



Hybrid problem-based learning radiology module in an integrated medical curriculum Al-Baha faculty of medicine experience

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ABSTRACT

Introduction: Al-Baha faculty of medicine has adopted an integrated, system-based block curriculum. This paper represents an innovative experience to insert the Radiology module to the 4th year of Al-Baha faculty medical students, as a part of integrated based learning. This module adopts different instruction modalities for teaching and assessment. The teaching tools include a hybrid mixture of lectures, problem-based learning (PBL), HPT, self-directed learning, and seminars. Assessment tools include quizzes, continuous, objective structured clinical examination (OSCE), clinical, and final written exam. Quizzes and final written exam comprise multiple choice questions, extended matching questions, and case scenario. **Aim:** The aim of our work was to investigate the effectiveness of inserting PBL in radiology teaching in comparison with other teaching and learning activities as a step to alleviate our instruction methods of both teaching and assessment. This investigation is done through evaluation of PBL construction according to the module learning objectives and how these PBL met with achieving the objectives through doing item analysis for each assessment tool. **Results:** Our results showed that most of learning objectives (81%) applied to PBL has been achieved more in clinical, OSCE, and written exam (85%, 80%, and 77%), respectively. **Conclusion:** PBL as an instruction tool is of great value in radiology teaching and of high efficacy especially if well-constructed and met with the module learning objectives.

KEY WORDS: Integrated, instructional tools, lecture, problem-based learning, radiology

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INTRODUCTION

Radiology Module Description

Radiology module is applied to the 4th year of medical students in the school of medicine, Al-Baha University, as a part of integrated based learning. This module has 3 credit h, i.e., 3 weeks duration. This module comprises many instruction tools for teaching and assessment. The teaching tools include hybrid of lectures, problem-based learning (PBL), hospital based teaching (HPT), self-directed learning (SDL), and seminars. Assessment tools include a quiz, objective structured clinical examination, clinical, and final written exam. Quiz and final written exam comprise different tools as multiple-choice questions (MCQs), extended matching questions, and case scenario. One of this instruction tools is PBL; our presenting module comprises two PBLs, one PBL per week.

Brief Description of PBL

Problem-based learning or PBL, as described by Barral and Buck [1] is a pedagogical practice employed in many medical schools. While there are numerous variants of the technique,

the approach includes the presentation of an applied problem to a small group of students who engage in discussion over several sessions. A facilitator provides supportive guidance for the students. The discussions of the problem are structured to enable students to create conceptual models to explain the problem presented in the case. As the students discover the limits of their knowledge, they identify learning issues - essentially questions they cannot answer from their fund of knowledge. Between meetings of the group, learners research their learning issues and share results at the next meeting of the group [2,3].

PBL has become popular in medical schools that have undergone curriculum reforms incorporating multidisciplinary-system-based courses rather than discipline-specific ones. This approach provides relevance, encourages SDL, targets higher-order learning, and engages students in ways that result in the better long-term retention of content than traditional, lecture-based courses [4].

Aim of the Work

So, our work was concerned on the efficacy of PBL in achieving its learning objectives in our institute and how to judge the

PBLs among other instruction tools. For this purpose, we selected PBLs designed for radiology module as example of this study. This was done through investigation of students' answers of questions applied by doing item analysis for all questions situated for quiz and final written exam and those applied for PBLs specifically through this module to stand on student's achievement of learning objectives applied for these PBLs and compare our results of PBLs with that obtained by other teaching tools applied in this module.

MATERIALS AND METHODS

In radiology module 2 PBLs were settled in the timetable. The learning objectives of each PBL were applied by radiology module committee and PBLs were designed to meet their applied objectives by experts of medical education of medical education committee of school of medicine in collaboration with quality and accreditation unit of Albaha university, Saudi Arabia. In integrated system-based learning, many instruction tools were introduced, all module' learning objectives were designed according to intended learning outcomes and these objectives were distributed in response to its suitable instruction tools. All students were aware from the starting point of module with these learning objectives and its instruction tools as well as its mode of assessment through receiving a hardcopy of module' study guide. The teachers also were informed how learning objectives could be achieved through these different instruction tools especially those related to PBL. At the end of PBL sessions we did what we called problem subject expert lecture in which an expert related to the problems of PBL were gathered all students in the class and did tutorial session. During this session all students can ask and receive answers from both peers and the expert. Also questions were thrown from the expert to students and so active session occurred and accordingly most of learning objectives were achieved. At the end of PBL sessions, teachers were asked to provide the module' director with number of questions valid to these PBL and questions were being selected thoroughly and applied in both quiz and final exam in an integrated manner without referral to it in question paper. The module committee categorized the questions according to its instruction tools. So selection of questions at the expense of its instruction tools was done at ease. The number of questions applied either in quiz or final exam widely depended on the weight of these tools in the timetable as well as number of learning objectives subjected for each tool. To make comparison of the effectiveness of PBL among these different variable, we did a constant figure for all tools separately i.e. final mark for each questions-specific tool was out of 20. Accordingly we multiplied the degree obtained for each questions-specific-tools by factor to be out of 20 and so the comparison was done.

Each PBL has two sessions, each session was of two hours duration (debriefing and brainstorming) with four days interval between the two sessions. For each PBL learning objectives were identified clearly in facilitator's guide only and was hidden in student version. Due to small numbers of questions in final exam we selected both quiz and final

exam to put in the presenting study, firstly; to get more questions and secondly; all questions were gathered from teachers in the same time and were distributed in both quiz and final exam to stand on validity of PBL in this module. All questions of assessment either quiz or final exam were subjected for item analysis and discrimination index (DisI) including PBL questions. In item analysis, number of right answers in proportion to student number was calculated for all questions presented in both quiz and final written examination to stand on overall score for all students, then all questions were categorized according to its teaching tool to facilitate the process of comparison.

We Calculated Difficulty Index (DifI) and DisI as Follow

Difficulty index (DifI) was calculated as the proportion of students who answered the test item accurately. Discrimination Index (DisI) showed how well an assessment differentiates between high and low scorers, it is either a positive discrimination index (between 0 and 1) indicating that students who received a high total score chose the correct answer for a specific item more often than the students who had a lower overall score or a negative discrimination index (between -1 and 0) indicating that more of the low-performing students got a specific item correct [5-8].

So in the presenting work we calculated the DifI and DisI by the following steps:

1. The students were arranged with the highest overall scores at the top.
2. Counted the number of students in the upper and lower group who got each item correct.
3. Determining the Difficulty Index by dividing the number who got it correct by the total number of students.
4. Determining the Discrimination Index by subtracting the number of students in the lower group who got the item correct from the number of students in the upper group who got the item correct, then divided by the number of students in each [9-13].

After doing DifI and DisI, all questions that showed extremities in both parameter were excluded.

After doing DifI and DisI, all questions that showed extremities in both parameters were excluded. In the rest of questions, we applied one figure for all groups, i.e., all groups are out of 20 irrespective of number of questions applied for each group. For do that we multiplied the score of each group by a specific factor to yield the figure out of 20.

RESULTS

Student overall performance in radiology module was analyzed in relation to tool- related- questions to stand on the efficacy of PBL among other teaching tools in radiology teaching, and the following results were obtained as shown in the following Tables 1 and 2, Figures 1 and 2.

Table 1: Differential student's performance in relation to tools-related question

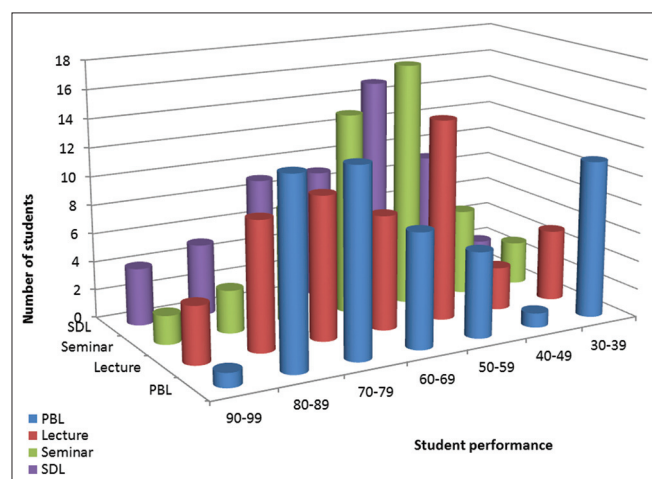
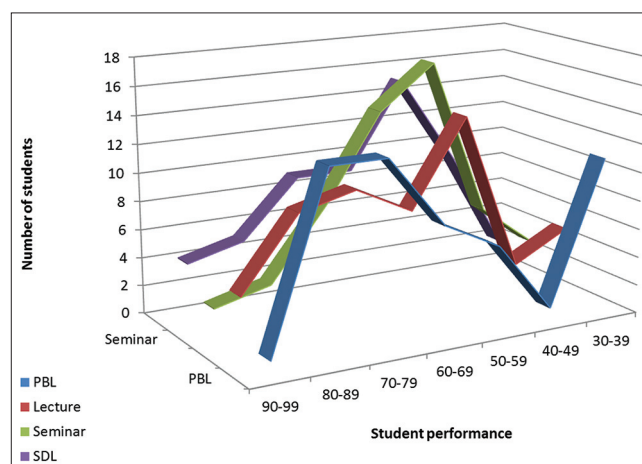
Tools-related - questions	Specific student's performance in relation to topic-related questions in radiology module							Total number of student	Number of questions	Pass	Fail
	90-99	80-90	70-79	60-69	50-59	40-49	30-39				
PBL	1	13	13	8	6	1	11	53	16	35 (66%)	18 (35%)
Lecture	4	9	10	8	14	3	5		48	31	22
Seminar	2	3	8	14	17	6	3		8	27	26
SDL	4	5	9	9	15	9	2		8	27	26
Total	11	30	40	39	52	19	21		80		

PBL: Problem-based learning, SDL: Self-directed learning

Table 2: DifI and DisI of PBL- related- questions in radiology module

Steps of DifI and DisI calculation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Total right answer	45	40	33	23	35	30	30	30	29	28	26	43	43	43	38	43
DifI	0.85	0.75	0.62	0.43	0.66	0.57	0.57	0.57	0.55	0.53	0.49	0.81	0.64	0.64	0.72	0.81
Mean	0.64±04															
Calculation of DisI																
Right answers in upper group	21	25	22	18	22	18	19	19	19	20	16	26	23	23	24	27
Right answers in lower group	24	15	11	5	13	12	11	11	10	8	10	17	11	11	14	16
DifI	-0.11	0.37	0.41	0.48	0.33	0.22	0.3	0.3	0.33	0.44	0.22	0.33	0.44	0.44	0.37	0.33

PBL: Problem-based learning, DisI: Discrimination index, DifI: Difficulty index

**Figure 1:** Column graph show student performance in comparison to other instructional tool**Figure 2:** Linear relationship of student performance in comparison with other instruction tools**Table 3: Scores of students in PBL, lecture, SDL, and seminars for total questions in both quiz and final exam**

Tools-related -questions	No	Mean score out of 20	P value
PBL	16	13.35	<0.001
Lecture	46	11.3	
SDL	10	10.6	
Seminar	8	11.4	

PBL: Problem-based learning, SDL: Self-directed learning

After doing item analysis for all questions presented in both quiz and final written exam, we found that: Lecture-related-questions was 56 out of 80 (70%) showed average DifI 0.65, that of PBL-related-questions, it was 16 out of 80 (20%) and average DifI was 0.64, of SDL-related-questions, it was 4 out of 80 (5%) and average DifI was 0.60, while that of seminars, it was 4 out of 80 (5%) and average DifI was 0.56 [Table 3].

DISCUSSION

As regard our results obtained, we find that PBL is of high value in elaborating the student's knowledge and identification of learning objectives through problem discussion from the student, which enrich acquisition of knowledge and professional skills. PBLs among other teaching tools, PBL beside it is student – centered, it encourages competencies among the student. Our results showed that PBL-related questions have average DifI of 0.64, this means that questions related to PBL-related questions were reliable, applicable, and knowledge was delivered easily among the students. This observation coincides with Moore *et al.* [14] who found that PBL students who were enrolled in 1989 and 1990 at Harvard Medical School, United States, learned in a more reflective way, memorized less than their peers, and preferred active learning.

In the present study, student performance was high in PBL-related questions than other instructional tool. This is in agreement with study of Hwang and Kim [15] who reported that students in the PBL group gained more knowledge and had higher motivation toward learning compared to students in the lecture group, also they reported that PBL was more effective for improving students' knowledge, and satisfactions, also Hwang found that scores of PBL group were significantly higher than that of students in the lecture-based learning (LBL) group.

In the study done by Khoshnevisasl *et al.*, [16] they reported that students preferred PBL because of motivation boost, quality learning, knowledge retention, class attractiveness, and practical usefulness of contents. However, in the case of answering the exam questions, lecture method was considered more effective, presumably because of the speaker's emphasis on teaching key points.

The presenting results come in contact with Smits' study of the management of mental health problems for occupational health physicians who showed that in both PBL and LBL groups, knowledge had equally increased right after the programs and decreased equally after the follow-up. They concluded that the problem-based program appeared to be more effective than the lecture-based program in improving performance. Both programs, however, were equally effective in improving knowledge levels in spite of Smits found that the PBL group was less satisfied with the course [17].

Furthermore, our results are in accordance with that of Woodward [18] and Post [19] who compares the preparations of PBL curriculum (PBLC) graduates with those of their peers in the conventional curriculum show no evidence to suggest that PBLC graduates perceive themselves to be disadvantaged.

Antepohl and Herzig [20] compared PBL versus lecture-based learning in a course of basic pharmacology and on analysis of their results of both groups in the examination of basic pharmacology, consisting of multiple-choice and short-essay questions, revealed similar scores with a tendency favoring PBL students in the category of short-essay questions. They concluded that overall student short essay questions are more appropriate for the assessment of learning objectives of PBL than MCQs. Hence, it seems clear that PBL does not imply a disadvantage in terms of factual knowledge. Students considered PBL to be an effective learning method and favored it over the lecture format. Furthermore, students reported positive effects of PBL in terms of use of additional learning resources, interdisciplinary, teamwork, and learning fun.

In addition, our results come in contact with that of Santos-Gomez *et al.* [21] who compared the performances of 130 PBLC graduates and 130 graduates of a parallel, conventional curriculum at the University of New Mexico School of Medicine, United States. They found that graduates from the PBLC group received superior ratings than graduates from the conventional group in the areas of health care costs, communication with patients, and patient education.

Doucet *et al.* [22] found that PBL in continuing medical education of headache management was associated with greater knowledge acquisition and with greater improvement in clinical skills than lecture-based approach. McParland *et al.* [23] compared PBL with LBL in the field of psychiatry and concluded that the performance of the students holding PBL was better in both multiple-choice questions and the viva. However, there were no differences between the two methods in the learning style and attitude of students. Moreover, our results coincide with that obtained by Tack and Plasschaert [24] on dental students who stated that students' knowledge turned out to be higher in the topic chosen for PBL. Furthermore, in a study done by Lin *et al.* [25] on nursing students, he found that the group who received PBL as the training method was more effective than conventional teaching as students showed more satisfaction, critical thinking, and self-motivated learning.

In addition, our results coincides with that of Meo [26] who assessed knowledge and skills of undergraduate medical students in a respiratory physiology course and concluded that students in PBL group obtained significantly higher scores compared to LBL approach.

Furthermore, our results coincide with a that of Moreno-López *et al.*, [27] who carried out on dental students and found that PBL participants obtained higher scores compared with the LBL group. PBL participants spent more time on group work and literature analysis. Furthermore, our results are in accordance with that of Rolfe *et al.* [28], who showed that graduates from the PBLC were rated significantly better than their peers, with respect to their interpersonal relationships, reliability, and SDL. Our results are in accordance with a study done by Anyaehie *et al.* [29], who indicated that PBL increased students' attendance, participation in classes and performance in the examination.

As regard student' satisfaction many studies as those done by Dehkordi and Heydamejad [30], Tack and Plasschaert [24], Meo [26], Kawai *et al.* [31] and Tsou *et al.* [32] showed that there is increased level of student's satisfaction in PBL than other teaching tools. Choi *et al.* [33] found that students in PBL group showed improved abilities in problem-solving, SDL and critical thinking.

In the study done by Jabbari *et al.* [34], who studied lecture-based versus PBL methods in Public Health Course for Medical Students and showed a significant difference between knowledge scores of PBL and LBL groups in short and medium time. Furthermore, our results are consistent with Dodd *et al.* [35] and Tsou *et al.* [32] studies, they found that PBL has a significant impact on how students find and use information. Furthermore, our results coincide with the study of Gulpinar *et al.*, [36] who found that the mean total evaluation score in the PBL group was 4.5 points higher than that of LBL group.

No significant difference between PBL and LBL as shown in the studies of Carrero *et al.* [37], Goodyear [38], Choi *et al.* [33],

and Khan *et al.* [39]. Carrero *et al.* compared PBL with LBL in professional and continuing education courses in the topic of air embolism. They found that no significant differences were observed in the area of immediate knowledge for PBL and LBL. The study of Goodyear showed that, learning outcomes were similar in PBL and LBL. The study of Choi *et al.* on nursing students to compare PBL with LBL revealed that learning outcomes of problem-based learning were not statistically different from LBL. Khan *et al.* compared the effect of PBL versus LBL on the knowledge and attitude of students.

Our results come in contrary to study done by Johnston *et al.* [40], who compare PBL with LBL, and concluded that PBL was less effective at imparting knowledge than customary LBL. No significant difference between PBL and Lecture as shown by Khan and Fareed [41], who mentioned students in PBL and LBL produced similar MCQs test scores. They found that both groups demonstrated a similar level of knowledge. Furthermore, our results are not in accordance with that of Miller [42], who found no significant differences between PBL and LBL groups for any of the items measured.

CONCLUSION

The present study, which has been designed to determine outputs of the effectiveness of PBL as instruction tool in radiology module revealed that students' performance and satisfaction in PBL method were good and of value in comparison to other instruction tools especially lecture. For this instance, in order to improve the quality of health care as a central mission of medical education, PBL must be well constructed, more reliable and be generalized for all medical schools and health education.

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