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Problem-based learning as an effective method for teaching theoretical surgery courses to medical students

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Abstract:

BACKGROUND: This study was designed to assess the clinical judgment of medical students in surgery clinical decision-making by a standard examination after lecture-based learning (LBL) or problem-based learning (PBL).

MATERIALS AND METHODS: A prospective randomized trial study on 175 medical students whom were randomly allocated to three groups was performed during November 2017 and January 2018. LBL group (n = 103), PBL group led by an attending (n = 39), and PBL group (n = 33) led by an intern. Chi-squared test and independent student t-test were used to compare between the two groups. All the analyses were performed by the two-sided method using the Statistical Package for the Social Sciences software (SPSS version 22; SPSS, Inc., Chicago, IL, USA), and a $P < 0.05$ set as statistically significant.

RESULTS: The students in the PBL group scored significantly higher on the posttraining multiple-choice examination, compared to the LBL group (P = 0.048). However, there was no significant difference between the PBL group led by an attending and the PBL group led by an intern (P = 0.892).

CONCLUSION: We concluded that PBL remarkably increased the students' scores in the problem-solving examination, as compared to the conventional method. We found no significant differences in PBL facilitated by an attending or an intern.

Keywords:

Learning method, medical education, problem-based learning, surgical education

Introduction

Historically, students were asked to recite, define, describe, or list facts in educational systems and were barely required to assess, think, or rethink a phenomenon. Learners have adapted to this system of passing knowledge without considering how the learned phenomena can be applied to the real world.[1,2] The choice between didactic lecture-based learning (LBL) and problem-based learning (PBL) has been a controversial topic in the 21st century, especially in the medical field.[3,4] The concept of PBL was first introduced at McMasters University, Canada, in an attempt to make medical education more interesting. Considering the advances in medical education, attendance at intensive basic sciences lectures, followed by exhausting clinical training programs, cannot meet the increasing technological and information needs of people,[5] and there is a need for novel approaches.

Borrows *et al.* developed PBL in 1970 without any background knowledge of educational psychology or cognitive sciences. They merely aimed to make the traditional medical curricula of McMaster

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University more engaging.[6] In general, PBL takes the advantage of knowledge from real-life situations and case experiences. It is defined as "an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem."[5,7] In this study, we aimed to assess and compare the effects of LBL and PBL, facilitated by an attending or an intern, on the overall clinical judgment of general surgery externs at Sina Hospital, affiliated to Tehran University of Medical Sciences (TUMS), Tehran, Iran. The novelty of the present study lies in the comparison of PBL implementation, facilitated by interns and attending, especially in surgery courses.

Materials and Methods

Study design and setting

This study was conducted at TUMS, Tehran, Iran, from November 2017 to January 2018 which was designed as randomized trial (reference ID for trial registration and ethic committee approval was TUMS: 96-04-38-37211).

Study participants and sampling

The participants were selected among medical externs with general surgery rotations at the time of the study (8th or 9th semester). Medical education in Iran is comprised of 14 semesters, in which selected candidates partake immediately after graduating high school. Furthermore, the externship program takes 2.5 years from the 8th to 12th semester, based on the curriculum. The only exclusion criterion was unwillingness to participate in PBL sessions. "Appendicitis" was selected as the learning subject for all participants. The project manager attending designed a standard scenario for PBL sessions, based on the study objectives in a way that discussions during sessions would help the students achieve their goals. We allocated 175 students randomly to three groups by the block randomization method. Group 1 consisted of 103 participants, attending a single 1-h lecture. Group 2 included 39 students attending two 1-h sessions of PBL, supervised by a surgical attending. The final group consisted of 33 students, participated in two 1-h sessions of PBL, assisted by a trained medical intern (medical students in semester 13–15 in the Iranian educational system). Figure 1 exhibits the consort diagram for participants' retrieval. The lecture sessions were held in the hospital's main hall with audio-visual equipment. The lecture content and slides were reviewed and standardized by the authors. The scenario was presented in sequential slides, including brief history-taking and physical examination in the first slide, additional clinical data in the second slide (if requested by the student), and para-clinical data in the successive slides. It should be noted that the results of imaging and laboratory examinations were also presented to the students in original format, not only conclusions and interpretations.

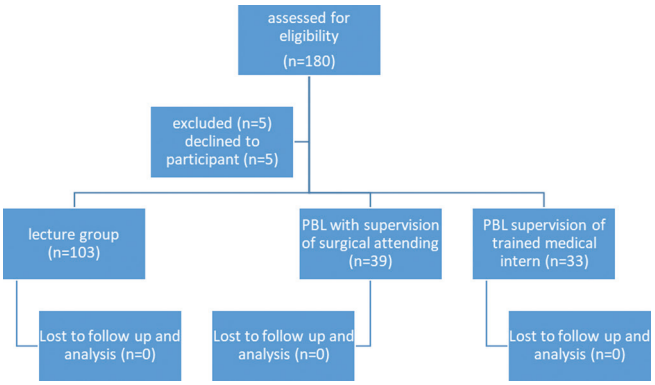

Figure 1: Consort diagram for participants' retrieval

Data collection tool and technique

Finally, the tutors reviewed the goals with the students and asked them to complete a questionnaire about the quality of PBL sessions and tutor management [Table 1]. Furthermore, the tutors assessed each student at the end of the session, using a questionnaire [Table 2]. There was also a final question about the tutor's overall judgment of each student's performance in PBL, which was completed separately. About 15 days after the sessions, the students participated in a standard examination, consisting of 13 multiple-choice questions (taxonomy levels 3 and 4), to evaluate their clinical judgment. The face and content validity of the examination were evaluated by an expert panel, and its reliability was measured using the test-retest method.

The categorical variables are presented as frequency and relative frequency and continuous variables are introduced as mean (standard deviation). The categorical variables were compared using the Chi-squared test. An independent student *t*-test was used to compare the means between the two groups. All analyses were performed by the two-sided method using the Statistical Package for the Social Sciences software (SPSS version 22; SPSS, Inc., Chicago, IL, USA), and a $P < 0.05$ set as statistically significant.

Ethical consideration

In every step of running, these research current ethical considerations were noticed and the study protocol conforms to the ethical guidelines of the Declaration of Helsinki 2013. In this study, all participants completed written consent forms to participate in the study.

Results

A total of 175 students participated in this study (103 in the LBL group, 39 in the PBL group led by an

Table 1: Tutor's evaluation checklist of the students in the problem-based learning sessions

Question	Strongly agree (5)	Agree (4)	No idea (3)	Disagree (2)	Strongly disagree (1)
The student actively participated in group discussions					
The student refrained from marginalization, and his/her questions and suggestions were purposeful					
In group discussions, the student respected the opinions of others					
The student's behavior toward the tutor was respectful					
The student's suggestions and opinions were based on scientific principles and logical thinking					
How do you rate the student's overall learning performance?			0-10		

Table 2: Evaluation checklist of problem-based learning sessions for the students

Question	Strongly agree (5)	Agree (4)	No idea (3)	Disagree (2)	Strongly disagree (1)
The session was purposeful and aimed at teaching the subject					
The tutor encouraged less active learners to increase their participation in the group					
The tutor controlled individuals with impaired group functioning					
Summary of the content at the end of the sessions was sufficient, considering the content volume					
The tutor refused to teach the subject, and his/her activities were directed toward encouraging people to think and study					
This session met my expectations of learning and understanding the subject					
This session encouraged me to participate in novel educational programs					
This session encouraged me to participate in the hospitals' educational programs					

attending, and 33 in the PBL by an intern). Female gender distribution in the three mentioned groups was 44.7%, 48.7%, and 63.6%, respectively, and no significant difference was observed among them ($P = 0.17$).

Based on the findings, the mean final scores of the examination in the three groups were 6.81 ± 1.8 (r = 6.46–7.16), 7.18 ± 1.3 (r = 6.76–7.6), and 7.58 ± 1.25 (r = 7.13–8.02) out of 12, respectively. The comparison of the scores between the groups by the analysis of variance ANOVA test showed a marginally significant difference ($P = 0.048$). However, the *post hoc* analysis and two-by-two comparison of the groups using *t*-test showed no significant difference ($P > 0.05$).

Moreover, we pooled all students in the two PBL groups and compared the mean examination scores between the PBL and LBL groups. The mean scores of the PBL and LBL groups were 7.36 ± 1.3 (r = 5–10) and 6.81 ± 1.8 (r = 2–10), respectively, and the difference was statistically significant ($P = 0.018$). Furthermore, the mean tutor-rated scores were 20.6 ± 3.3 (r = 14–25) and 22.41 ± 2.5 (r = 18–25) out of a total score of 25 in the PBL groups, led by an attending and an intern, respectively; a significant difference was found between these groups ($P = 0.018$). On the other hand, the mean students' evaluation scores of the tutors and sessions were 36.6 ± 3.4 (r = 29–40) and 35.96 ± 4.9 (r = 24–40) out of a total score of 40 in the PBL groups, led by an attending and an intern, respectively; however, the difference was not significant ($P = 0.5$).

Finally, we analyzed the total tutor-rated score of each student (question 10) in the two PBL groups. The mean scores of the PBL groups, led by an attending and an intern, were 8.13 ± 1.52 (r = 5–10) and 8.79 ± 1.1 (r = 7–10) out of 10, respectively; however, the difference was not significant statistically ($P = 0.075$).

Discussion

Clinical practice has entered a new era, which requires experts to have novel medical skills. This shift in expectations is mostly related to the discovery of medical conditions, adding substantial study materials to the medical curriculum. Currently, expecting the medical community to memorize every disease and syndrome appears to be an illogical approach to the raising educational needs of new generations of our physicians. Critical thinking and problem-solving skills are among the top requirements of today's medical practice, which should be fostered at all levels of education.[1] Moreover, modern perspectives of medical training show that collaboration of peers during the learning process improves the students' acquisition of knowledge.[8,9]

Despite the efficiency of trainees' exposure to real-life situations during clinical years, most medical faculties do not have adequate human resources to both tutor and facilitate small groups.[10,11] Accordingly, PBL, with a realistic approach, was introduced to the realm of medical education. PBL was first implemented in North America, where curriculum overload and

inappropriate teaching methods made medical teachers to rethink the conventional learning approaches toward a more integrated approach. In general, PBL focuses on engaging students in problem-solving and independent learning processes. In addition, PBL focuses on receiving critical feedback from students and makes sure that learners have great knowledge to apply in the real world.[12,13]

Evidence suggests that PBL graduates have equal or even superior professional competencies, compared to conventionally trained graduates.[6,14] However, cognitive psychologists debate otherwise in some domains, as they have found that mere immersion in practice is not sufficient for teaching medical experts and that holding problem-solving sessions cannot solely meet all the knowledge requirements of students for practice.[1,15] The debate is even more controversial in basic sciences, such as anatomy and biochemistry, where well-organized databases are essential.[16,17] On the other hand, some literature asserts that PBL students score lower on knowledge examinations; therefore, traditional approaches are necessary for ensuring content coverage.[18,19]

Previous studies have reported controversial results regarding the absolute effect of each teaching method on the cognitive function of students. To recommend PBL over LBL, it is essential to conduct more process-oriented studies to determine how group learning in PBL can influence student learning from both motivational and cognitive points of view.[8,20] In the present study, we concluded that students attending PBL sessions scored higher in the post-session examination, compared to the LBL group; this result is in line with previous findings. Furthermore, the observed difference between the groups was small, as we only addressed the short-term effects of PBL due to our inability to follow-up the study population. Although long-term follow-ups can represent knowledge application more accurately, it should be noted that a simple advantage may increase the efficacy of our medical education system.

A novel question in this study was whether the presence of a surgical attending in PBL sessions increased the overall outcome and satisfaction of students, compared to PBL facilitated by an intern. To the best of our knowledge, no previous study has considered the latter in their study design. Although PBL facilitated by an intern is a type of peer-to-peer education, our results showed no significant difference between the two PBL groups. Furthermore, the difference between the attending- and intern-rated scores of students was too small to be interpretable.

Limitation and recommendation

One limitation of this study is that we did not compare the students' satisfaction with the learning approach between PBL and LBL groups, as the students did not have the opportunity to participate in the opposite group. This can be accomplished in larger programs with dual training methods to provide valuable information for improving the future clinical performance of medical students.

Conclusion

Based on the present results, the use of PBL in medical education is more effective than or at least as effective as traditional lectures, as shown by the scores of short-interval examinations, especially those with higher levels of taxonomy, which are more frequently used in standard tests. Because of the practical nature of PBL, the objective evaluation of student performance in the clinical setting can provide more detailed information about the benefits of this method. In our experience, PBL is more interesting and engaging for most students and has a strong positive impact on their self-confidence and teamwork skills. The results of this study showed that assigning a part of clinical training to senior medical students not only increases the efficacy of medical education but also prevents occupational burnout in the professional staff.

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Conflicts of interest

There are no conflicts of interest.

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