Problem-based Learning in Medicinal Chemistry Laboratory from Pharmacy Students' Perspective

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ABSTRACT

The aim of this research was to assess advantages and disadvantages of the modified version of PBL in Medicinal chemistry laboratory courses

Method: This research was a self-control trial which means that the training method in the previous semester (non-PBL) was used as control. Seventy three students reflected the effectiveness of applying the modified version of PBL on a 19 item questionnaire. The reliability and validity of the questionnaire was confirmed by Cronbach- alpha test ($r = 0.72$) and experts, opinions respectively. Collected data was analyzed by using ANOVA and T-test ($p < 0.05$).

Results: The students believed that using the pre-lab questionnaire increased rate of experience and comprehension, reformed problems and study before the class session 69.6%, 74.6%, 79%, 66% respectively. It reduced errors in experience resulted (65.8%) and prepared sufficient guideline on how to write the details (67%).

Conclusion: pre-lab questionnaire via PBL method stimulated students' activities and achievements in the learning process.

Keywords: Problem-based Learning, Science Education, Medicinal Chemistry Laboratory, Pharmacy students.

INTRODUCTION

Nowadays, in line with the development of universities, education systems are responsible for developing different skills as the leading aim of higher education.

They have to reappraise the teaching methods and existing educational strategies, replacing them with more effective methods for enriching the knowledge and ability of students.[1]

Problem-based-learning (PBL) has been employed as a design method for education systems in the recent decades. Many advantages have been associated with PBL as it is a learning method based on the idea of using problems as a starting point for acquisition and combination of new knowledge; in fact, students work in groups and identify what they have already learnt, what they need to learn and how to consider new knowledge.[2]

PBL method can promote development of critical thinking skills.[3] It is a student-directed method, which encourages self-dependence, prepares students for life-long learning and promotes active and deep learning.[1] It makes powerful learners conduct studies, combine theory and practice and apply knowledge and skills to find a possible solution for a defined problem.[4] Therefore, PBL method can be an effective way of motivating undergraduates in a lab course to learn and enjoy the learning course.[5,6]

Despite the evidence suggesting potential benefits of PBL, unfortunately, no single education method is perfect for all educational situations and PBL has several sig-

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nificant disadvantages. The knowledge achieved through common PBL is less organized than knowledge achieved through traditional learning.[7] In addition, students do not know how to write details and report.[8] So, it is necessary to improve PBL method. A modified version of PBL in which content knowledge in the pre-lab form was provided prior to class session and students did not receive lectures was used in this study. This approach was different from what is commonly considered PBL.

It is essential for the success and continuity of a new method that students view the innovation positively.[5,6] It is needed to truly evaluate its overall effectiveness as compared to traditional learning models.[9–12] The aim of this research was to assess advantage and disadvantage of modified version of PBL in medicinal chemistry laboratory in view of students.

Methodology

In this study, students were trained using a modified version of PBL method in Medicinal chemistry laboratory courses; then, advantages and disadvantages of PBL training were assessed in comparison with the conventional method.

This study included three parts:

Part A: Sampling

Part B: Applying the modified version of PBL to Medicinal Chemistry Laboratory courses

Part C: Assessing advantages and disadvantages of the modified PBL according to the students

Part A: The sample population, selected through the census method, comprised of 79 pharmacy students in Kerman University of Medical Sciences, who passed one course of medicinal chemistry lab presented in lectures (non-PBL).

Note: This research was a self-control trial; meaning that the training method in the previous semester (non-PBL) was used as the control.

Part B: Implementing the modified version of PBL

A modified version of PBL in which content knowledge in the pre-lab form was provided prior to class session and students did not receive lectures was used in this study. The pre-lab form in modified version of PBL indicated what had to be learned by specifying learning outcomes, setting objectives and planning learning by students themselves, identifying appropriate learning resources and advising on their use and providing opportunities for students to assess their own competence.

The modified version of PBL including pre-lab questions was presented in the process outlined below.

Step1: Teacher's designing a questionnaire according to the course outline.

The samples of pre-lab question list in organic synthesis lab (the major part of medicinal chemistry lab course) and volumetric analysis lab (the part of medicinal chemistry lab course) were as follows:

Step 2: Briefing the students on style of teaching and content of the lab course,

Step 3: Briefing the students on the target search source and team work in small groups,

Step 4: Giving opportunity for the students to complete pre-lab question list (about one week because essential duties of the students were researching, studying and attending to complete the questionnaire before the chemical laboratory session),

Step 5: Collecting the students' completed questionnaires at the beginning of the lab session (before beginning experience),

Step 6: Doing the experiment by the students,

Step 7: Finally, teacher's directing the students to discuss the questions and problems for better learning.

Form. 1: The Pre-lab list used for organic synthesis lab Practical work

Pre-lab assignment for organic synthesis.	
No. of group:	**Date:**
Title of experiment	
Purpose of synthesis (product)	
Materials and instruments	
Schematic of reaction	
Role of materials (reactant, catalysis, solvent, etc)	
Optimal conditions (rate, pH, temperature, kind of instruments, etc)	
The likely problems in experimental steps and solutions	

Form. 2: The Pre-lab list used for volumetric analysis (titration) lab Practical work

Pre-lab assignment for volumetric analysis (titration).	
No. of group:	**Date:**
Title of experiment	
The kind of titration	
Analyte	
Titrand	
Titrant	
Instruments or substances for identifying the end point	
Characteristic of the end point	
Conditions	
Methods for preparing of solutions (calculation)	

Part C: Assessing advantages and disadvantages of the modified PBL

Instrument: A 19 item questionnaire was used for assessing advantages and disadvantages of the modified PBL on a five-degree Likert scale (19–95).13 Reliability and validity of the questionnaire were confirmed by Cronbach's alpha test (r=0.72) and experts' opinions, respectively.

Note: The participants received brief explanation about the objectives and were informed of the voluntary participation. The questionnaire was anonymously answered by the students. Ethical approval was obtained from Kerman University of Medical Sciences' ethics committee (Code:K/92/01)

The data analysis: Collected data was analyzed by using ANOVA and T-test ($p<0.05$) through SPSS version 16.0.

Results

Seventy three students participated in the present study, female and male were 33 (45.2%) and 40 (%54.8), respectively. The mean age of the students was 24±2 years. The mean of students' score about the pre-lab questionnaire was (59.20±11.72). There was greater consensus among the females than males and fifth semester students of lower semester students that this method is beneficial (P<0.01).See table 1 and table 2.

Results showed the respondents confirmed that this method convinced them to study before the lab experience (66%). They believed that comprehension became easier because of the preliminary preparations (74.6%). The students commented that the rate of experience increased (69.6%) and they were ready for the questions and revision of the problems (79%). They held that using the pre-lab questionnaire reduced error during the experiment (58.2%) and errors in experience resulted (65.8%). Students believed pre-lab form was sufficient guideline on how to write the details (67%). Some students believed wasting time on preliminary preparations and questionnaire completion was a weakness of this method (58.2%). They said that the anxiety is the disadvantage of this method (55.7%). and because of the multiplicity of other courses there was not sufficient time for this method (62%). The respondents said that there were not enough references available (75.9%) and claimed that this modified method was more motivating and stimulated learning (50.7%). They said that in a co-course ((contemporary of theoretical and practical course)); it is difficult to use this method (51.9%).

Table 1. Satisfaction score (based on sex) about the efficacy of applying the modified version of PBL

Gender	Mean	SD*	t-test
Female	60.2	10.09	0.729
Male	58.3	13.17	P<0.012

Table 2. Satisfaction score (based on level) about the efficacy of applying the modified version of PBL

Level	Mean	SD	ANOVA test
Third semester students	54.7	10.4	F=6.055
Fourth semester students	57.8	13.6	
Fifth semester students	65.1	8.29	P<0.004

Discussion

Based on the results of this research, most of the respondents believed that using the pre-lab questionnaire would persuade them to study before the course session, which was in line with Hosseini Shahidi's survey (2005), who found that PBL persuaded the respondents to study harder.[14] Previous curiosity is a major factor for durability of the learned material or life-long learning. Generally, student-based methods arouse curiosity, encourage studying prior to the course and are very effective in learning the details.[11]

The majority of respondents commented that the modified method increased comprehension of the subject matters. Considering the fact that better learning or in-depth understanding is an educational objective, using pre-lab assessment is highly regarded as an advantage. It seems that PBL, which emphasizes collaborative and survey-based learning as well as understanding the subject matter, should enhance achievement for all undergraduates.[15]

The respondents mentioned their enhanced readiness for asking questions, reformulating problems and cooperating in lab activities as advantages of this method. This readiness makes students spontaneously active and makes teaching more effective for learning in the comprehension process.13–16 Researchers believe that using PBL provides better guidance and feedback.[17]

About half of the students found the method helpful in creating a sense of cooperation and tendency toward the learning process. Hence, it broadened students' motivation and participation. Based on another research, cooperation and active participation of students are two factors for improving graduation.[13–16]

Over half of the students believed that making mistakes decreased during the test and a great number found the method effective for decreasing errors of test results, which was in accordance with another research finding in chemical lab courses.[18,19] Reduction of errors, especially in the test results, is effective for increasing self-esteem and self-confidence which contribute to mental health.

The majority of respondents believed that pre-lab form was a sufficient guideline on how to write the details. Liceaga believed that a challenge in common PBL was existence of no sufficient guideline on how to write the report[20], which showed that using pre-lab form improved the PBL method.

The results showed that, regarding value of other courses, another common challenge in applying this method was time deficiency and the time wasted on primary preparation for form completion. Other studies have stated that a disadvantage of PBL is the time required for learners to fully engage in PBL which can be particularly problematic for poor time faculty.[7] A Turkish study showed a relationship between allocated study time and success, and student's satisfaction with using PBL method.[21]

Previous studies have shown that time management and access to previous matters of study skills are the most difficult parts for students with learning trouble and who are not.[22] The time problem can be related to time management and study skills; it is suggested that workshop or course plans include study and time management skills. These skills can help educators to reduce problems in applying new methods.[22] This suggestion was confirmed by Nouhi (2008) who advised students to learn study skills as soon as starting the university course work.[23]

Limited number of references was another factor mentioned by many students. One obstacle toward shifting from a teacher-based method to a student-based method is the limited number of resources available for students and a barrier of PBL is lake of prepared materials for education. Present curriculum guides and textbooks do not contain a variety of sample problems or assessment tools for this method.[24] In this modified method, students had a guideline for writing details; therefore, it caused better organization of knowledge than common PBL. By developing new sources via the Internet, another major factor needed by educational systems is provided which helps students in finding appropriate study sources.

About half of the students mentioned that this method was hard in a co-course (contemporary of theoretical and practical course), which was consistent with Prince et al.'s (2005) observation that sufficiency of sources was essential for educational methods (PBL or non-PBL methods).[25] It can be concluded that educational programming must reconsider educational programs.

Over half of the participants stated that this method led to anxiety, which was in accordance with O'Shea', who stated that self-directed learning led to anxiety for students as a result of the deficiency of a common acceptance in self-directed learning.[26] Peterson (2004) stated that anxiety could be the result of unreliability of PBL, especially with students who experienced PBL method for the first time.[27] Furthermore, researchers have emphasized the fact that some levels of anxiety are necessary for PBL method's effectiveness.[20–27] Lewis et al. (2009) emphasized that there were significant diversities in the perceived course-related stressors affecting PBL and non-PBL methods. PBL is becoming more and more popular; hence, it is important to identify sources of the stressors that can be effectively minimized or addressed to ensure optimum learning and well-being.[28]

The mean score of students' opinions showed that they positively considered the new method. Thus, the students had the potential for active learning and experiencing new educational methods.

CONCLUSION

The students believed the modified PBL method produced studying motivation before the lab session and resulted in improved comprehension, faster experiment, problem reformulation and error reduction. It was discovered that application of pre-lab questionnaire via PBL method stimulated students' activities and achievements in the learning process. In this modified method, students had a guideline for writing details; therefore, it caused better organization of knowledge than common PBL. In fact, this method provided effective guidance and feedback. Although application of pre-lab questionnaire was suggested to improve learning via PBL method but other study can improve ability of this method with optimizing of group size and comparative this method with other collaborative learning methods

Limitation of this study: The limitation of this study was that the group size was not optimized.

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