ORIGINAL ARTICLE

Effectiveness of Problem Based Learning as an Instructional Tool for Acquisition of Content Knowledge and Promotion of Critical Thinking Among Medical Students

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ABSTRACT

Objective: To assess effectiveness of PBL as an instructional tool in clinical years to improve learning of undergraduate students in terms of acquisition of content knowledge, critical thinking and problem solving skills through problem based learning and traditional way of teaching.

Study Design: Quasi-experimental study.

Place and Duration of Study: Fatima Jinnah Medical College for Women, Lahore, from October 2009 to April 2010.

Methodology: Final year medical students attending Obstetrics and Gynaecology and Surgery rotations were inducted as participants in this study. Two batches of 50 students each attended Gynaecology rotation and two batches attended Surgery rotation, i.e. 100 students in each. Each batch was divided into two groups i.e. A and B of 25 students each. Group-A learnt through traditional teaching, involving bedside teaching and lectures in wards and Group-B learnt relevant clinical knowledge through a modified PBL process. Content knowledge was tested by MCQs testing recall while clinical reasoning and problem were assessed by MCQs testing analysis and critical thinking. Intra-group comparison of mean scores of pre and post-test scores was done using paired sample t-tests while for intergroup comparison of mean scores was done through independent sample t-test.

Results: Teaching through traditional method significantly improved content knowledge, ($p = 0.001$) but did not considerably improve clinical reasoning and problem solving skills ($p = 0.093$) whereas, content knowledge of students who studied through PBL remained the same ($p = 0.202$) but there was marked improvement in their clinical reasoning and problem solving skills ($p = < 0.001$).

Conclusion: PBL is an effective instructional tool to foster critical thinking and problem solving skills among medical students.

Key words: *Problem based learning (PBL). Traditional teaching. Critical thinking. Problem solving. Content knowledge.*

INTRODUCTION

Education has long focused on teaching students to give a correct answer. Teachers too often ask students to recite, define, describe or list facts. They are less frequently asked to analyse, infer, synthesize, evaluate, think and rethink.[1] Students have become familiar with this process of passing knowledge back and forth without inquiring into how this information applies to the real world.[1] How knowledge can improve medical expertise, has been a focus of extensive debate over the last century dating back to the time of Flexner, who emphasized the importance of acquiring sound scientific knowledge, which underpins medical essentials, while Osler took the opposite position by asserting that practice-oriented teaching method was more relevant in medical education. The latter view was endorsed by learning through PBL approach in early 1970s, which was inclined towards marginalizing the role of knowledge by stressing on the significance of learning to solve problems whereas, knowledge was assumed to be learned automatically, as a by-product. This paradigm shift advocated using learning resources rather than memorizing facts. However, cognitive psychologists have been generating evidence that mere immersion in practice is not enough to develop expertise and expert problem solving is not possible without well organized knowledge database. Nevertheless, highlighting importance of content knowledge can lead to short-term exam-driven learning, which can undermine medical expertise altogether.[2]

21st century has brought new challenges in its wake in the context of medical teaching as well with a demand to teach contextually relevant material to students in a way that critical thinking is fostered at all levels of education. Those responsible for providing professional education have specially responded to it by initiating curricular reforms and UK General Medical Council's report- "Tomorrow's Doctor" is one example of such educational reforms, which aims at critical thinking development,

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professional knowledge acquisition and life-long learning. Likewise, the USA's National League for Nursing insists the incorporation of critical thinking development in their documents for accreditation of nursing programmes. Promotion of critical thinking has been considered a major learning outcome for the nursing curriculum as stipulated by the Council of Europe also. While, there is agreement on the significance of critical thinking, difference of opinion exists as to how critical thinking should be taught? Some believe that there is no one method to foster critical thinking among students while others assert use of specific teaching strategies to promote it. Among educational strategies PBL is thought to promote critical thinking whereas, traditional lecturing is criticized for its role in making learning a passive experience and thereby discouraging critical thinking altogether.[3]

The current education climate reflects the importance of not only learning content information but also developing skills to think critically so that evidence based solutions of actual life problems may be proposed more efficiently.[1,4]

In clinical years, students' learning is at best contextualized. “Learning opportunities” derived from real life situations dominate their academic experience, which enrich their perspective as future clinicians. In order to promote meaningful learning, situated learning theory has come to the fore-front by providing a framework for modified PBL process, which maintains 'Legitimate Peripheral Participation' as a central process to cultivate clinical reasoning and problem solving in clinical years.[5-7] Students trained through PBL after graduation appear to have better self-directed learning and other professionally relevant skills.[8-11]

Besides, PBL is a continuum of approaches rather than one immutable process. It is a teaching method that can be included in the teacher's tool-kit along with other teaching methods rather than used as the sole educational strategy.[12] This insight paved the way to conceive the following objective:

The objective of this study was to assess effectiveness of PBL as an instructional tool in clinical years to improve learning of undergraduate students in terms of acquisition of content knowledge, critical thinking and problem solving skills through problem based learning and traditional way of teaching.

METHODOLOGY

A total of 200 final year medical students who attended Obstetrics and Gynaecology and Surgery rotations were involved as participants in this study, in four batches of 50 students each for a duration of 3 months. Two batches attended Gynaecology rotation and two batches attended Surgery rotation, i.e. 100 students in each. Each batch of 50 students was divided into two groups i.e. A and B of 25 students each. Group-A learnt through traditional teaching, involving bedside teaching and lectures in wards and Group-B learnt relevant clinical knowledge through a modified PBL process after taking informed consent and elaborating the purpose of study. This study was approved by the Ethical Review Board of FJMC in September 2009.

Content knowledge was tested by MCQs testing recall, while clinical reasoning, critical thinking and problems solving skills were assessed by one best type of MCQs. Intra-group comparison of mean scores of pre- and post-test scores was done using paired sample t-tests while for intergroup comparison of mean scores was done through independent sample t-test. The research inquiry was quantitative with quasi experimental design. Non-probability convenience sampling technique was used for selection of sample for this study, which led to selection of only final year students from Fatima Jinnah Medical College, who came for their clinical rotations to the above mentioned units.

Non-probability purposive sampling technique was used to distribute students in Group-A and B after taking informed consent and elaborating the purpose of intervention. All those who volunteered to experience new intervention were purposively assigned Group-B and those who preferred traditional way of teaching were grouped in batch A. However, to keep an equal number in both groups, some of them were requested to join the control group on a pretext that they would also be given an opportunity to experience learning through PBL in the cross-over phase after the completion of the first phase (lasting for 6 months). Therefore, 100 students were taught by traditional teaching (control group, Table I) and were designated as Batch-A, while 100 students were taught through PBL and were designated as Batch-B (interventional group, Table II). Variations in how instructions are administered can pose an implementer threat to internal validity. To control it, teachers were selected based on characteristics of their formal preparation for teaching. Six teachers were selected and they attended orientation sessions to teach through either traditional or PBL approach. Student orientation to PBL methods and its assessment tools was also carried out. The data was collected using pre- and post-test measures of scores on MCQs, testing content knowledge and critical thinking with 30 MCQs of each type i.e. C1 and C3 MCQs. Each MCQ carried one mark and pass percentage was decided to be 60%. Data was subjected to statistical analysis on Statistical Package for Social Sciences (SPSS) version 13.0. To evaluate the pre-test and post-test comparison within each group paired t-test was used. For post-test comparisons between A and B group assessment results, independent sample t-test was used. Results were considered significant at a p-value of 0.05 or less.

Table I: Batch-A: Control group's scores (experiencing learning through traditional teaching).

Pre-test score on C1 MCQ			Post-test score on C1 MCQ			Pre-test score on C3 MCQ			Post test score on C3 MCQ		
Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students
<=10	0	0%	<=10	0	0%	<=10	02	02%	<=10	03	3%
<=20	95	95%	<=20	56	56%	<=20	98	98%	<=20	97	97%
<=30	5	5%	<=30	44	44%	<=30	0	0%	<=30	0	0%

Table II: Batch-B: Interventional group's scores (experiencing learning through PBL).

Pre-test score on C1 MCQ			Post test score on C1 MCQ			Pre-test score on C3 MCQ			Post-test score on C3 MCQ		
Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students	Scores out of 30	No. of students 100	Percentage of students
<=10	0	0%	<=10	0	0%	<=10	0	0%	<=10	0	0%
<=20	74	74%	<=20	76	76%	<=20	100	100%	<=20	47	47%
<=30	26	26%	<=30	24	24%	<=30	0	0%	<=30	53	53%

RESULTS

Intra group comparison of pre- and post-test scores of Group-A and Group-B for acquisition of content knowledge, assessed through C1 level MCQs was tabulated (Table III). A highly significant difference ($p < 0.001$) was observed in the level of knowledge before and after instruction assessed in Group-A through MCQs at C1 level. On the other hand in group-B an insignificant difference ($p < 0.202$) was observed for acquisition of content knowledge, assessed through C1 level MCQs.

Intra group comparison of pre- and post-test scores of Group-A and Group-B for acquisition of critical thinking, assessed through C3 level MCQs was tabulated (Table III). In Group-A an insignificant difference ($p < 0.093$) was observed for acquisition of critical thinking and problem solving, assessed through C3 level MCQs. On the other hand a highly significant difference ($p < 0.001$) was observed in the level of knowledge before and after instruction assessed in Group-B through MCQs at C3 level.

Inter group comparison of post-test of traditional teaching (Group-A) and PBL (Group-B) for acquisition of content knowledge and critical thinking and problem solving, assessed through C1 and C3 level MCQs was tabulated as Table IV. Analysis of table depict that students in Group-A, experiencing traditional teaching have shown better results than students in Group-B, experiencing teaching through PBL in the domain of basic content knowledge assessed through post test, consisting of MCQs meant to asses mere recall i.e. C1 level. This showed a highly significant difference ($p < 0.001$). On the other hand a highly significant difference was observed between Group-A and Group-B when it comes to acquisition of problem solving and critical thinking skills through post-test of MCQs (C3 level) assessing higher order thinking. It was observed that Group-B, experiencing learning through PBL has a clear edge over the Group-A, learning through traditional way of teaching.

Table III: Intra-group comparison of pre- and post-test scores of traditional teaching (Group-A) and PBL-learning (Group-B) for acquisition of content knowledge and critical thinking.

	Intra group comparison through			
	C1 Level MCQs		C3 Level MCQs	
	Group-A	Group-B	Group-A	Group-B
Pre- intervention mean score with SD	17.15±1.88	18.43±2.23	14.70±1.68	15.10±2.79
Post-intervention mean score with SD	22.92±4.60	18.67±1.63	15.11±1.87	21.94±3.83
p-value	< 0.001	< 0.202	< 0.093	< 0.001

Table IV: Inter-group comparison of post-test of traditional teaching (group-A) and PBL (group-B).

	Inter-group comparison of post-test scores of group-A and group-B through			
	C1 Level MCQs		C3 Level MCQs	
	Group-A	Group-B	Group-A	Group-B
Mean ± S.D	22.92±4.60	18.67±1.63	15.11±1.87	21.94±3.83
p-value	< 0.001		< 0.001	

DISCUSSION

Various studies have examined the outcomes of PBL in medical school curricula. There is agreement on the contribution of PBL to factors such as knowledge retention, student satisfaction, motivation, and critical thinking.

Studies indicate that instructional strategies within the classroom and experiential learning activities can increase critical thinking ability.

Literature also reveals that PBL students did not perform very well on knowledge exams and more traditional approaches to instruction are recommended to ensure content coverage.[9,11,13]

This study (Table III) revealed similar findings that teaching through traditional method significantly improves content knowledge with a p-value determined at < 0.001. However, traditional teaching does not significantly improve critical thinking and problem solving skills with a p-value found out to be < 0.093,

nevertheless, some improvement can be seen in the mean score of post-test in Table III, indicating that overall instruction through traditional way has helped students score better in the post-test. In addition, in final year many students are preparing for USMLE steps and other foreign exam in which MCQs assess higher order thinking. Therefore, that preparation might also be responsible for slight improvement in the scores in this group.

It is also suggested that PBL students are at a disadvantage when compared to traditional students on content knowledge.[9] Findings from meta-analysis of Albanese and Mitchell indicated that this was not always true and that variations of PBL, produced students who performed well on basic exams as well as conventional exams. In contrast, they found that PBL students scored higher on clinical exams. These exams are closely associated with problem solving and utilize critical thinking skills.[1,5,14] However, Dods found no difference in the content knowledge of students exposed to PBL compared to traditional instructional strategies.[6]

In this study, content knowledge of students who studied through PBL almost remained similar as shown by their pre-test and post-test scores in Table III, the slight improvement noted in the mean scores can be attributed to elaboration and encoding, which occur with PBL as an instructional strategy ensuring storage of information in the long-term memory. Conversely, there was significant improvement in the students' problem solving and critical thinking skills with a p value of < 0.001.

Proponents of the method claim that PBL promotes student centered learning and life-long learning, is more nurturing and enjoyable than traditional methods of instruction, and improves student motivation and teamwork.[15] PBL has been found to be effective in promoting higher order thinking especially when assessments become more complex, asking students to explain the underlying relationships between concepts or to apply their knowledge in the solution of novel problems, PBL students perform markedly better,[16,17] the observation is similar as shown in Table III.

Literature also suggests that PBL students have as much content knowledge as their lecture-based counterparts, and they perform better at more complex forms of assessment, and retain more of what they learn.[17,18] It is partially supported by these results, which claim insignificant difference in the content knowledge of students in the PBL group as seen in the post-test but marked improvement in higher order thinking skills, Table III.

The evidence suggests that students trained through PBL become more accomplished diagnosticians, which is among the main competencies to be acquired by young doctors towards the end of 5 years' learning in a medical school. In addition, after graduation they appear to have better self-directed learning and other professionally relevant skills.[3,19-22] Additionally students in PBL programs show an increase in transfer and application of knowledge and more active engagement in analysis and application required in clinical trials, each considered essential to problem solving.[23,24]

To explore the topic further, it is recommended to follow the results in the cross-over phase and then to extend this study to other years of the same medical school and to other medical schools as well. A qualitative phase can also be added to have in-depth insight into various confounding factors posing a threat to internal and external validity of the study.

Non-probability sampling technique with a limited sample size and one institution used for this study impose limitations to generalization of the study's results. Therefore, caution should be used in an attempt to generalize the results of this study beyond the participants of this study.

CONCLUSION

Despite above mentioned limitations, the results indicate that PBL when used as an instructional tool does significantly foster critical thinking and problem solving skills, whereas, it does not appreciably influence acquisition of content knowledge. On the other hand, teaching through traditional approach considerably improves content knowledge but does not notably improve acquisition of critical thinking and problem solving skills.

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