Review Article

E-LEARNING TOOLS FOR ONLINE PROBLEM BASED LEARNING IN MEDICAL EDUCATION

Srikumar Chakravarthi[1], Barani Karikalan[2*]

1. Director, Postgraduate Studies, Research and Innovation, MAHSA University, 2. Senior Lecturer, Department of Pathology, Perdana University, Malaysia.

*Corresponding author – **Barani Karikalan**

Email id – baranisri@gmail.com

ABSTRACT

PBL is an instructional student-centred method that uses meticulously built real-world problems within the context of learning objectives. PBL in medical education was first introduced at McMaster University in Canada by Howard Barrows in the 1960s. PBL encourages learners to actively participate not only in the construction of knowledge and but also enhance competencies across multiple principles essential to solve a problem. PBL has become a major contributor to teaching and learning methods in medical education. PBL is an instructional framework that encourages active and collaborative learning based on the principle that effective learning occurs when learners learn and co-learn knowledge by means of interactions and directed self-learning. Traditional PBL is face to face where a facilitator guides students' learning, especially in the problem understanding phase and problem-solving phase of the PBL, as well as facilitating students' inquiry by discussion and sharing learning resources. Synchronous PBL sessions conducted through online communication platforms allow learners to communicate and also to share content and learning resources. Studies show that online learning encourages individualised student-centred learning. While many communication systems allow synchronous conversation, the facility to record and summarise ideas and facts of all students is missing. We shall be discussing two video conferencing apps in this article that has a synchronous whiteboard facility to record ideas and facts.

Keywords: Problem Based Learning, Online PBL, ePBL, Videoconference, Collaborative whiteboard

INTRODUCTION

Problem-based learning (PBL) is one of the best initiatives in the field of education that arose in the 1960s. They were originally based on advancements in behavioural psychology **(1-3)**. Research showed that learners who started the learning process by solving problems before trying to understand underlying mechanisms had better success than other learners learning by traditional methods where underlying mechanisms are presented as lectures and then the application to specific problems is practised. PBL in medical education was first introduced at McMaster University in Canada by Howard Barrows **(4-6)**.

PBL is an instructional student-centred method that uses meticulously built real-world problems within the context of learning objectives. The problem is then presented to the students to recall their previous knowledge and experiences through discussion with fellow colleagues in a self-directed and collaborative manner. This is known to develop problem-solving and reasoning skills of the students.**(7)**. In comparison with the traditional lecture-based one-way teaching and learning methods, PBL encourages learners to actively participate not only in the construction of knowledge and enhance knowledge across many principles essential to solve a problem **(8, 9)**, but also in day to day work skills and self-directed learning **(10)**. PBL is a major contributor to

learning and teaching methods in medical education, but it has its own limitations. It is less efficient than the traditional approach in terms of time duration since it is time-consuming (**11**). Other negative points of PBL are that learning through PBL requires self-motivation, the possibility of some learning objectives being overlooked and uncertainties regarding the extent of learning (**12**).

Traditional PBL

In a traditional PBL session, learning is prompted by real-life problems that need to be solved. Dewey describes the cognitive component of student involvement by explaining how thinking occurs by not knowing, uncertainty, or doubt that is prompted by a specific real-life situation that requires understanding beyond doubt (**13**). Learners relate this unknown content to recalling their own and group previous knowledge about the subject matter (**14**) and fishing out resources regarding unknown knowledge to make sense of the problem. They also participate in collaborative learning by discussing with their colleagues in the group (**15**) and summarize knowledge learned through reflective writing (**16**). It enables students to understand the concepts and subject matter better. This learning method is also more likely to aid students to gain an understanding of the context along with ways and methods in which they gain knowledge efficiently (**17**).

PBL is a pedagogic learning method that is liked by many teachers. It is an instructional framework that encourages collaborative understanding and problem solving based on the principle that efficient learning occurs when learners learn and co-learn knowledge by means of interactions and directed self-learning. PBL helps students learn to apply aspects of basic science to solve problems that arise in clinical scenarios that are important for their clinical practice in future (**18, 19, 20**). Its execution can vary across courses and universities. It is seen as an interactive process composed of a problem understanding phase, a phase of self-directed learning and lastly, a problem-solving phase (**21, 22**). The PBL facilitator guides students' learning, especially in the problem understanding phase and problem-solving phase of the PBL, as well as directs students' inquiry as they understand the problem and come up with ideas through directing and discussing [Figure 1].

The problem is usually presented to the students by the facilitator in the form of triggers in a step by step process. In medical education, for example, it usually involves presenting a patient case scenario and guiding the students to arrive at a diagnosis. The students brainstorm with each trigger and arrive at a hypothesis at the end of each trigger [Table 1]. Once the trigger is presented, students will start to brainstorm. It's the facilitators' job to ensure the participation of all students. The discussion needs to be synchronous to not to miss any of the student perspectives on the problem. This is possible by using a whiteboard and recording all the ideas by the facilitator with the help of a volunteer among the students [Table 2]. Similarly, at each triggers students come up with ideas and regenerate hypotheses and identify knowledge gaps and learning issues. At the end of all the triggers, the students would have solved the problem (diagnosed the case) and achieved all the learning outcomes. This is the traditional PBL methodology which is hugely adopted and practised in many universities all over the world including medical universities.

PBL in the Virtual Learning Environment System

A virtual learning environment is an online platform that allows network teaching and learning for teachers and students. Students and lecturers interact online like an ordinary classroom. Students are able to interact with one another and the teacher via the virtual learning environment. The Learning Management System (LMS) is a form of a virtual learning environment. It helps manage all student information such as their portfolios, student logs and progress record. Moodle LMS is open source and it works on computers and handphones. These days learning happens via smartphones in a regular fashion. This kind of learning is different from traditional classroom learning encouraging students to drive through subject content online to acquire knowledge and skill (**23**). Content can be provided in the LMS through various methods including documents, ebooks and animated demonstrations. Youtube live streaming can be used for demonstrations as well (**24**).

Discussion forums are inbuilt in the LMS system for communication between students and lecturers. The communication system has been enhanced these days via many social networking apps such as Facebook messenger, twitter, LinkedIn, myspace, Instagram, WhatsApp and many more of them that allows instant communication (**25**). Assessment can be done in LMS as well in the form of assignment, quiz, reflective writing and feedback submitted online on the LMS platform (**26**).

While many communication systems allow synchronous conversation, the facility to record and summarise ideas and facts of all students is missing. To overcome this technical defect, we shall be discussing two video conferencing apps in this article that have a synchronous whiteboard facility to record ideas and facts. The whiteboard feature allows editing by all the participants so that all the students can contribute equally. Also, the limitation of space for conducting small group teaching which is requiring many small rooms can be overcome by using this whiteboard supporting applications.

Google Hangouts

There is an increased use of online communications systems that has led to research on the comparison of traditional teaching and online learning. Some researchers say that there is no significant change in learning between traditional face to face PBL and online PBL in spite of different students' learning style **(27,28)**. Easy availability of internet connections with good bandwidth has enabled students from different places to take part in collaborative teaching sessions. Synchronous PBL sessions conducted through online video conferencing platforms allow learners to communicate with one another in real-time and also to share content and learning resources. Research studies show that online learning encourages individualised student-centred learning **(29)**.

Google Hangouts is one such application that supports synchronous virtual interaction that enables users to make synchronous conversation with one another and to share both online and other learning resources from different locations (Table 3). This application can be used from any smartphones with varied operating systems such as Android and iOS, and also desktop computers that usually have webcams, microphones and speakers. Google Hangouts has a chat tool for simultaneous texting among the participants. Users are enabled to share their screens or files on their devices. Teaching sessions can be captured and broadcasted as youtube videos that can be made available via cloud storage controlled by the organiser **(30)**. Google Hangouts is a useful and easy to use video conference application available through Google Plus **(31)**. Educators are using it already by integrating it into online and blended classrooms **(32, 33)**. Google Plus account is easy to set up and is mandatory to use google hangouts. Once you add people to your google plus account, close circles can be created with student groups for specific learning sessions. The circle concept makes it easy to communicate with group members, send invitations to the teaching sessions **(34)**.

Google hangouts offer collaborative usage of whiteboards that can be used by all the participants. It is called a Jamboard [Figure 2]. Jamboard functions just like a whiteboard. The best part of instant digital collaboration is the sharing between students and lecturers in different locations. Everything explained over one Jamboard can be seen across devices of all the students participating in the teaching session. The students logged on to their own devices can also edit on the exact same content displayed. The collaborative whiteboard supports all word documents, excel sheets, PowerPoint slides, and images from cloud accounts, making them easy to access, edit and share on multiple devices over the platform. This helps jot down all the ideas in the whiteboard during PBL sessions, summarise the ideas, identify knowledge gaps and learning outcomes and hence arrive at a solution collaboratively. Whiteboard helps visualize and organise collaborative ideas, knowledge and prioritise solutions to the problem at the discussion. Whiteboard feature helps students to type in all their ideas one by one. The facilitator can organise all the ideas and guide the students towards the solution. This helps students to stay on track and feel involved **(35)**.

Zoom.us

Zoom.us is a web-conferencing platform that is free for students. Using zoom.us enables one to easily start instant meetings. It requires paid licenses to be bought by the lecturer to pre-schedule teaching sessions. Zoom web-based conferencing uses good quality audio and video. It is compatible with all operating systems such as Windows, macOS, Android and iOS mobile devices. Also, Zoom can be used with conventional phone lines for audio conferencing without video. Individuals who want to host a meeting that will last longer than 40 minutes will need to buy an appropriate license. Purchasing a license for dedicated use with a physical location such as a classroom or a conference room is allowed. Only meeting organisers /hosts need a license. Participants or students do not need to buy a license. Zoom.us is a cloud-based web conferencing platform that enables even less structured courses to be delivered in a more learner interactive method when compared to recorded or print interactive media **(36)**.

The dashboard for Zoom.us is very simple and user friendly. Distance learners can begin a learning session with or without their video and later during the session they can turn their video on and off, a great feature that can help save data. The students can also organise and schedule their meetings with fellow students or just join a meeting scheduled by their lecturer. There is this great option of scheduling a recurring meeting for students who take regular lessons at a specific time that saves time of repeatedly scheduling the same meeting over the semester. A meeting ID and a link will be generated when an organiser schedules a learning session to be shared across all the students. The meeting ID along with a link will be added to their calendar automatically. Zoom.us offers a supreme connection with very efficient content sharing settings. The system enables students to share desktops, content, or an application on all your devices like iPad, iPhone, Mac PC and other AirPlay-compatible devices. Also, Zoom gives learners the opportunity to share content and conduct audio sessions under situations of low bandwidth and other situations where content is required to be shared and not video (37).

The most important feature that is required for a PBL or a classroom or any small group discussion or a brainstorming session offered by zoom is its collaborative whiteboard. The whiteboard feature comes along with an advanced annotations toolbox that can be used to guide students or explain a concept [Figure 3]. Screen Share feature enables sharing a camera input so that two cameras can be used at once during a Zoom meeting, with one focused on lecturer's writing. Creating a "shared board" allows the whiteboard to be managed jointly with teaching fellows. Prerecorded illustrations such as a video can be done and played during class. Chat tool encourages active participation by enabling more students to interact with the live session and not just listen passively. Zoom has useful annotation tools such as text box, drawing, pen, shapes, and highlighter that can be used on the whiteboard to explain concepts or mechanisms. Polling feature allows setting up polls in advance and launching them during the class session. This feature can be used to take attendance or feedback. Activating the non-verbal feedback feature for teaching sessions allows students to express thoughts to the lecturer without disturbing the meeting. Teachers can often check in and address any issues that the student might have expressed via non-verbal feedback. This feature also has an option to permit verbal feedback.

The raise hand feature of the annotation tools helps to indicate when a student likes to speak up. Keeping the students muted unless required can help avoid extraneous background noise. Zoom's breakout rooms function enables students to do group work. The instructor can enter breakout rooms virtually, render instructions to students breakout rooms, and end the breakout sessions when the students are done (38). Zoom has so many features that can help to overcome the downsides of an online classroom over a traditional classroom [Table 4].

CONCLUSION

Take home message

1. Videoconferencing applications with synchronous whiteboard facility can be used to overcome shortcomings of traditional problem-based learning.

2. These apps also allow problem-based learning possible distance learning not requiring the students to travel to a physical classroom

3. Limitations in terms of space requiring multiple small discussion rooms can be overcome by these applications.

REFERENCES

1. Foord M. inductive versus deductive methods of teaching area by programmed instruction. Educational Rev 1964; 16:130- 136.

2. Gagne RM, Brown LT. Some factors in the programming of conceptual learning. Exp Psychol 1975; 66:325-331.

3. Markle SM. Good frames and bad: a grammar of frame writing. John Wiley and Sons, New York 1964.

4. Barrows HS, Tamblyn RM. An evaluation of problem-based learning in small groups utilising a simulated patient. J Med Edu 1976; 51:52-54.

5. Barrows HS. How to design a problem-based curriculum for pre-clinical years. Springer, New York 1985.

6. Neufeld VR, Barrows HS. The "McMaster philosophy": an approach to medical education. J Med Edu 1974; 49:1040- 1050.

7. Barrows HS. Problem-based learning in medicine and beyond: a brief overview. New Directions for Teaching and Learning. 1996;68:3–12.

8. Prosser M, Sze D. Problem-based learning: student learning experiences and outcomes. Clin Linguist Phon. 2014;28:131–142.

9. Walker A, Leary H. A problem based learning meta-analysis: differences across problem types, implementation types, disciplines, and assessment levels. Interdisciplinary Journal of Problem-based Learning. 2009;3:6–28.

10. Schmidt HG, Vermeulen L, van der Molen HT. Longterm effects of problem-based learning: a comparison of competencies acquired by graduates of a problem-based and a conventional medical school. Med Educ. 2006;40:562–567.

11. Seneviratne RD, Samarasekera DD, Karunathilake IM, Ponnamperuma GG. Students' perception of problem-based learning in the medical curriculum of the Faculty of Medicine, University of Colombo. Ann Acad Med Singapore. 2001;30:379–381.

12. Maudsley G, Williams EM, Taylor DC. Problem-based learning at the receiving end: a mixed methods study of junior medical students perspectives. Adv Health Sci Educ Theory Pract. 2008;13:435–451.

13. J. Dewey. How we think Prometheus Books, Buffalo, N.Y (1910/1991).

14. H.S. Barrows, R.M. Tamblyn. Problem-based Learning: An Approach To Medical Education, New York, Springer Pub, Co (1980).

15. H.S. Barrows. The Tutorial Process. Southern Illinois University School of Medicine, Springfield, Ill (1992).

16. D.R. Woods. Problem-based Learning: Helping Your Students Gain the Most from PBL. D.R. Woods, Waterdown, Ont. (1994).

17. M. Savin-Baden. Problem-based Learning in Higher Education: Untold Stories Society for Research into Higher Education: Open University Press, Buckingham (2000).

18. R. Glaser, M. Bassok. Learning theory and the study of instruction. Ann Rev Psychol, 40 (1989), pp. 631-666.

19. A.S. Palincsar. Social constructivist perspectives on teaching and learning. Ann Rev Psychol, 49 (1998), pp. 345-375.

20. Darnal H K, Yadav H, Ramakrishnappa S, Karikalan B, Reverse teaching- A strategy for undergraduate medical education in pathology. Indian J Pathol Oncol 2019;6(2):233-236.

21. H.S. Barrows. The Tutorial Process. Southern Illinois University School of Medicine, Springfield, ILL (1988).

22. H.G. Schmidt. Foundations of problem-based learning - some explanatory notes. Med Educ, 27 (5) (1993), pp. 422-432

23. N.N. Chana, C. Walkerb, A. Gleavesb. An exploration of students' lived experiences using smartphones in diverse learning contexts using a hermeneutic phenomenological approach. Computers & Education, 82 (2014), pp. 96-106

24. L. Kyei-Blankson, E. Ntuli. Practical application and Experiences in K-20 blended learning environment, IGI-Global, Hershey, PA (2013).

25. D.M. Boyd, N.B. Ellison. Social network sites: Definition, history, and scholarship Journal of Computer-Mediated Communication, 13 (1) (2008), pp. 210-230.

26. Rojana Phungsuk, Chantana Viriyavejakul, Thanin Ratanaolarn. Development of a problem-based learning model via a virtual learning environment. Kasetsart Journal of Social Sciences. Volume 38, Issue 3, September–December 2017, Pages 297-306.

27. Dennis JK. Problem-based learning in online vs. face-to-face environments. Education for Health. 2003;16(2):198–209. https://doi.org/10.1080/1357628031000116907.

28. Tichon JG. Problem-based learning: a case study in providing e-health education using the internet. Journal of Telemedicine and Telecare. 2002;8(S3):66–8. https://doi.org/10.1258/13576330260440907.

29. Jonassen D, Howland J, Moore, J, Marra, R. Learning to solve problems with technology: a constructivist perspective. Columbus, OH: Merrill Prentice Hall; 2003. p. 1–256.

30. Hazwanie H, David WK Chong, Er HM, Pran Kishore D, Wong PS, Lee MS, Maharajan MK, Lee EL, Baloch HZ. Student's perceptions of live online virtual e-problem based learning (LOVE-PBL) using google hangouts. Education in Medicine Journal. 2017;9(4):31–39.

31. Duffy, J. (2013). Does Google+ Have a Future? PC Magazine, 42-44.

32. Isaacson, K. (2013, June). An Investigation into the Affordances of Google Hangouts for possible use in Synchronous Online Learning Environments. In World Conference on Educational Multimedia, Hypermedia and Telecommunications (Vol. 2013, No. 1, pp. 2461-2465).

33. Roseth, C., Akcaoglu, M., & Zellner, A. (2013). Blending Synchronous Face-to-face and Computer-Supported Cooperative Learning in a Hybrid Doctoral Seminar. TechTrends, 57(3), 54-59.

34. Michiko Kobayashi. Students' Evaluation Of Google Hangouts Through A Cross-cultural Group Discussion Activity. Turkish Online Journal of Distance Education-TOJDE April 2015 ISSN 1302-6488 Volume: 16 Number: 2 Article 3.

35. Joel Basedow. (16 July 2018). 4 Reasons Google Jamboard Is the Digital Whiteboard For Smart Business And Education Collaboration. Retrieved from: https://www.drivendigitally.com.au/blog/intera ctive-whiteboards-jamboard-australia

36. Debbi Weaver. Technology choices to support international online collaboration. Show me the learning. 2016. Conference Proceedings. 33rd International Conference of Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education, University of South Australia, Adelaide, Australia.

37. Maria Koutroumpousi. Zoom.Us in the Distance Education Environment of Michigan State University (MSU). An Actual Educational Technology Application and its Use in the Distance Education Environment it Serves. Technology in Education and Training. 2015. Athabasca University.

38. Harverd University Information Technology. (Mar 24 2020). In-depth Guide: using Zoom to teach online class sessions. Retrieved from https://harvard.service-now.com/ithelp?id=kb_article&sys_id=4c3290f 6db5b845430ed1dca4896197f
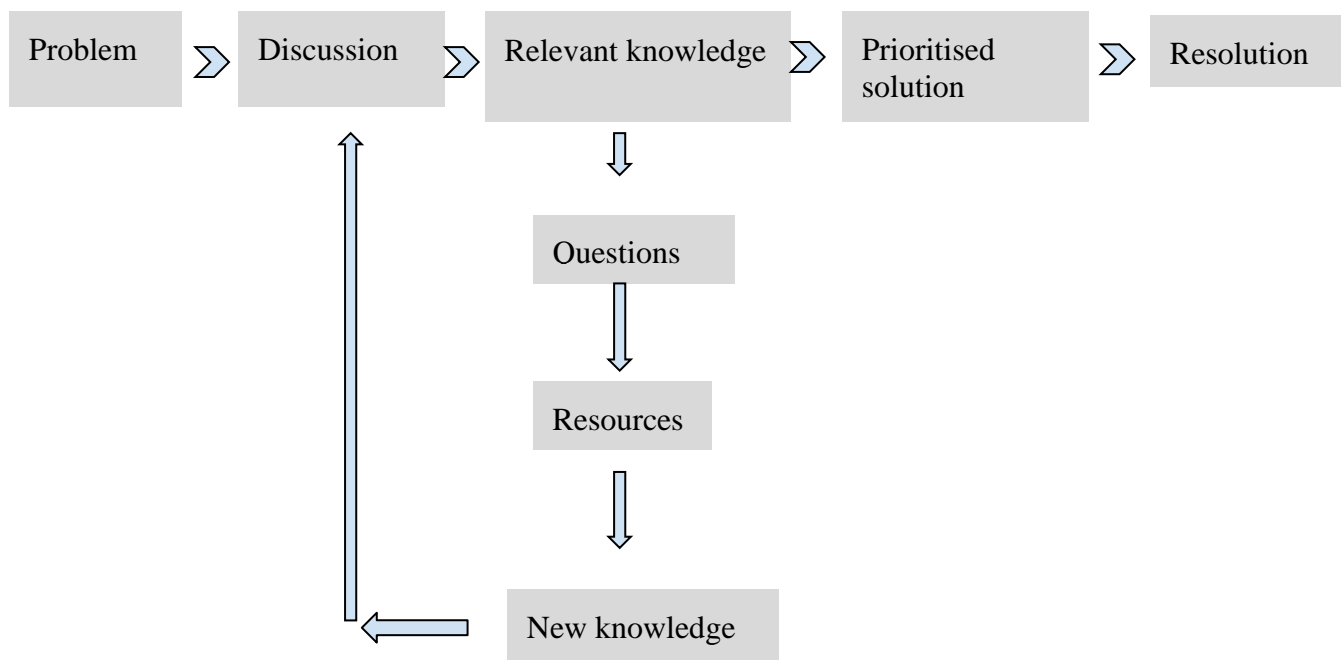
Figures

Figure 1: Problem Based Learning Process
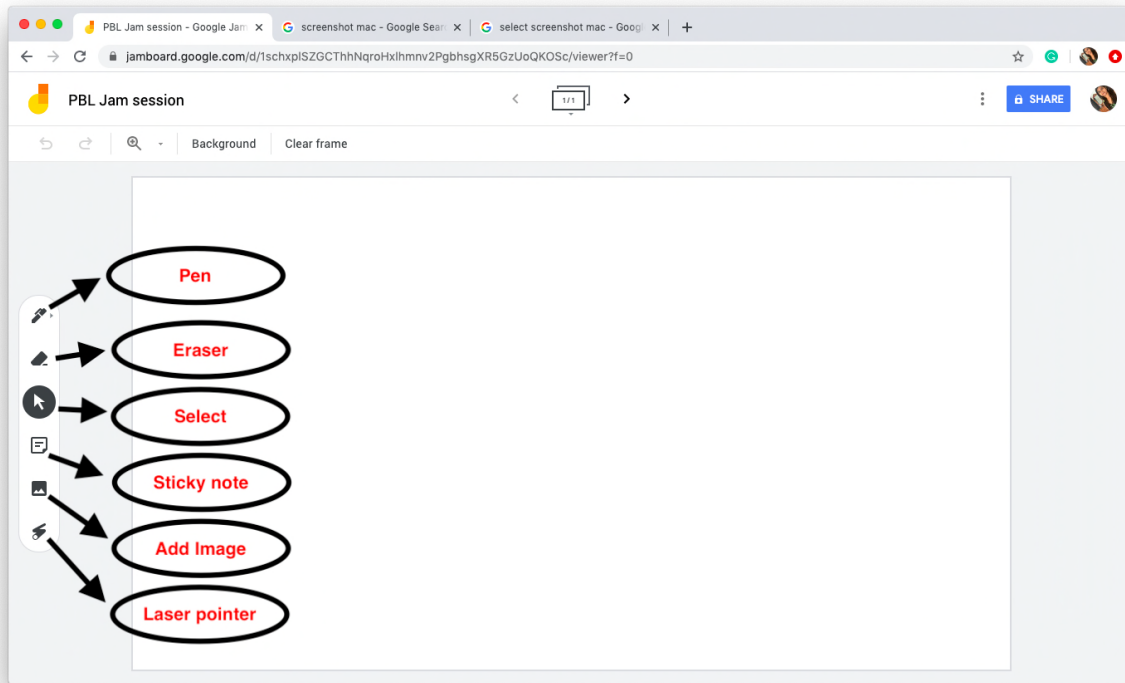
Figure 2: Google jamboard with tools highlighted

Figure 3: Annotation tools of zoom whiteboard

TRIGGER 1: The patient and complaint
A 5-year-old boy, while playing outdoors during the break in his playschool, suddenly started coughing severely and was gasping while saying "I can't breathe...I can't breathe!" The teacher on duty ran to him and tried to comfort him. She also noticed that his breathlessness progressively worsened. She immediately called his mother and asked to meet in the emergency department of a nearby hospital.

Table 1: Trigger 1 given to the students

FACTS/CASE INFO	HYPOTHESIS/IDEAS	LEARNING ISSUES
• 5-yr-old boy • Sudden onset of severe cough and gasping • Breathlessness • Taken to emergency department of a nearby hospital	• URTI • Allergic disease involving upper airway • Foreign body? • Bronchial asthma – allergic/ seasonal • Pneumonia • Bronchiectasis	• Causes of acute onset breathlessness • Red flag signs in breathlessness

Table 2: student ideas and hypothesis can be recorded as shown and learning issues can be identified

Google hangouts - Highlights
❏ Screen sharing ❏ Documents (Word, PowerPoint, excel) sharing ❏ Collaborative whiteboard ❏ Chatbox ❏ Record sessions ❏ Google circle ❏ Google classroom

Table 3: Highlights of Google Hangouts

Zoom - Highlights
❏ Screen sharing ❏ Airdrop on airplay devices ❏ Collaborative whiteboard ❏ Chatbox ❏ Polling ❏ Verbal and non-verbal feedback ❏ Record sessions ❏ Breakout rooms

Table 4: Highlights of Zoom.us