

Effect of Problem Complexity on Group Learning and Problem Solving Skills of Medical Students

Samia Sarwar ¹, Shaista Ali ², Nadeem Ikram ³, Abdullah Bin Khurram ⁴, Assad Kamal Sheikh ⁴, Muhammad Abdullah⁴

1. Department of Physiology Rawalpindi Medical College; 2. Department of Anatomy Rawalpindi Medical College;
3. Department of Pathology Rawalpindi Medical College; 4. Final year MBBS student Rawalpindi Medical College

Abstract

Background: To analyze the effect of problem difficulty on group learning and problem solving skills of second year MBBS students.

Methods: In this prospective descriptive study two problem based learning (PBL) scenarios (one easy and the other difficult) were constructed on topic of hyperthyroidism were given consecutively to of 270 students (199 girls and 71 boys). At the end of two PBL scenarios, the students' perceptions regarding group learning were recorded for both PBLs (easy and difficult) simultaneously using 5 point Likert scale on a standardized questionnaire. At the end of the difficult scenario, knowledge retention and problem solving skills of students were also tested by giving them a written test comprising of MCQs and SEQs. Data was analyzed by SPSS version 20 for frequencies and percentages. Paired Likert data regarding group learning items was analyzed using the Wilcoxon Signed Ranks test. Central tendency for positive and negative item outcomes were assessed to evaluate whether there is a significant directional change in the two responses. p value <0.05 was considered significant.

Results: Wilcoxon Signed Ranks test indicated that the two testing conditions were not significantly different (z score, p>0.05). There was not a statistically significant difference between the simple and difficult scenario of PBL. Mean scores of the students were obtained as 0.92, 0.76, , 0.73, 0.53, 0.47 while for C-1 (recall) level MCQs mean scores are 0.79, , 0.61, 0.48 and 0.19. For SEQs best mean score was again observed for one SEQ of C-2 level and it is found 0.79 while for C-3 level (Problem solving level) the mean score were 0.43 only. After accomplishing difficult PBL, students have shown better performance in C-2 level (interpretation level) questions as compared to C-1 (recall) and C-3 level (problem solving).

Conclusion: There was significant difference in group work between during the simple and difficult PBL scenario. MCQs and SEQs of C-2 level (level of

interpretation) were attempted well than C-1 and C3 level

Key Words: Problem Based Learning, Problem Solving

Introduction

Problem Based Learning (PBL) is a learner-centered instructional strategy which is presented in the scaffold of a defined core curriculum. In addition to knowledge acquisition PBL also assists development of numerous soft skills including group work and problem solving. PBL scenarios can either be simple or difficult. PBL problems may be challenging for students. Learning from problems is crucial for human survival.¹PBL commenced by Howard Barrows at McMaster University in 1969 and latter on was adapted by many medical colleges across the globe partially or inclusively as part of their curriculum. ²PBL is a learner-centered instructional strategy which is in general presented in the framework of a defined core curriculum. In addition to knowledge acquisition, PBL also facilitates several other advantageous attributes including, teamwork, problem solving, independent responsibility for learning, sharing information, respect for others and communication skills.³ PBL starts with write up of a "problem" in the form of clinical scenario with integration of basic and clinical sciences.⁴An effective PBL scenario should be realistic, synchronized with the pre-set learning objectives, engaging with adequate built-in interest for the students , able to kindle integration of knowledge across disciplines, challenging, but adjusted to students' previous knowledge, motivating to students' discussion at a higher cognitive level, rational in flow, open-ended or using a gradual revelation design so that discussion is not curtailed too prematurely in the process and planned in a milieu corresponding to students' future career.^{5,6}PBL scenarios can either be simple, well structured and ill structured with a rational degree of structuredness or they can be complex. Complex PBL problems may be challenging for students and can provide opportunity for students

to analyze the problem from numerous perspectives.⁷ Individuals learn more in group as when they learn alone.⁸ PBL provides a platform to work productively with others and to share information.⁹ Knowledge acquisition and retention through PBL can be evaluated by using MCQs (Multiple Choice Questions) test as one tool for assessment.^{10, 11} SEQs (Short Essay Questions) can also be utilized as an added tool for assessment of knowledge in PBL.¹² Successful Implementation of PBL is a challenge for medical colleges in Pakistan due to multiple reasons.^{13,14}

Subjects and Methods

This prospective descriptive study was performed on 2nd year MBBS students of Rawalpindi Medical College, from April-June in 2012. Total number of 270 students (199 girls and 71 boys) participated in this study. Two PBL scenarios, one simple and the other difficult were constructed on topic of Hyperthyroidism and were standardized through discussion by a group of basic sciences subject specialists and clinical specialists in context of problem structure (easy or complex), authenticity, curricular relevance, thinking requirement and potential solutions. Students were divided in 21 PBL groups approximately 15 students in each group. They were given these two PBLs, first one easy and the second was complex (each PBL consisting of two sessions). Both PBLs were given consecutively and were finally completed within a month's time. At the end of complex scenario, the students' perceptions regarding group learning were recorded for both PBL (easy and difficult) simultaneously using 5 point Likert scale (SD - Strongly disagree; D - Disagree; N - Cannot Comment; A - Agree; SA - Strongly agree) on a modified version of the instrument (Questionnaire) used at Nelson Mandela School of Medicine at the University of KwaZulu-Natal in South Africa.¹⁵ This modified version of the Questionnaire containing 16 items (Table-1) was validated and pretested before it was used for the present study. At the end of the complex scenario, knowledge retention and problem solving skills of students were also tested by giving them a written test comprising of standardized questions including 9 MCQs and 3 SEQs. Each MCQ carried one mark and each SEQ carried two marks. Paired likert data regarding group learning items was analyzed using the Wilcoxon Signed Ranks test. Central tendency for positive and negative item outcomes were assessed to evaluate whether there is a significant directional change in the two responses. P value <0.05 was considered significant.

Table-1: Questionnaire for assessment of group work during PBL class

No	Questions
1	Motivation to participate in PBL class was increased
2	PBL Increased motivation to do well in PBL
3	PBL increased comfort level for working in a group
4	Working in a group was better than working alone
5	When working alone, I did not learn as much as I did as when I worked in a group
6	Group learning did not take too much of time
7	Learning in a group was not frustrating and stressful
8	Group learning was a very good way of learning the content of the course
9	I learnt to be tolerant in group
10	I learnt to work successfully with students from different social and cultural groups
11	My group worked together effectively (i.e Learning happened)
12	Members in my group shared information freely
13	I was benefited from the input of other group members
14	I became more perceptive and sensitive to the needs of others during group work
15	Group work helped to make sense of areas of the year's studies that were still confusing after the lectures, tutorials and/or practical
16	PBL did not increase motivation to attend the PBL class

Results

Wilcoxon Signed Ranks Tests were used to compare two PBL assessments of group learning. The results from the Wilcoxon Signed Ranks test indicated that the two testing conditions were not significantly different. (z score, p>0.05) indicated that there was not a statistically significant difference between the simple and difficult scenario of PBL (Table 2). At this point, the analysis is limited to identifying the presence or absence of a significant difference between the groups and does not describe the strength of the treatment. We can consider the effect size (ES) to determine the degree of association between the groups. We use the

formula $ES = \frac{|z|}{\sqrt{N}}$, to calculate the effect size, where

|z| is the absolute value of the z-score and N is the

number of matched pairs included in the analysis. The effect size ranges from 0 to 1 (Table 3). Cohen (1988) defined the convention of effect size as small=0.10, medium=0.30, and large =0.50. Output 3 shows very small effect sizes.

Table-2: Comparison of items regarding group learning between complex and easy PBL problem (Test Statistics^c)

	Z	Asymp.Sig. (2-tailed)	Exact Sig. (2-tailed)	Exact Sig. (1-tailed)	Point Probability
q1b - q1a	-.774 ^a	0.439	0.446	0.223	0.005
q2b- q2a	-.618 ^a	0.537	0.542	0.271	0.004
q3b - q3a	-1.206 ^a	0.228	0.234	0.117	0.002
q4b - q4a	-.747 ^a	0.455	0.456	0.228	0.004
q5b - q5a	-.296 ^b	0.767	0.776	0.388	0.007
q6b - q6a	-.825 ^b	0.41	0.417	0.209	0.005
q7b - q7a	-.918 ^a	0.358	0.373	0.186	0.009
q8b - q8a	-.418 ^a	0.676	0.679	0.34	0.004
q9b - q9a	-1.644 ^b	0.1	0.102	0.051	0.002
q10b - q10a	-1.449 ^b	0.147	0.15	0.075	0.002
q11b - q11a	-.482 ^b	0.63	0.645	0.322	0.01
q12b - q12a	-.829 ^b	0.407	0.405	0.203	0.001
q13b - q13a	-.616 ^b	0.538	0.543	0.272	0.007
q14b - q14a	-.376 ^a	0.707	0.719	0.359	0.009
q15b - q15a	-.185 ^a	0.853	0.874	0.437	0.012
q16b - q16a	-.080 ^a	0.936	0.935	0.468	0

a. Based on positive ranks;Based on negative ranks; Wilcoxon Signed Ranks Test

Out of 270 students in the class, 2 (0.7%) of them did not attempt, 10 (3.7%) got maximum marks and 60(22.2%) students got 5 marks out of 9 marks (Table 4). One hundred and eighty nine (70%) students attempted correctly SEQ-2, 162(60%) attempted correctly SEQ-1, and 108(40%) attempted correctly SEQ-3 (Table 5).

Table-3: Effect Size between items of group learning between complex and easy PBL problem

	Effect Size
q1b - q1a	0.05
q2b - q2a	0.04
q3b - q3a	0.08
q4b - q4a	0.05

q5b - q5a	0.02
q6b - q6a	0.05
q7b - q7a	0.06
q8b - q8a	0.03
q9b - q9a	0.1
q10b - q10a	0.09
q11b - q11a	0.03
q12b - q12a	0.05
q13b - q13a	0.04
q14b - q14a	0.02
q15b - q15a	0.01
q16b - q16a	0

Table-4: Result of MCQs (each MCQ carried one mark)(n=270)

MCQ No.	Cognition level of MCQ	Mean score of MCQ	Total marks obtained out of 9 marks	Frequency & % of students who gave correct answer
1	C2	0.47	1	(7%) 2.6
2	C2	0.53	2	(14%) 5.2
3	C1	0.19	3	(12%) 4.4
4	C1	0.61	4	(34%) 12.6
5	C2	0.92	5	(60%) 22.2
6	C2	0.76	6	(59%) 21.9
7	C1	0.48	7	(22%) 8.1
8	C1	0.79	8	(22%) 8.1
9	C2	0.73	9	(10%) 3.7
Did not attempt		0.00	0	(2%).7

Table-5: Result of SEQs (each SEQ carried two marks)(n=270)

SEQ NO.	Cognition level of SEQ	Mean score of SEQ	Total Marks obtained out of 6 marks	Frequency & % of students who gave correct answer
1	C2	.13		162 (60%)
2	C2	.79		189(70%)
3	C3	.43		108(40%)
Did not attempt		0.00		27(10%)

Discussion

Problem difficulty has received little consideration among the issues in PBL research. Generally, instructional designers or teachers use their preeminent verdict based mostly on their experiences or perceptions to establish an appropriate difficulty level for PBL scenario.⁷ Collaboration is crucial in learning processes. Learning and working in small groups senses natural and human. After school life

most learners come across the need to share information and work productively with others. Small-group learning is the heart of PBL. PBL offers a platform for the development and refinement of essential skills of collaborative group learning and teamwork in medical graduates. During a PBL session the tutor asks questions to make certain that information has been shared between members in relation to the group's problem.⁹

One important attribute of PBL is students collaborating and learning in small groups. Ideally a small group should not exceed 8-10 students, but in public sector Medical Colleges in Pakistan where we have large number of students.^{3,16} In the present study the groups comprised of 15 students in each PBL group (class size at RMC usually exceeds 300 students) and this can be considered as one of the limitation of our study. Studies focusing on the cognitive effects of PBL seem to reveal that activation of previous knowledge, recall of information, interpretation or theory building, cognitive disagreements leading to conceptual change and mutual learning edifice take place in the PBL group. Studies focusing on the motivational effects of PBL display that group discussion certainly influence students' intrinsic interest in the subject topic under discussion. The studies also exhibit that a slapdash discussion in the PBL group or a discussion that just scratches the outer shell, perhaps caused by students being less motivated, restrains student learning in a small group.¹⁷ Designing PBL problems with appropriate depth requires two parameters, complexity and ill-structuredness. If only basic information is required to solve a problem, the learners are expected to study the topic only superficially. When a problem is easily resolved, the need and motivation for the learners to probe the topic deeper fades away.¹⁸ Learning in small group begins when students come across a real health problem or scenario that cannot be fully elucidated by the members of the group at the level of their existing knowledge. Problems are plotted specifically to provoke curiosity and to create a need to know upon which students will act collaboratively and individually. Problems may vary in their level of difficulty and complexity for example following a recipe is a simple problem while sending a rocket to the moon is a complicated problem. Similarly raising a child is complex problem.¹⁹ As far as results of our study are concerned it is found that there is no significant difference between the student's perception regarding effectiveness of group learning in an easy and a difficult PBL scenario but more extensive

research work is required to find the effects of problem difficulty on group learning activity.

Well-defined and ill-defined problems involve separate cognitive processes and epistemic beliefs (i. e. assumptions about the nature and attainment of knowledge) play an important role in ill-defined problem solving. These findings supported Kitchener's three-level model of problem solving.²⁰ Kitchener's three-level model of cognitive processing says that when individuals are faced with ill-structured problems, at the first level, level of cognition, individuals work out, memorize, read, recognize, solve problems, etc. At the second level, metacognitive level, individuals monitor their own advancement when they take on these first-level tasks. At the third level, epistemic cognition level, individuals reflect on the perimeter of knowing, the sureness of knowing and criteria of knowing. Epistemic assumptions manipulate how individuals understand the nature of problems and decide what kinds of approaches are appropriate for solving them.²¹ Further research is required to obtain more facts and deeper approach in the cognitive and emotional effects of small group learning in PBL.¹⁷

One more strategy that we can try and can make group learning more productive is cooperative learning technique rather than simple discussion among group members. Cooperative learning method is an active education approach with small groups in order that the students will build up the learning of both themselves and the group members. Better understanding of the material learned is attained when students interact with each other and they clarify and discuss each other's viewpoints. The effort to resolve potential differences during collaborative activity leads to outcome of quality reasoning, the precision of long term retention and increased depth of knowledge and higher level of learning.²² PBL process often uses cooperative learning as part of it. In one study cooperative learning was launched in a PBL course in 10-week surgery clerkship, and the difference was evaluated between this method and conventional PBL. No significant differences in outcome were found between the study and control group. In this study students in the cooperative learning group experienced that cooperation assisted them learn, it was enjoyable to study and uttered contentment, but they complained about the plenty of time required by the group to work together, also it was not easy to perform group work, and noise during the sessions.⁴

As far as results of MCQs and SEQs given in our study are concerned we find that in MCQs of C-2 level

(level of interpretation) mean scores of the students were obtained as 0.92, 0.76, , 0.73, 0.53, 0.47 while for C-1 (recall) level MCQs mean scores are 0.79, , 0.61, 0.48 and 0.19. For SEQs best mean score was again observed for one SEQ of C-2 level and it is found 0.79 while for C-3 level (Problem solving level) the mean score were 0.43 only. These results show that in present study after accomplishing difficult PBL, students have shown better performance in C-2 level (interpretation level) questions as compare to C-1 (recall) and C-3 level (problem solving). Data is scarce to compare appropriately our results with other studies to analyze the effect of problem difficulty upon level of cognition achieved after going through a difficult problem.

Few of the important limitation of the study which might had some impact upon the outcomes of the study include that students were not aware about a written test at the end of two PBLs and further more results of this kind of test was not having any weightage in their academic record.

Conclusion

1. In problem based learning there is no significant effect of problem difficulty upon group learning as well as on problem solving skills and knowledge recall as is shown by the results of C-3 level (problem solving level) and C-1 level (recall) questions in the written test.

2. Difficult Problems in Problem Based Learning has lead to better outcomes of interpreting the problem as is shown by performance of students for C-2 (interpretation) level question

References

1. Barrows HS, Tamblyn RM. Problem-based learning: an approach to medical education. New York: Springer; 1980.p.1.
2. Rehman R, Rubab Z, Usmani A, Rehan R. Problem Based Learning Development Program at Bahria University Medical and Dental College. Pakistan Journal of Medicine and Dentistry (PJMD)2013, 2 (2): 21-26
3. Wood DF. Problem based learning. BMJ 2003; 326:328-30
4. Turan S, Konan A, Kili VA, Ozvans SB, Sayek I. The effects of problem based learning with co-operative learning strategies in surgery clerkships. J Surg Educ 2012; 69(2): 226-30
5. Azer SA, Peterson R, Guerrero AP, Edgren G. Twelve tips for constructing problem-based learning cases. Med Teach 2012; 34(5):361-67
6. Dolmans DH, Balendong HS, van der Vleuten CPM. Seven principles of effective case design for a problem-based curriculum. Med Teach 1997; 19(3): 185-89
7. Jonassen DH. All problems are not equal: Implications for Problem-Based Learning. Interdisciplinary Journal of Problem- Based Learning 2008 ; 2(2) : 6-28
8. Michael J. Where's the evidence that active learning works? Adv Physiol Educ 2006; 30(4):159-67
9. Savery JR. Overview of Problem-based Learning: Definitions and Distinctions. Interdisciplinary Journal of Problem- Based Learning 2006 ; 1(1) :9-20
10. Khan I, Fareed A. Multiple choice questions as a single tool for assessing retention of knowledge in problem-based learning. J Coll Physicians Surg Pak 2001; 11:494-96
11. Khan I and Fareed A. Problem-based learning variant: transition phase for a large institution. J Pak Med Assoc 2001; 51:271-74
12. Hameed S, Khalid T, Aslam S, Ahmad M. Small group discussion- impact on student's test scores in an undergraduate pathology course. J Uni Med Dent Coll 2013 ; 4(1) :17-21
13. Zaman V. Problem based learning in the 3rd world context. J Pak Med Assoc 2001; 51:290-92
14. Khan MM, Saga Z, Minhas F, Anwar I, Kulsoom A. Innovation in medical education: implementation of problem based learning under the umbrella of a traditional curriculum – perceptions of students and faculty. Pak Armed Forces Med J 2012; 62(1): 63-67
15. Singaram VS, Dolmans DHJM, Lachman N. Perceptions of problem-based learning group effectiveness in a socially-culturally diverse medical student population. Educ Health (Abingdon). 2008 ;21(2):116
16. Azhar MA. Faculty's Perceptions of Factors hindering the Introduction of problem based Learning. Ann. Pak. Inst. Med. Sci. 2012; 8(2): 125-28.
17. Dolmans DH, Schmidt HG. What Do We Know About Cognitive and Motivational Effects of Small Group Tutorials in Problem-Based Learning? Adv Health Sci Educ Theory Pract 2006 Nov;11(4):321-36
18. Hung W. The 3C3R Model: A Conceptual Framework for Designing Problems in PBL. Interdisciplinary Journal of Problem- Based Learning 2006; 1(1): 55-77
19. Mennin S. Small-group problem-based learning as a complex adaptive system. Teach Teach Edu 2007; 23:303-13.
20. Schraw G, Dunkle ME and Lisa D. Bendixen. Cognitive processes in well-defined and ill-defined problem solving. Appl Cogn Psychol 1995; 9(6), 523-38
21. Kitchner K.S. Cognition, Metacognition, and Epistemic Cognition. A Three-Level Model of Cognitive Processing. Hum Dev 1983;26 (4):222-32
22. Simşek U, Yilar B, Kucuk B. The effects of cooperative learning methods on students' academic achievements in social psychology lessons. International Journal on New Trends in Education and Their Implications 2013; 4 (3) :5-9