Original Article

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The effects of homogeneous small groups on the efficacy of problem-based learning

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Abstract

Introduction: Problem-based learning (PBL) as a learning style has gained a special position amongst different levels of education systems, and many different approaches, such as tutor education, proper scenario presentation, etc., are used to increase its efficiency. However, the role of homogeneous groups to facilitate team working has never been studied. The purpose of this study is to examine the effect of selective group allocation in PBL efficiency.

Methods: In this semi-experimental double-blinded study, 40 students of medicine during their externship in the radiology department were divided into two equivalent groups based on their grade average points. The same topics and the same instructors were chosen for both groups. In the control group, the students were randomly divided into four subgroups each with five members. The subgroups in the study group, on the other hand, were homogenized based on their grade average points.

Results: The students' rate of learning of the theoretical topics and their performance in reporting and interpreting the stereotypes in radiology were measured at the beginning and at the end of the study in both groups by two questionnaires with Alpha Krunback of 0.87 and 0.85. All students were male with the mean age of 23.7 years ± 1.19. Age, grade point average of the students in the last semester and the mean of their pre and post-test scores in both groups showed a normal pattern of distribution ($p>0.05$). The learning and performance scores in each group at the beginning and at the end of the course showed a statistically significant difference with a p value of 0.011 and 0.03, respectively.

Conclusion: Homogenizing the PBL groups with allocation of more competent student in each group plays a complementary tutor role and boosts the level of learning by enhancing group dynamicity.

Keywords: Homogenization, Problem-based learning, Competent students

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Introduction

Traditional education systems used from preschool to university usually leave alumni with a vast amount of information most of which have no practical use in their future career. In fact, in these teaching systems most of the taught subjects are forgotten easily, and consequently this will reduce the enthusiasm for learning among the students (1).

Problem-based learning (PBL) as a teaching style has gained a special position amongst different levels of education systems. Problem-based learning was implemented for the first time in MC. Master, Canada (1). Perhaps one of the advantages of this education system is that students enjoy the learning process and this indeed motivates them to find the ways to solve different problems (2). This method has caused students to believe in their own capabilities, which in turn, increases the self confidence among them (3). PBL is a student -centered system in which students cooperate with one another closely. By this method they do exchange the information and learn the problem solving skills and critical thinking (2).

In this method the professor acts as a facilitator who holds the responsibility to guide and support students.

A PBL tutor should encourage the group members to have a close collaboration with one another, and only needs to assess the team work progress (3).

In 1992, Rankin JA conducted a study on the impact of PBL method in four medical schools, two of which used the traditional education system and two PBL system (4).The Purpose of the study was to define the correlation between PBL method and the students' information and their use of information resources. The results showed that the students who were taught through PBL method had referred to library recourses more than those taught through traditional methods and this had caused the first group to develop their searching abilities significantly even at the early stages of learning (5).

One of the purposes of PBL method in medical sciences is the integration of basic courses with clinical ones. This helps the students to see the connection between these two types of courses and develop a clinical standpoint from the very beginning (5).

Today the PBL method is not only used in medicine but also in different fields of study like engineering, advocacy, and social sciences (6).

The studies conducted on PBL method demonstrates that this method positively affects both the students' performance and learning rates (1-8). Some evidence showed that this method motivated medical students to do more research. Furthermore, PBL can help medical students to improve their competency in diagnosis and make better treatment decisions both in their internship period, and in practice.

One of the criticisms on PBL method is that the students do not exactly know which subjects are more important to learn; therefore, the professor, as a facilitator, should continuously supervise and evaluate them (9-13). A lot of studies were carried out on PBL and particularly looked into the factors which might help improve the efficiency and efficacy of this method.

A study by Norman and Schmidt on PBL showed that the facilitator's intervention improves not only the students' understanding of the Problems but also their performance (14).

The problems in PBL method are often written as a scenario whose preparation in a well-formed and systematic manner can add to its efficiency (14).

In 2004, Taradi S. K. and his colleagues integrated PBL with Internet technologies in order to make it as efficient as possible. In their study which was on physiology, they divided students into two experimental and control groups. In the experimental group, the PBL was integrated with a web-based learning (WBL) while in the control group it was employed as usual. The results showed that the students taught through WBL-PBL had better performance (15).

In 2008, Lymn and Kingsburg studied the PBL method, employing it with larger groups. They divided the students into 16 groups, each with 20-21 members and then assigned a tutor to each group. The groups were further divided into 7 subgroups, each with 2-3 members. When working with the students, the tutors felt that this specific way of grouping significantly improved the students' learning and triggered the elucidation of medical concepts, but they suspected that the scenarios stimulated the students' use of subsidiary references or enhanced their motivation. The researchers came to the conclusion that the PBL method is not only practical in small but also in larger groups (16).

Up to now the role of different factors such as the correct performance of tutors, proper problems or scenario preparation and the integration of PBL with WBL has been studied in order to increase the efficiency of PBL. One of the factors which can be very effective is the division of students into small groups because PBL is a student oriented method whose success greatly depends on the student activity, team work, information exchange, and the use of problem solving and critical thinking skills (16).

In spite of widespread use of PBL in the preclinical curricula of the U.S.A, fewer than %6 of the universities there use PBL for more than %50 of their instructions (17), which may be partly due to difficulties of its delivery or disorganization of knowledge which is gained by small group team working (18, 19).

If the students through the PBL course are divided into smaller groups randomly or have the opportunity to select their own group, it is probable that the students with greater capabilities and less able students are separated without any interaction. This certainly reduces the active discussion, scatters student's attention, misleads them from the correct method of learning and finally wastes their time.

Although the well oriented and expert tutor can prevent this, the difference in the rate of learning between more competent and less competent groups still exists and the students' learning will not be the same.

On the other hand, the presence of more competent students with less competent ones may be useful when working together. In the study with even distribution of more and less competent students together in small groups, we have tried to make PBL more effective.

Methods

This study, which was of a semi-experimental type, was carried out on 40 students of medicine during their externship in the radiology department. In this study based on their grade average points, the students

Table 1. The comparison of means in pre and post-tests in the experimental and control. groups; knowledge and performance tests

	Experimental, Matching group			Control, Random group		
	Pre test	Post test	P	Pre test	Post test	P
Knowledge test	2.5	7.9	0.0001	2.4	7.4	0.0001
Performance test	3.4	9.8	0.0001	3.6	9.2	0.0001

were divided, according to paired wise matching, into two equivalent groups (a control and a study). The same topics and the same instructors were chosen for both groups. The length of the study and teaching of the topics were decided to be in a two week period.

In the control group, the students were randomly divided into four subgroups each with five members and the topics were taught to them according to the PBL method. On the other hand, the subgroups in the study group were homogenized based on their grade average points. For these subgroups, the topics were also taught based on PBL. The variables to be measured in this survey were the students' rate of learning of the theoretical topics (knowledge) and their performance in reporting and interpreting the stereotypes in radiology. These variables were evaluated at the beginning and at the end of the study in both groups.

Data collection tools were two questionnaires one of which with nine items and a reliability of 0.87 evaluated the students' performance and the other with eight items and a reliability of 0.85 measured their knowledge. The reliability of both questionnaires was calculated by Alpha Crunbakh method. The content validity of the questionnaires was confirmed by a panel of experts.

The study was double-blinded, i.e., neither the tutors nor the students were aware of the composition of the groups. Both the tutors and students thought that the assigning of the students in each subgroup was random.

All of the variables were checked regarding the normal distribution, using one–sample Kolmogrov Smirnov test.

The data were analyzed through independent t-tests and paired t-tests were used, using the statistical software. The independent t-test was used to compare the two groups' scores in the post-test and the paired t-test to compare the students' scores in the pre and post-tests. The significant p value was considered less than 0.05 ($p<0.05$).

Results

The students were divided into two 20 member groups (study and control). All of the students were male with the mean age of 23.7 years and a standard deviation of 1.19.

The variables of age, grade point average of the students in the last semester and the mean of pre and post-test scores in each group were analyzed, using one-sample Kolmogrov Smirnov test which confirmed that the data were following a normal distribution ($p>0.05$).

The average score of the students in the test group was 15.4 with a standard deviation of 1.13 and that in the control group was 15.33 with a standard deviation of 1.07. Employing the independence t-test, we did not find statistically any significant difference between the means of the two groups. ($p<0.05$) This denotes the homogeneity of the two groups.

On the other hand, the grade point average of the four subgroups, each with 5 members, in the previous semesters was 15.27, 15.34, 15.47 and 15.59, respectively. The comparison of these grade point averages, revealed statistically no significant difference ($p<0.05$).

The results of knowledge tests and the students' performance are reported in Table 1. The comparison of the results of the knowledge tests and the students' performance did not indicate any statistically significant difference at the beginning of the study ($p>0.05$).

Comparing the means of the knowledge and performance tests in each group at the beginning and at the end of the course, we found a statistically significant difference in both groups (Table 1).

The independent statistical t-test was used to compare the means of the knowledge and performance

Table 2. The comparison of means of post test values in experimental and control groups

	Experimental group post test	Control group post test	P
Knowledge test	9.8	7.9	0.011
Performance test	9.2	7.4	0.03

tests between the two groups at the end of the course. For the learning test, p value was .011 and for the performance test it was 0.03 (table 2).

Discussion

Problem-based learning (PBL) as a new teaching method has gained a special reputation amongst different methods of education. It is a student-oriented method in which students actively cooperate with one another, share information and acquire the problem solving skills and critical thinking (2). In this method the instructor serves as a facilitator who holds the responsibility of guiding and supporting the students. He should encourage the group members to have a close collaboration, and continually assess the activities done by the groups (2, 4).

Up to now a lot of studies have been carried out on this method to find out the factors which enhance and improve its efficiency. Norman and Schmidt maintain that the tutor's approach not only affects the students' performance but also improves their understanding of the problems in PBL.

In 2004, Taradi and his colleagues combined web-based learning with PBL in order to make it more efficient, and showed that a combination of PBL and Internet technology can improve students' performance (15).

So far the role of different factors such as the tutor's proper approach, proper scenario or problem provision and the combination of PBL-WBL has been studied to enhance the efficiency of PBL. Among these methods the way of putting which students together in the small groups can be very important because PBL is a student-oriented method and its success depends on the students' activities, team work, information exchange, problem solving skills and critical thinking. The purpose of this study was to investigate the selection of the students in small groups (16, 17, 19).

If the students are divided into smaller groups randomly or they have the opportunity to select their partners themselves, it is likely that in some groups there are only more capable students and in the other groups only less capable students. This reduces active discussion, less attention to important points, learning disorientation and finally waste of time in less able students.

Although the tutor, by employing a proper approach, can prevent this, the rate of learning will not be at the same level and there would be a wide gap in learning between the more competent and less competent groups (19). On the other hand, the combination of students with different competency can lead to active discussion and therefore more effective to less competent students. In the study we divided the students into two homogeneous groups, a control and a test group, based on paired-wise matching, using their grade point averages. The comparison of these two groups' grade point average showed that the two groups were identical regarding their competency.

The small 5 member subgroups were also homogeneous based on their grade point averages in the past semesters, which did not show any statistically significant differences.

Conclusion

Comparing the results of both the learning and performance tests at the beginning and at the end of the study in the control group, we noted a statistically significant difference, denoting that instruction through PBL was effective. This difference was more notable in the test group.

The results of our study showed that educationally the presence of more competent students in each group can increase learning in team-mates, initiate active discussion within the group and prevent the learning disorientation. In fact, the presence of a more competent student in each group plays a complementary tutor role and boosts the level of learning in the group, particularly in less competent students.

This study enjoys the advantages of having homogeneous control and experimental groups, also homogeneous subgroups in the experimental group and finally the participants' being blind to the study. However, for more precise results, it is better to perform such studies with larger samples in different educational departments.

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