



Implementing Problem Based Learning in a Virtual Format for First Year Medical Students

Ashwin Kulkarni^{1*}, Vanitha Gowda MN², Chandrika Rao³ and Medha Y Rao⁴

¹Department of General Medicine, Ramaiah Medical College, Bangalore, India

²Department of Biochemistry, Ramaiah Medical College, Bangalore, India

³Department of Paediatrics and Coordinator of MEU, Ramaiah Medical College, Bangalore, India

⁴Academics, Ramaiah University of Applied Sciences, Bangalore, India

*Corresponding e-mail: kulkarniashwin86@gmail.com

Received: 1-May-23, Manuscript o. i mrhs-23- 423 **Editor assigned:** -May-23, Pre- C o. i mrhs -23- 423 P **Reviewed:** 1 -May-23, C o. i mrhs -23- 423 **Revised:** 22-May-23, Manuscript o. i mrhs -23- 423 R **Published:** 31-May-23, -invoice: - 423

ABSTRACT

Background: The COVID-19 pandemic and subsequent lockdowns which happened worldwide made it imperative for everyone to explore newer methods of teaching and learning. Problem Based Learning (PBL) which is a student-centric method of teaching learning can be conducted using virtual platforms like Microsoft team and WhatsApp. This study was done to understand the perception, acceptance, and challenges in the implementation of PBL in a virtual format (Online PBL). **Methodology:** This is an institution based cross sectional study conducted over one year (1st December 2020 to 1st December 2021). All 150 first-year Medical students were included in the study. Four sessions of Online PBL were conducted using Microsoft team and WhatsApp. The assessment was done using Multiple Choice Questions (MCQs) and concept maps after each session. The student's feedback was collected using a validated questionnaire and analyzed. Convenience sampling was used. The results were tabulated and SPSS was used for statistical analysis. **Results:** A total of 130 students attended the sessions. Amongst these, were 75 (62.5%) male and 45 (37.5%) female students. There was a significant improvement in the post-test score in all the sessions. 97 (80.8%) students agreed that the Problem based learning strategy is interesting. 102 (85%) of the students opined that PBL improved their reasoning skills. Students felt that virtual mode is feasible, interesting, and convenient. **Conclusion:** Students found PBL using virtual platforms to be interesting. Overall feedback and perception of the students were good. Online PBL encouraged the students towards self-directed learning and critical thinking without time constraints and geographical barriers.

Keywords: Problem Based Learning (PBL), Online education, Virtual education

INTRODUCTION

The COVID-19 pandemic and subsequent lockdowns which happened worldwide have forced everyone to explore newer methods of teaching and learning. In such a critical time, where there are geographical barriers to medical education; technology can be used in an innovative way to continue learning [1]. This crisis has allowed us to divulge into unexplored areas of technology-based medical education. When COVID-19 resolves, transformative changes are expected in medical education through the use of emergent technology [2].

Problem Based Learning (PBL) is an established method of teaching learning in medical education. PBL involves presenting a problem or a trigger to a small group of students who involve in a discussion over several sessions. The PBL sessions emphasize finding solutions to the problem and attributes to becoming a better clinician. This includes gaining the right knowledge, and improvement of communication skills and clinical reasoning [3]. With the advent of the internet in 1994, digital literacy spread its wings in academics paving the way for formal, accredited online courses and modules. Easy availability of mobiles, internet services, web, and social media provided opportunities to learners for personalized learning experiences [4].

The pandemic has caused widespread disruption in the field of medical education and skill development [5,6]. This is due to quarantine and the impact of illness on medical educators and students, deployment of teachers to clinical care settings. Local and international travel and attendance at training programs have been halted. Online learning has the advantage of transcending time and geographical boundaries. Students can use it according to their own pace of learning and it provides a good opportunity for self-directed learning [4]. Online teaching and learning have many advantages over the traditional didactic ways of teaching like delivery of the updated evidence-based content to the students [7].

The current CBME (Competency Based Medical Education) has emphasized a paradigm shift from teacher-centric learning to student-centric learning, focusing on interactive small group teaching and self-directed learning. The NEP-2020 (National Education Programme) has a vision of creating an environment for holistic and comprehensive learning. PBL can bring out critical thinking, and comprehensive learning and can promote self-directed learning. PBL can be conducted on virtual platforms. WhatsApp is a common app used by students. It is easy, quick, supports media, and is familiar to students. Hence this study was undertaken as an experiment to understand the feasibility and perceptions of students for PBL conducted using online platforms.

METHODOLOGY

This study was conducted at Ramaiah Medical College, Bangalore from 1st December 2020 to 1st December 2021. The process of conducting Online PBL was planned under the guidance of the Management, Curriculum Committee, and medical education unit of the institution. All the students of first-year MBBS were included in the study. Students who remained absent for two PBL sessions were excluded. The study was conducted after the clearance from the institutional ethical committee [MSRMC/EC/AP-01/02-2019].

Planning the Trigger/Case Scenario

The topics which were clinically relevant and required both horizontal and vertical integration were chosen. The case scenarios were framed in such a way as to stimulate reasoning skills and clinical applications. The case scenarios were approved by the subject experts and senior members of the Medical Education unit.

Conduct of Online PBL

All of the 150 students were divided into 7 groups, each having a minimum of 21 students. WhatsApp groups were formed and all of these students were added to the group. A faculty member was also added to the group for the process of facilitation. The facilitators were the faculty who were trained in conducting PBL sessions. Each group had a student leader and his/her role was to monitor the process of interaction. A scribe was appointed among the students of the group, who would collate all the responses and discussions which happened in the group. On the first day of the session, a faculty member presented the case scenario to all 150 students on the Microsoft team online platform. The students were encouraged to clarify their doubts. The case scenario, the learning resources, and the E-books were posted in each WhatsApp group. The students were encouraged to actively interact in the group. They framed the learning objectives of the case scenario. Students generated the questions independently. A few sample questions were sent to them by the facilitators. The objectives were sent to a Google Document by the students. Students then discussed through their WhatsApp groups to analyze the questions to see if they are research questions. Each member had a role. The first member checked to see if the question was fact-based. The second checked if it was within the topics' purview. The third checked to see if it was specific. The fourth person monitored the quality of work and ensured a balance of the group dynamics. They were given 3 days for self-learning and a literature review. In the meanwhile, they were encouraged to interact in the group regarding their doubts, and opinions. The facilitators tried to solve their doubts whenever there was a need. After 3 days, the students were asked to post a draft of their specific learning objectives and material in the form of a Word draft, a power-point presentation, and voice notes. The group was asked to compile all the teaching-learning materials posted in the group in one draft and prepare a concept map. All the students were asked to read the final compiled draft and concept map. On the final day of PBL, a facilitator interacted with all the students using the Microsoft team platform, and each student presented and shared their work. Informed consent was taken from all the students. The topics and the case scenarios have been listed in Table 1.

Table 1 Topics and the triggers

S. No	Topic	Trigger (Case Scenario)
1	Hypertension	Mr. Vikram, a 40-year gentleman who is a software engineer was found to be having blood pressure was found to be of 160/100 mmHg during his annual health check-up. His blood pressure continued to be more than 160/100 mmHg on repeated recordings. His mother was hypertensive and passed away due to a stroke at the age of 50 years due to a heart attack. On examination, his height was 155 cm and his weight was 90 kg. He was put on antihypertensive and was asked to be on follow-up. After 2 years, the patient presented to the hospital with a history of breathlessness on exertion. He was not on regular treatment for hypertension which was advised to him. On examination, his, BP was 200/100 mmHg, bilateral pitting pedal edema. Investigation showed Urine routine-Albumin ⁺⁺⁺ , Serum creatinine was 4.6 mg/dL, Serum potassium was 5.6 mg/dL
2	Chronic liver disease	Mr. Raju 45 years old gentleman presented to OPD with a history of yellowish discoloration of eyes and urine for 8 months, swelling of abdomen for 2 months, and swelling of lower limbs for 3 months. His wife mentioned that he was not sleeping at night but was sleepy all day for 3 days. He complained that he vomited blood in the morning. He is a chronic alcoholic for 25 years. On examination, he had icterus, bilateral pitting pedal edema, and ascites. Total Bilirubin-3.5

		mg/dL, Direct Bilirubin-2.5 mg/dL, Aspartate transaminase-320 IU/ml, Alanine transaminase-124 IU/ml, Alkaline phosphatase-130, Gamma Glutamyl-transpeptidase-140, Serum Albumin levels-2.1 gm/dL.
3	Chronic kidney disease	Mr. Suresh, a 60 years gentleman presented to the hospital with h/o swelling of lower limbs for 8 months, and facial puffiness for 4 months. He also complained of fatigue and generalized pruritis. He was a known diabetic and hypertensive for 20 years. He was initially compliant with his medications, but for the past 6 years, he was irregular with his anti-diabetics and his diet. There was no history of chest pain or palpitations. His pulse rate was 80 per min, Blood pressure was 180/90 mmHg in the supine position. Serum Urea-50 mg/dL, Serum Creatinine-2.5 mg/dL, Serum Sodium-128 mmol/dL, Serum Potassium-5.9 mmol/dL, Serum Calcium-6.9 mg/dL, Serum Phosphorous-5.8 mmol/dL
4	Diabetes mellitus	Mrs. Asha, a 55 years old lady has come to the hospital with a history of a non-healing wound on her left foot for 1 month. She mentioned that she was not aware of how she got hurt. There was no history of pain in the wound. She also complained that she was not able to feel any sensations on her feet for the past 3 months. She had a loss of weight and felt the dryness of her mouth. On examination, he had mild bilateral pitting pedal edema.
		Hemoglobin-12 gm/dL, Fasting blood sugar-210 mg/dL
		Post prandial blood sugar-320 mg/dL, Glycated Hemoglobin (HbA1C)-11.4, Creatinine-0.8 mg/dL, Urine routine-Albumin ⁺⁺

Evaluation

Evaluation of the students was conducted by multiple choice question-based assessment. The questions were framed by the faculty who were not part of the study to avoid bias. A pre-test and post-test were conducted using these questions for each session. The mean scores of the students have been summarised in Table 2.

The perception of the students regarding PBL sessions was assessed using a validated questionnaire published by Usmani *et al* [8]. There were 17 questions in the questionnaire. The feedback was using a five-point Likert's scale. There was an open-ended question to share their experience of the Virtual PBL session. The questionnaire was sent to all the students in a Google form after the end of each session. The feedback given by the students was analyzed by senior members of the Medical education unit. The questionnaire and the scores have been summarised in Table 3. Thematic analysis was conducted on the open-ended question. The data was familiarized. Inductive coding was done and themes were identified.

Statistical Analysis

Collected data were entered into MS Excel, and analysis was done using SPSS software. Descriptive statistics of the student feedback were analyzed in terms of mean and standard deviation. The percentages of the individual responses in the Likert's scale were calculated. The analysis was carried out using SPSS Inc. released in 2009. PASW Statistics for Windows version 18.0, Chicago. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 130 students attended the sessions. Among them, 120 students responded to the questionnaire. The response rate was 92.3%. One hundred twenty (n=120) students gave the feedback. The response rate was 85.71%. There were 75 (62.5%) male and 45 (37.5%) female students.

The mean scores of the students have been summarised in Table 2. There was a significant improvement in the post-test score in all the sessions. 97 (80.8%) of the students agreed that the Problem based learning strategy is interesting. 102 (85%) of the students opined that PBL improves their problem-solving skills. 89 (74.1%) of the students felt that PBL helps to develop competence in self-directed learning.

Table 2 Pre-test and post test scores of each session

Topic	Pre-test score (Mean)	Post test score (Mean)	p-value
	Out of 10		(Paired T-test)
Hypertension	4.9	7.5	0.002
Chronic liver disease	5.2	8.6	0.08
Chronic kidney disease	4.7	7.9	0.042
Diabetes mellitus	4.1	8.6	0.001

Table 3 Feedback of students regarding PBL on leikert's 5 point questionnaire

S. No	Parameter	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	The Problem based learning strategy is interesting	8 (6.7%)	5 (4.1%)	10 (8.3%)	45 (37.5%)	52 (43.3%)
2	The Knowledge gained is more thorough than it would be by conventional teaching (Lectures)	20 (16.6%)	18 (15%)	12 (10%)	30 (25%)	40 (33.4%)
3	The course is focussed on real medical problems making it more relevant to the interest	5 (4.1%)	4 (3.3%)	5 (8.3%)	55 (41.6%)	51 (42.5%)
4	PBL takes more time than lectures	15 (12.5%)	14 (11.6%)	35 (29.1%)	20 (16.6%)	36 (30%)
5	Knowledge is organized around problems rather than disciplines	9 (7.5%)	9 (7.5%)	2 (1.6%)	40 (33.4%)	60 (50%)
6	Learner assumes responsibility for their learning	15 (12.5%)	10 (8.3%)	10 (8.4%)	43 (35.8%)	42 (35%)
7	The curriculum should be completely PBL based	45 (37.5%)	40 (33.3%)	15 (12.5%)	10 (8.4%)	10 (8.3%)
8	Enhances the ability to find the information using library/internet	10 (8.3%)	10 (8.3%)	10 (8.3%)	50 (41.7%)	40 (33.4%)
9	Helps in identifying areas of weakness for improvement	18 (15%)	15 (12.5%)	10 (8.3%)	40 (33.4%)	37 (30.8%)
10	Pushes the learner to the limits of knowledge	10 (8.3%)	20 (16.6%)	15 (12.5%)	35 (29.2%)	40 (33.4%)
11	Enables the learner to establish a concrete action plan to achieve their goals	8 (6.6%)	5 (4.1%)	9 (7.5%)	46 (38.3%)	52 (43.3%)
12	Enhances the ability to speak in front of people and increases the ability to manage time effectively	5 (4.1%)	10 (8.4%)	5 (4.1%)	65 (54.2%)	35 (29.2%)
13	Helps to convert from passive learner to active lifelong learner	6 (5%)	7 (5.8%)	5 (4.1%)	39 (32.5%)	63 (52.5%)
14	The role of facilitators in the process is useful	4 (3.3%)	3 (2.5%)	5 (4.1%)	42 (35%)	66 (55%)
15	Improves the decision-making skills	5 (4.1%)	10 (8.3%)	6 (5%)	25 (20.8%)	74 (61.7%)
16	Improves problem-solving skills	8 (6.6%)	5 (4.1%)	5 (4.1%)	55 (45.8%)	47 (39.1%)
17	Develops competence in self-directed learning	10 (8.3%)	11 (9.2%)	10 (8.3%)	54 (45%)	35 (29.1%)

Thematic analysis of the responses to the open-ended questions in student feedback has been depicted in Table 4.

Table 4 Thematic analysis of the open-ended question in the student feedback

Describe your experience of Virtual-Problem Based Learning sessions		
Inductive Codes	Themes identified	Reference quotes

Think more.	Promotes thinking and clinical reasoning	The discussion made me think about why was the patient having the symptoms.
Analyze why the patients had the symptoms		
Improves clinical reasoning.		
Why the tests were advised?		The session made me think about why the investigations were ordered.
Improves critical thinking.		I understood the importance of anatomy, physiology, and biochemistry in understanding the disease process.
Understood physiology underlying the clinical features	Helps with the application of knowledge	I could recollect the knowledge of anatomy and physiology and analyze the patient's current problem
Recall and revise basic science knowledge		
Applied the knowledge learned		
Understood the importance of anatomy, physiology, and biochemistry	Interesting and innovative	It was a fun session, very innovative, and learned a lot
Enjoyed the session		
Interesting		
Innovative method		
Good utilization of time		
Fun session	Encourage self-learning	The session made me go back and read in detail
Encourages self-learning		
Motivated to study in detail		
Very helpful for exam preparation	Self-paced learning without any geographical barriers.	I could participate in the sessions without any time constraints and being at home
Online platform was easy to work on.		
No time constraints.		
Participate from any place.		
Participate at your own pace		

DISCUSSION

The above study demonstrates that PBL sessions can be conducted using virtual platforms like Microsoft team and WhatsApp without compromising the essence and principles of PBL. Students were satisfied and enjoyed the online PBL sessions. The virtual methods of teaching learning were indeed helpful to continue medical education even during the COVID related lockdowns. However, they can be further used in the routine curriculum also. A vital attribute of online learning is that learning can happen at the learner's pace and time. Medical education at present times is very different from what it was years ago when the internet was not such a powerful tool [4,7]. But with changing trends, online learning in medical training has come a long way from correspondence courses to computerized virtual patient simulation.

Teaching in an online environment should not mean simply posting resources or information. Teacher-student interaction is a critical factor for motivating students toward peak performance. Supportive and non-threatening online classrooms and open synchronous as well as asynchronous communication channels encourage students to complete their work resulting in higher levels of achievement. An online PBL session can help to promote teacher-student interaction and break the monotony of the didactic lectures [4].

The students were comfortable using the online tools. Online platforms help students to read and understand the concepts at their own pace. These sessions also helped to develop self-directed learning. Also online platforms

Kulkarni A. *et al.*

helped many students to express themselves more freely. As per the study conducted by Rojana Phungsuk *et al.*, the virtual environment stimulates students' interest in learning and results in higher satisfaction. The gap in the communication channel between students and teachers is reduced due to easier and more informal communication [9]. Trupti Jivram *et al.* reported that students favoured the simpler interaction of the web-based platforms, which provided them with the essential learning needed for practice [10]. As per the study done by Peter Rollero *et al.*, Students used creative thinking and analyzed working on a virtual platform. Students learned from the activity, enjoyed it, and appreciated the work [11].

Problem based learning methods can help to save time as the students and the facilitators can participate without any time constraints and at their own pace. This method can be useful even if the students and facilitators are not on campus. There is no requirement for infrastructure.

The use of technology in medical education should be to support learning; it should not be a replacement for face-to-face learning. Educators must still focus on the principles of teaching, not on specific technologies [12]. Using learning technology in the workplace changes the interaction with others and raises issues of professionalism and etiquette. Distraction and dependency are charges levelled at smartphone use in the workplace and these need further research [13]. The flexibility of online learning paired with PBL's focus on working collaboratively in groups to analyze real-world scenarios mirrors what students are being asked to do in their professional settings. With little research having been done in this area, exploring the context for utilizing online problem-based learning to learn technology integration is worthwhile [14]. Therefore, under the dual background of the development of new medical science and the impact of sudden disasters, comprehensive utilization of online Case-based learning and PBL teaching method. This will improve students' experience and curriculum quality and guide significance for the realization of offline and online mixed teaching modes in the future [15]. The authors opine that the essence of face-to-face interaction and in-person interaction was challenging on the virtual platforms. The role of facilitators was to encourage more interaction and active discussion during PBL sessions. The strengths of the study are that the sample size was good and the study was conducted over one year. Limitations were that all students may not have similar devices and the same internet connection. All students may not have a quiet workspace at home. Power dynamics were noted to exist online with some students hesitant to express themselves in the group.

CONCLUSION

Students found PBL using virtual platforms to be interesting. Overall feedback and perception of the students were good. Online PBL encouraged the students to do self-directed learning without time constraints and geographical barriers. Online PBL can save time and resources and can be incorporated into the curriculum to break the monotony of traditional teaching.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

REFERENCES

- [1] O'Doherty, Diane, et al. "Barriers and solutions to online learning in medical education—an integrative review." *BMC medical education*, Vol. 18, No. 1, 2018, pp. 1-11.
- [2] Saiyad, Shaista, et al. "Online teaching in medical training: Establishing good online teaching practices from cumulative experience." *International Journal of Applied and Basic Medical Research*, Vol. 10, No. 3, 2020, p. 149.
- [3] Chang, Bliss J. "Problem-based learning in medical school: A student's perspective." *Annals of Medicine and Surgery*, Vol. 12, 2016, pp. 88-89.
- [4] Goh, Poh-Sun, and John Sandars. "A vision of the use of technology in medical education after the COVID-19 pandemic." *MedEdPublish*, Vol. 9, No. 49, 2020, p. 49.
- [5] Ahmed, Hanad, Mohammed Allaf, and Hussein Elghazaly. "COVID-19 and medical education" *Lancet Infectious Diseases*, Vol. 20, No. 5, 2020, p. 79.
- [6] Murphy, Brendan. "COVID-19: How the virus is impacting medical schools." *American Medical Association*, 2020.
- [7] Ruiz, Jorge G., Michael J. Mintzer, and Rosanne M. Leipzig. "The impact of e-learning in medical education." *Academic medicine*, Vol. 81, No. 3, 2006, pp. 207-12.
- [8] Usmani, Ambreen, et al. "Comparison of students and facilitators' perception of implementing problem based learning." *JPMA-Journal of the Pakistan Medical Association*, Vol. 61, No. 4, 2011, p. 332.
- [9] Phungsuk, Rojana, Chantana Viriyavejakul, and Thanin Ratanaolarn. "Development of a problem-based learning model via a virtual learning environment." *Kasetsart Journal of Social Sciences*, Vol. 38, No. 3, 2017, pp. 297-306.
- [10] Jivram, Trupti, et al. "The development of a virtual world problem-based learning tutorial and comparison with interactive text-based tutorials." *Frontiers in Digital Health*, Vol. 3, 2021.
- [11] Rillero, Peter, Ali Kozan Soykal, and Alpay Bicer. "Virtual Exchange with Problem-Based Learning: Practicing Analogy Development with Diverse Partners." *The American Biology Teacher*, Vol. 82, No. 7, 2020, pp. 447-52.
- [12] Guze, Phyllis A. "Using technology to meet the challenges of medical education." *Transactions of the American clinical and climatological association*, Vol. 126, 2015, p. 260.
- [13] Bullock, Alison, and Katie Webb. "Technology in postgraduate medical education: a dynamic influence on learning?." *Postgraduate medical journal*, Vol. 91, No. 1081, 2015, pp. 646-50.
- [14] Nelson, Erik T. "Effects of online problem-based learning on teachers' technology perceptions and planning." *Capella University*, 2008.

Kulkarni A. *et al.*

[15]Liang, Yin-Ji, et al. "An innovative approach of using online problem. based learning and case-based learning in teaching disaster nursing during the COVID-19 pandemic." *Journal of Integrative Nursing*, Vol. 2, No. 4, 2020, p. 196.