Perception and Attitude of Second-year Medical and Dental Students regarding the Use of a Problem-based Learning

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ABSTRACT

Backgrounds: Problem-based learning (PBL) is a learner-centered pedagogical approach in which a person learns about a subject by working in groups to solve an open-ended problem. The objective of the present study was to assess students' perceptions and attitudes toward Problem-based learning and the role of tutors in Problem-based learning.

Methods: This quantitative study was conducted among second-year medical and dental undergraduate students from November 2022 to November 2023. The students were divided into eight groups, and each group was facilitated by tutors. A Problem-based learning tutor guide, with a case on the topic of diarrhea/dysentery, was designed as a module with six triggers and given to the groups. At the end of nine days of PBL sessions, feedback from students on the process of Problem-based learning and tutors was received using the 'Dolmans and Schmidt' and 'Dolmans and Ginns' questionnaires, respectively. The level of attitude of the students based on their feedback toward the Problem-based learning process and the tutors were also assessed. The data were entered into Microsoft Excel, and descriptive analysis was performed using the Statistical Package for Social Sciences (SPSS), version 21.

Results: Among the 79 responses received, 72 (92.4%) students gave a good rating of the process of Problem-based learning, indicating a favorable attitude. The participants agreed with the themes based on the influence of discussion, content tested, course objectives, lectures, tutors, and reference literature. Similarly, 63 (81%) students gave a good rating of the tutorials' performance, suggesting a favorable attitude. They agreed that tutors facilitated active, self-directed, contextual, and collaborative learning.

Conclusions: This study revealed the positive perceptions and attitudes of medical and dental undergraduate students regarding the PBL process and the role of tutors in Problem-based learning. The outcomes of this study have provided a foundation for implementing Problem-based learning in Nepal's medical and dental undergraduate curricula.

Keywords: Dental education; diarrhea; dysentery; medical education; problem-based learning.

INTRODUCTION

Problem-based learning (PBL) is a self-directed active learning strategy.[1,2] In PBL, real-life problems are presented first, and students are engaged in self-directed learning, unlike didactic lectures. In didactic lectures, relevant content is delivered, and students

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are expected to apply the knowledge.[3] PBL can be defined as a small-group teaching style that combines information acquisition with the development of general skills and attitudes.[4]

PBL was first introduced in the medical curriculum by McMaster University in Canada in the 1960s and has since been adopted as a method of teaching learning by various medical and dental schools around the world.[5,6] In Nepal, PBL was first introduced by Tribhuwan University (TU) in 1980, followed by the BP Koirala Institute of Health Sciences, Kathmandu University, and the Patan Academy of Health Sciences.[7,8] This method of learning was recently introduced at our institute through an online approach in 2021 for second-year students with a bachelor's degree in dental surgery (BDS), and the students responded positively. They agreed with various processes of PBL as well as the role of the tutor.[9] In medical education, this pedagogy has not yet been introduced for the MBBS stream. Thus, the objective of the study was to conduct onsite PBL and assess the perceptions and attitudes of MBBS and BDS students toward the PBL process and the role of the tutor in PBL.

METHODS

A quantitative descriptive cross-sectional study was carried out among second-year MBBS and BDS students enrolled in the 2021–2022 academic year at the Gandaki Medical College Teaching Hospital and Research Center (GMCTHRC), Pokhara, Nepal. The study duration lasted for one year, from November 2022 to November 2023. All the students who agreed to participate were included. There were 100 second-year MBBS students and 17 BDS students, for a total of 79 of whom completed the questionnaire.

The Institutional Review Committee granted ethical approval with registration number 300/079/080, dated 13 June, 2023. The PBL module was prepared after several meetings with the principal, the basic science coordinator, and the dental coordinator. A module in the gastrointestinal system was designed for the PBL. We chose the topic of diarrhea/dysentery as our problem, where different subjects could be integrated. Students' understanding of pathophysiology, clinical features, and treatment in a preclinical course could be utilized in their clinical practice. The module was prepared by experts from the Anatomy, Physiology, Biochemistry, Microbiology, Pharmacology, and Pathology departments, and necessary modifications were made. The tutor guide was compiled with the inclusion of six triggers. At each trigger, the subject experts developed their own student-tutor interaction questions, learning needs, and learning objectives. A case summary and one mini-problem were also ultimately incorporated. Suggestions were also gathered from PBL specialists both inside and outside of the institute.

The PBL tutorial was organized following the Maastricht "seven jump" process.[4] The steps are as follows: Unfamiliar terms are clarified (1), the problems are identified (2) and discussed with the brainstorming method (3), possible answers are reviewed as tentative solutions, and after that, the group reaches consensus on learning objectives (4), and the tutor ensures that the objectives are appropriate. The students privately gather information related to the learning objectives (5); then, the group shares the results of the private studies of each student (6), and the tutor evaluates the learning results (7).[10]

Before conducting the PBL sessions, the students were informed about the process of PBL by the PBL committee members on the first day. Likewise, a one-day refresher training workshop was held for the tutors who voluntarily agreed to contribute as tutors. On the same day, a mock session was also conducted with a different case than that used in PBL. The students were randomly divided into eight work groups, and a tutor was assigned to each group. A venue for eight tutorial rooms with an adequate number of seats and teaching aids (flip board, white board, flip chart papers, markers, etc.) was arranged. Each day, supervisors were assigned to observe the tutorial sessions. A tutor led each work group, and the team followed the group dynamics. The PBL process took a total of nine days (63 hours) to complete.

Tutorial sessions were arranged for two hours (10.00-12.00) for the next six days, with supervised self-directed learning (SDL) for two hours daily in the afternoon (14.00-16.00), and the participants were instructed to continue their SDL at the hostel or at residency thereafter. SDL sessions were also conducted to motivate and guide students toward deep learning.[11] We supplied study resources from books, journal articles, and videos as reference learning aids during the sessions. Students were presented with a topic assigned to them by lottery on the last two days of the module. The seminar was held on the last two days, during which each student was evaluated by individual subject experts regarding their communication skills, presentation style, knowledge, problem-solving skills and analytical thinking skills.

After completion of the PBL process, the students were approached to consent to provide their feedback on the module. The feedback from the students was obtained via a validated, structured questionnaire containing 20 closed-ended statements and two open-ended questions.[12,13] The questionnaires used were in open access domain. The feedback questionnaire consisted of two parts: Part I: Students' perceptions and attitudes toward PBL (20 statements); and Part II: Students' perceptions about the role of tutors in PBL (12 statements). Dolmans and Schmidt's questionnaire were utilized to collect student comments on the PBL session (Part I), and Dolmans and Ginns' questionnaire were used to collect student feedback on tutors (Part II).[14,15] Written feedback through the viber application was acquired with the tutors after the completion of the whole process to express their thoughts about the strengths of this approach and any future suggestions.

The level of attitude of the students based on their feedback toward the PBL process was calculated using Bloom's cut-off point.[16] A cut-off score of 15 was determined using the formula = (minimum score + maximum score)/2. We had a total of 20 questions. For each question, the minimum possible score was 1, and the maximum possible score was 5. Hence, the minimum score obtained by any respondent was 20, and the maximum score was 100; thus, the cut-off score was (20+100)/2=60. A score was interpreted as good if it was between 60 and 100% and poor if it was less than 60%. Similarly, the tutors' performance was rated based on feedback from the students. A cut-off score of 39 was used; those with scores greater than or equal to 39 were considered to indicate positive feedback on the tutor's performance.

The data were entered into Microsoft Excel. Percentages and means were calculated in relevant places using the Statistical Package for Social Sciences 21.0 version. Descriptive analysis was performed; the frequency, mean, and standard deviation were computed.

RESULTS

There were 100 second-year MBBS students and 17 second-year BDS students, 79 of whom completed the questionnaire. Thus, among 117 students, 79 participated, for a response rate of 67.5%.

The majority of the students agreed or strongly agreed on seven categories based on their responses regarding the PBL process, as shown in Tables 1 and 2. The average score of student feedback to PBL was 72.32 ±10.37, as presented in Table 3. The results showed that 73 (92.4%) students gave good ratings to feedback on PBL.

The tutors were evaluated by students through a questionnaire under five themes, which showed that there was overall agreement on each theme, as shown in Table 4. The average score for attitude toward feedback on tutorial performance was 43.83 ±7.24, as displayed in Table 5. The results showed that 64 (81%) students had given good ratings of feedback on tutorial performance.

The students' feedback on the open-ended questions was also recorded in Table 6. Likewise, written feedback from the tutors revealed that they felt that PBL was very interactive throughout the sessions, and they were given the opportunity to learn about the PBL process.

Table 1. Frequency distribution of student feedback on the PBL process, Part I.

Theme 1	Influence of the discussion in the tutored group	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly agree n (%)	Mean± SD
	1.The discussion in the tutorial group determines to a large extent what I will study	0(0)	3(3.8)	16(20.3)	40(50.6)	20(25.3)	3.97±0.78
	2. The tutorial group discussion is an important stimulus for my learning activities during self-study	1(1.3)	5(6.3)	10(12.7)	45(57)	18(22 .8)	3.94±0.85
	3. The learning issues generated are the most important starting point for my learning activities during self-study	5(6.3)	17(21.5)	39(49.4)	18(22.8)	0(0)	3.89±0.83
	4. I study to a large extent independently from the learning issues generated	0(0)	10(12.7)	30(38)	23(29.1)	16(20.3)	3.57±0.96

Table 1. Frequency distribution of student feedback on the PBL process, Part I.							
Theme 2	Influence of content tested						
	5. I take a look at the questions included in the tests to get an idea of how deeply I should study particular subject-matter.	0(0)	10(12.7)	7(8.9)	44(55.7)	18(22.8)	3.89±0.91
	6. The questions that are included in the tests to a large extent determine what I will study.	0(0)	8(10.1)	21(26.6)	41(51.9)	9(11.4)	3.65±0.82
	7. The closer the date the test will be administered to us, the more time I spend on test	5(6.3)	10(12.7)	24(30.4)	29(36.7)	11(13.9)	3.39±1.08
	8. The closer the date the test will be administered to us, the less time I spend on studying the learning issues generated in the tutorial group.	1(1.3)	15(19)	26(32.9)	28(35.4)	9(11.4)	3.37±0.96
	9. I do not spend any time on studying particular issues, if I am convinced that these issues will not be tested.	3(3.8)	22(27.8)	24(30.4)	21(26.6)	9(11.4)	3.14±1.07
	10. The learning issues generated in the tutorial group are tuned to the subject matter expected to be tested.	0(0)	9(11.4)	28(35.4)	30(38)	12(15.2)	3.57±0.89

Table 2. Frequency distribution of student feedback on the PBL process, Part II.							
Theme 3	Influence of the course objectives	Strongly Disagreen (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly agree n (%)	Mean± SD
	11. At the start of a course, I consult the course objectives stated in the course book.	0(0)	8(10.1)	18(22.8)	41(51.9)	12(15.2)	3.72±0.85
	12. At the end of the course, I consult the course objectives to check whether I covered all the subject matter I was expected to cover.	1(1.3)	7(8.9)	24(30.4)	37(46.8)	10(12.7)	3.61±0.87
	13. During the course, the course objectives influence what kind of learning activities I will conduct.	3(3.8)	5(6.3)	20(25.3)	37(46.8)	14(17.7)	3.68±0.97
Theme 4	Influence of lectures						
	14. Topics covered during lectures influence which topics I select for self-study	4(5.1)	11(13.9)	15(19)	36(45.6)	13(16.5)	3.54±1.08
	15. Lectures are an important source of information to decide which topics I will study more extensively	4(5.1)	6(7.6)	15(19)	28(35.4)	26(32.9)	3.84±1.13
Theme 5	Influence of the tutor						
	16. In general, tutors stimulate my learning activities	1(1.3)	6(7.6)	14(17.7)	46(58.2)	12(15.2)	3.78±0.84
	17. In general, tutors stimulate students to make use of different sources of information.	0(0)	5(6.3)	23(29.1)	37(46.8)	14(17.7)	3.76±0.82
	18. In general, tutors have an important influence on the selection of learning issues.	1(1.3)	10(12.7)	20(25.3)	32(40.5)	16(20.3)	3.66±0.99

Table 2. Frequency distribution of student feedback on the PBL process, Part II.							
Theme 6	Influence of reference literature						
	19. I usually confine myself to the reference literature cited in the course book when searching for relevant literature.	1(1.3)	11(13.9)	34(43)	28(35.4)	5(6.3)	3.32±0.84
	20. I hardly review literature beyond the sources that are included in the course book.	5(6.3)	18(22.8)	32(40.5)		7(8.9)	3.04±1.03

Table 3. Frequency distribution of attitudes toward PBL feedback.	
Feedback	n (%)
Poor	6 (7.6)
Good	73 (92.4)
Total	79 (100)

Table 4. Frequency distribution of student feedback on the role of tutors in PBL.						
A. Constructive/active learning The tutor stimulated us	Strongly disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly agree n (%)	Mean ± SD
1.To summarize what we had learnt in our own words	0(0)	5(6.3)	13(16.5)	38(48.1)	23(29.1)	4±0.85
2.To search for links between issues discussed in the tutorial group	1(1.3)	5(6.3)	15(19)	34(43)	24(30.4)	3.95±0.93
3.To understand underlying mechanisms/theories	0(0)	4(5.1)	33(41.8)	24(30.4)	18(22.8)	3.71±0.88
B. Self-directed learning The tutor stimulated us						
4.To generate clear learning issues by ourselves	1(1.3)	6(7.6)	10(12.7)	43(54.4)	19(24.1)	3.92±0.89
5. To search for various resources by ourselves	3(3.8)	6(7.6)	16(20.3)	32(40.5)	22(27.8)	3.81±1.05
C. Contextual learning The tutor stimulated us						
6.To apply knowledge to the discussed problem	0(0)	7(8.9)	17(21.5)	38(48.1)	17(21.5)	3.82±0.87
7. To apply knowledge to other situations/problems	1(1.3)	5(6.3)	25(31.6)	35(44.3)	13(16.5)	3.68±0.87
D. Collaborative learning The tutor stimulated us						
8.To give constructive feedback about our group work	1(1.3)	6(7.6)	23(29.1)	33(41.8)	16(20.3)	3.72±0.92
9. To evaluate group co-operation regularly	3(3.8)	4(5.1)	22(27.8)	33(41.8)	17(21.5)	3.72±0.99
E. Intrapersonal behavior as tutor						

Table 4. Frequency distribution of student feedback on the role of tutors in PBL.						
10. The tutor had a clear picture about his strengths/weaknesses as a tutor	0(0)	9(11.4)	30(38)	26(32.9)	14(17.7)	3.57±0.92
11. The tutor was clearly motivated to fulfil its role as a tutor	2(2.5)	10(12.7)	14(17.7)	25(31.6)	28(35.4)	3.85±1.12
Global score	7.07±2.09					
12. Give a grade (1-10) for the overall performance of the tutor (6 being sufficient, 10 being excellent)						

Table 5. Frequency distribution of attitudes toward feedback on the role of tutors in PBL.	
Feedback rating	n (%)
Poor	15 (19)
Good	64 (81)
Total	79 (100)

Table 6. Frequency distribution of students' responses to open-ended questions about the PBL sessions.	
How does PBL compare to other forms of learning you have experienced?	n (%)
1. Comprise active learning , active participation and interaction	15 (18)
2. Promotes self-directed learning, deep learning	17 (21)
3. It is unique which comprise group discussion and team work.	5 (6)
4. It was effective than lecture as it covered all six subjects.	7 (8)
5. Time consuming	3 (3)
In what ways, if any, has PBL changed your view of learning?	n (%)
1. Encouraged self-study, group study, deep learning, active learning, communication	31 (39)
2. Learned different subjects simultaneously	7 (8)
3. Improve critical thinking skill	9 (11)
4. Find other sources besides books	4 (5)
5. Difficult to read all subjects in less time	4 (5)

DISCUSSION

PBL is an effective way of delivering medical education that is based on principles of adult learning theory; it includes motivating students, encouraging them to set their own learning goals, and giving them a role in making decisions that affect their own learning.[4] Another important contribution of the PBL was the horizontal and vertical integration of subjects. In the present study, we tested this innovative learning methodology in an institute where it is not mandatory to conduct PBL or assess students' perceptions of this approach.

The present study revealed students' positive perceptions of and attitudes towards PBL. They also discovered that this type of teaching-learning method can help them improve their critical thinking, group dynamics, and communication skills. Our findings corresponded with those of previous studies.[5,9,13,17-23] The authors of another similar study thoroughly agree with the statement "learning is active," and this statement exemplifies healthy thinking. The process of thinking, not the subject matter, determines both the quality and quantity of learning.[1] Similarly, they believed that the "process of learning is learning." This approach is applicable in PBL, where it places the responsibility of learning solely on the student's shoulders by presenting a challenging scenario or environment in which students must actively generate knowledge by assessing and examining the evidence in front of them.

One of the unfavorable responses from the students was about time commitment, which was consistent with the findings of Emerald et al.'s study.[24] The longer duration could be attributed to the increased number of triggers, which necessitated additional tutorial sessions. This will be kept in mind in the future when performing PBL with adequate preparation and administration. In contrast to the perceptions of the students in our study, the students from the previous study felt that all the participants did not equally participate in the discussion.

The current study revealed positive perceptions of the students regarding the role of tutors in PBL, which is similar to the findings of other studies.[5,9] The students appreciated the tutors' contributions and reported that tutors were extremely beneficial in achieving various PBL approaches. The majority of learners in our study were enthusiastic about the constructivism concept. Constructivism serves as the theoretical framework within which PBL works. Constructivism, according to Savery and Duffy, comprises three fundamental notions.[1] First, knowledge itself is "an individual construction." Second, the learner's aim or the cognitive question is the stimulus upon which understanding is built. Third, new learning occurs as a result of engaging with other people and being exposed to their different points of view.

In PBL, learning is initiated by the student. In our study, self-directed learning (SDL) sessions, which are the most prevalent feature of PBL at the student level, were employed. Additionally, direct supervision by instructors/supervisors/teachers should be considered, as PBL can be challenging for tutors, particularly those who are educated using traditional methods. The learning environment should be designed in such a way that previous knowledge and motivation are optimally activated, but the learner must nevertheless bring these qualities to the forefront.[25]

During the conversations with tutors, like students, they also felt that PBL was very interactive throughout the sessions, and they saw the students' confidence level during the seminar presentations. They exclaimed that they were given the opportunity to learn about the PBL process and develop facilitation abilities. Other studies have reported similar findings.[13,26] Tutors recognized that this unique teaching learning strategy benefited students by encouraging them to participate actively, breaking up the monotony of lecture classes. Students were encouraged to participate; they were involved in the process. All of these studies were able to correlate basic data with clinical science data, and all of these studies promoted deep learning. Furthermore, the tutors urged adequate planning and training in the future to improve any issues. It would also be interesting to look further into uplifting quality PBL cases, as this is one of the key elements in successful PBL implementation.

The study's shortcomings include a smaller sample size due to the small sample size. As a result, the findings cannot be applied to the entire population. This study provides a foundation for implementing PBL in Nepal's MBBS and BDS curricula. The outcomes of this study have provided evidence to the management of our institute about the benefits of implementing this teaching approach. Another limitation was that the actual knowledge and skills gained over time were not examined, as student performance is considered an influential factor essential for learning outcomes.

CONCLUSIONS

The students provided positive feedback on learning through PBL. Thus, this study investigated the positive perceptions of MBBS and BDS students toward PBL and the role of tutors in PBL. The outcomes of this study have provided a foundation for implementing PBL in Nepal's medical and dental undergraduate curricula.

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COMPETING INTEREST

The authors declare that they have no competing interests.

REFERENCES

1. McCarlie VW, Orr DL 2nd. Health science education: Reviewing a framework for problem-based learning. J Dent Educ. 2010;74(5):480-8. [PubMed]

2. Bate E, Hommes J, Duvivier R, Taylor DC. Problem-based learning (PBL): Getting the most out of your students - Their roles and responsibilities: AMEE Guide No 84. Med Teach. 2014;36(1):1-12.

[PubMed]

3. Bodagh N, Bloomfield J, Birch P, Ricketts W. Problem-based learning: a review. Br J Hosp Med (Lond). 2017;78(11):C167-70. [PubMed]

4. Wood DF. Problem based learning. BMJ. 2003 Feb 8;326(7384):328-30. [PubMed]

5. Yadav RL, Piryani RM, Deo GP, Sah DK, Yadav LK, Islam MN. Attitude and perception of undergraduate medical students towards problem-based learning in Chitwan Medical College. Adv Med EdU Pract. 2018:9:317-22. [PubMed]

6. Sathya Pl, Reddemma K. Development of problem-based learning training module in nursing education. Int J Res Med Sci. 2017;5(5):1986-90. [Article]

7. Pradhan B, Ranjit E, Ghimire MR, Dixit H. History of problem-based learning in Nepal and experiences at Kathmandu Medical College. J Kathmandu Med Coll. 2012;1(1):37-44. [Article]

8. Dixit H, Vaidya S, Pradhan B. PBL implementation of Kathmandu University Curriculum - Is It Quo Vadis? JNMA J Nepal Med Assoc. 2013 Oct-Dec;52(192):652-8. [PubMed]

9. Paudel S, Subedi N, Sapkota S, Shrestha B, Shrestha S. Perception of problem based learning by undergraduate dental students in basic medical science.[PubMed]

10. Walldén S and Erkki M. Educational Data Mining and Problem-Based Learning. Informatics Educ. 2014;13(1): 141-56. [Article]

11. Spencer JA, Jordan RK. Learner centred approaches in medical education. BMJ. 1999;318(7193):1280-3. [PubMed]

12. Piryani PM, Piryani S, Gautam N. PBL session conducted for second year undergraduate students of medicine and dentistry at Universal College of Medical Sciences Nepal: Perception of the participants. Janaki Medical College Journal of Medical Science. 2021;9(1):55-60. [Article]

13. Rimal J, Paudel BH, Shrestha A. Introduction of problem based learning in undergraduate dentistry program in Nepal. Int J App Basic Med Res. 2015;5(Suppl 1):S45-9. [PubMed]

14. Dolmans DH, Schmidt HG. What drives the student in problem-based learning? Med Educ. 1994;28(5):372-80. [PubMed]

15. Dolmans DH, Ginns P. A short questionnaire to evaluate the effectiveness of tutors in PBL: Validity and reliability. Med Teach. 2005;27(6):534-8. [PubMed]

16. Bloom BS. Learning for Mastery. Instruction and Curriculum. Regional Education Laboratory for the Carolinas and Virginia, Topical Papers and Reprints, Number 1. Eval Comment. 1968;1(2):1-11. [Article]

17. Zhao W, He L, Deng W, Zhu J, Su A, Zhang Y. The effectiveness of the combined problem-based learning and case-based learning teaching method in the clinical practical teaching of thyroid disease. BMC medical education. 2020;20(1):381. [PubMed]

18. Ibrahim ME, Al-Shahrani AM, Abdalla ME, Abubaker IM, Mohamed ME. The Effectiveness of Problem-based Learning in Acquisition of Knowledge, Soft Skills During Basic and Preclinical Sciences: Medical Students' Points of View. Acta Inform Med. 2018;26(2):119-24. [PubMed]

19. Joseph N, Sharada Rai SR, Animesh Jain AJ, Nelliyanil M, Kotian SM. Perception towards problem based learning among medical students of a private medical college in South India.[Article]

20. Alrahlah A. How effective the problem-based learning in dental education. A critical review. Saudi dent J. 2016;28(4):155-61. [PubMed]

21. Jacob PS. Problem based learning in dental education. J Educ Ethics Dent. 2011;1(1):7-11. [Article]

22. Al-Shaikh G, Al Mussaed EM, Altamimi TN, Elmorshedy H, Syed S, Habib F. Perception of Medical Students Regarding Problem Based Learning. Kuwait Med J. 2015;47(2):133- 8. [Article]

23. Abu-Hijleh MF, Kassab S, Al-Shboul Q, Ganguly PK. Evaluation of the teaching strategy of cardiovascular system in a problem-based curriculum: student perception. Adv Physiol Educ. 2004;28(1-4):59-63. [PubMed]

24. Emerald NM, Aung PP, Han TZ, Yee KT, Myint MH, Soe TT OS. Students' perception of problem-based learning conducted in phase1 medical program. South East Asian Journal of Medical Education. 2013;7(2):45-8. [Article]

25. Binshabaib M, Shalabi M, Mansour S, Alageel L, Alsuwidan N, ALHarthi SS. Role of problem-based learning in undergraduate dental education: a questionnaire-based study. Adv Med Educ Pract. 2019;10:79-84. [PubMed]

26. Ng ML, Bridges SM, Law SP, Whitehill T. Designing, implementing and evaluating an online problem-based learning (PBL) environment – A pilot study. Clin Linguist Phon. 2014;28(1-2):117-30. [PubMed]