and there is greater retension of information in the students' minds.

These findings are consistent with those of Ahmad Jafari et al. who indicated that community-based medicine for dental students improved the durability of information and

students' satisfaction (Jafari et al. 2009). Similarly, a study on nursing students in Golestan University of Medical Sciences indicated that problem based learning improved the retention of information learned for the course of mental health (Modanloo et al. 2010).

In the present study, students declared the tutor's role in educational improvement to be average. This was caused by the fact that tutors failed to improve the students' grades efficiently in short term. Although some studies have indicated that the presence of tutors enhances students' success (Yu et al. 2000), factors such as tutor's gender, socio-cultural background (Das et al. 2002) and information and skills affect his/her success (Groves et al. 2005). Therefore, the tutors' short-term failure in our study may be accounted for by the method of selecting tutors, socio-cultural differences, gender differences or their lack of appropriate skills.

Another section of our study indicated that familiarizing students with correct study skills will improve their scores significantly. In addition, the survey concerning the role of workshops for study skills indicates that most students evaluated these workshops to be good. Among the questions asked, the majority of positive comments pertained to the fact that these workshops improved the time spent for learning and the least satisfaction was with the acquisition of test skills and reduction of test stress. A similar study concerned with the impact of study and learning skills workshop on study approaches and learning of Exceptional Talent students of Isphahan University indicated that participation in the workshop improved the students' scores in 5 domains of idea selection, study guide, data processing, self-evaluation, and using examination approaches compared to the control group (Haghani and Khadivzade 2009). The scores of students instructed with lecture based method and study skills were not better than the traditional method on the exam conducted next year (Table 1) which raises questions. We inquired the students about the reasons why they failed to score higher; most students stated that study skills are most efficient when instructors and the educational system are compatible with them; in their opinion, some instructors' disbelief in these methods attenuated their motivation for using these method.

One challenge for implementing PBL is selection and training of efficient tutors, as mentioned by the students in the survey. The findings, however, indicate that it is justifiable to spend time and money in order to enhance the abilities of the tutors. In general, implementing this method faces certain challenges which are resolvable with serious determination; these challenges include training skilled instructors who are familiar with novel methods, modifying the beliefs of the educational system and support of the relevant authorities in order to facilitate the transition from traditional methods to problem-bases methods, reducing the size of subject courses and providing the opportunity for PBL teaching, and changing the evaluation systems which are solely based on test scores.

The main limitations of our study were small sample size and limiting our study only to respiratory physiology course.

In general, it may be concluded that despite all the current challenges, problem-based learning is superior to the traditional methods of education. It is recommended to familiarize students with study skills on their entry to university. Furthermore, it is necessary for instructors to become better acquainted with novel methods of study and teaching in order to improve efficiency and test scores and reduce stress. In addition, although PBL showed no advantage over the traditional methods in the short run, it is possible that making certain amendments to the method and improving the role of tutors enhance the short-term effects of PBL on physiology education.

However, future prospective short and long-term studies with greater sample size and focus on factors affecting short-term retension of information should be conducted to confirm our study findings.

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References

Abraham, R. R., Vinod, P., Kamath, M. G., Asha, K., & Ramnarayan, K. (2008). Learning approaches of undergraduate medical students to physiology in a non-PBL-and partially PBL-oriented curriculum. *Advances in Physiology Education, 32*, 35–37.

Antepohl, W., & Herzig, S. (1999). Problem-based learning versus lecture-based learning in a course of basic pharmacology: A controlled, randomized study. *Medical Education, 33*, 106–113.

Chou, F. H., & Chin, C. C. (2009). Experience of problem-based learning in nursing education at Kaohsiung Medical University. *Kaohsiung Journal of Medical Sciences, 25*, 258–263.

Das, M., Mpofu, D. J., Hasan, M. Y., & Stewart, T. S. (2002). Student perceptions of tutor skills in problem-based learning tutorials. *Medical Education, 36*, 272–278.

Groves, M., Régo, P., & O'Rourke, P. (2005). Tutoring in problem-based learning medical curricula: The influence of tutor background and style on effectiveness. *BMC Medical Education, 5*, 20–29.

Grzeskowiak, M., Podlewski, R., Turowska-Koska, A., Zaba, Z., & Drobnik, L. (2009). The first attempt at initiating problem-based learning as a method of teaching-learning at the University of Medical Sciences in Poznan, Poland. *Kaohsiung Journal of Medical Sciences, 25*, 271–275.

Haghani, F., & Khadivzade, T. (2009). The effect of a learning and study skills workshop on talented students' learning and study strategies in Isfahan University of Medical Sciences. *Iranian Journal of Medical Education, 9*, 31–40.

Jafari, A., Khami, M., Yazdani, R., & Mohamadi, M. (2009). Presenting the course of community dentistry as problem based learning workshop and comparing it to learning through lecture. *Iranian Journal of Medical Education, 9*, 216–228.

Mahdizadeh, M., Kermanian, F., Iravani, S., Markazi Moghaddam, N., & Shayan, S. (2008). Comparing lecture and problem-based learning methods in teaching limb anatomy to first year medical students. *Iranian Journal of Medical Education, 2*, 379–388.

Modanloo, M., Khoddam, H., Kolagaree, S., Bastani, F., Parvizi, S., & Abdollahi, H. (2010). The effect of problem-based learning on nursing students' learning level. *Strides in Development of Medical Education, 7*, 17–25.

Polyzois, I., Claffey, N., & Mattheos, N. (2010). Problem-based learning in academic health education. A systematic literature review. *European Journal of Dental Education, 14*, 55–64.

Tavakol, M., Dennick, R., & Tavakol, S. (2009). A descriptive study of medical educators' views of problem-based learning. *BMC Medical Education, 4*(9), 66.

Yu, H. Y., Wu, Z. A., Su, M. S., Yen, D. J., Luk, H. R., Chao, Y. C., et al. (2000). Problem-based, small-group tutorial learning in clinical neurology for second-year medical students. *Zhonghua Yi Xue Za Zhi (Taipei), 63*, 598–604.