

Combination of Multiple Teaching Tools in learning Biochemistry: Perceptions of Medical Undergraduate Students

¹Shrirang P Kulkarni, ²Vidya S Patil, ³Vijayetha P Patil, ⁴Deepti G Ingleshwar, ⁵Alagilwada S Shilpasree, ⁶Axita C Vani, ⁷Praveen K Shetty, ⁸Rakesh T Muddaraddi, ⁹Dhiraj J Trivedi, ¹⁰Anil B Bargale, ¹¹Pramod S Kamble

ABSTRACT

Introduction: Multiple teaching tools for medical undergraduates in biochemistry play a pivotal role for overall understanding of the subject and its applicability in clinical medicine. Students must be able to apply the knowledge of biochemistry effectively in dealing with real-life case scenarios.

Objectives: To implement combination of multiple teaching tools topic wise; to evaluate the students' perception toward effectiveness of combination of tutorials, case-based learning (CBL) sessions, video-based interactive sessions (VBIS) with demonstrations when they were supplemented and coordinated with didactic lectures (DLs) at regular intervals and also to evaluate the students' perception toward usefulness of formative assessments.

Materials and methods: Teaching methods were formulated for Carbohydrate metabolism and Genetics including multiple teaching tools. All 100 students of Phase 1 MBBS course were included. Formative assessments were conducted simultaneously with feedback to students. Students' perception was collected regarding the effectiveness and usefulness of multiple teaching tools and formative assessments by a pretested questionnaire.

Results: Regarding coordinated approach with multiple teaching tools like DL, tutorial, practical and CBL, most students felt that it was useful toward better understanding of the subject (83%), good retention of the subject (79%), improved communication skills (70%), and effective preparation for course end exams (83%). Students expressed that they want to have formative assessments regularly with feedback.

Conclusion: Using a combination of multiple teaching tools separately for each topic improves the understanding and retention of the contents better as perceived by the students. Students felt that formative assessment with feedback reinforces their ability to perform better.

Keywords: Case-based learning, Formative assessment, Multiple teaching tools, Tutorials in biochemistry, Video-based interactive learning.

How to cite this article: Kulkarni SP, Patil VS, Patil VP, Ingleshwar DG, Shilpasree AS, Vani AC, Shetty PK, Muddaraddi RT, Trivedi DJ, Bargale AB, Kamble PS. Combination of Multiple Teaching Tools in learning Biochemistry: Perceptions of Medical Undergraduate Students. *Indian J Med Biochem* 2018;22(1):41-46.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Biochemistry is one of the foundational sciences in the basic sciences of medical courses, which is essential to understand basic molecular interactions driving the functioning of human body and provides insight into the underlying mechanisms of both structure and regulation that occur at the cellular, tissue, organ, and whole system level.¹ Since long time, biochemistry is assumed to be difficult and pathway-laden discipline by students which makes them struggle to understand and reproduce. Because biochemistry is a key subject that includes laboratory medicine and diagnostic methodology, in-depth knowledge of it forms the basis for proper evaluation of clinical problem and its efficient treatment.²

In India, most universities include biochemistry in the 1st phase of MBBS along with anatomy and physiology. Existing curriculum needs the subject to be taught under specific teaching methods like DLs, tutorials, and practical. However, it is dealt under the same protocol without much interdisciplinary interaction with anatomy and physiology.

Didactic lectures, though popular and convenient for mass education, are passive, one-sided, and quality depends on the ability of the teacher. It gives little opportunity for students to interact, ask questions and clarify their doubts.³ But still DLs are the main stay in teaching at present. It is not feasible to suddenly change over from traditional DLs to interactive small group discussions, as our students are exposed to DLs in their pre-university course. The ways of teaching needs a paradigm shift from delivering knowledge only, toward that of critical thinking, reasoning, developing interactive skills, and also to inculcate the attitude of lifelong learning toward attaining the goal of an ideal doctor serving the community.

^{1,7,9}Professor, ²Professor and Head, ^{3,6,8}Associate Professor
^{4,5}Assistant Professor, ^{10,11}Tutor

¹⁻¹¹Department of Biochemistry, SDM College of Medical Sciences & Hospital, Dharwad, Karnataka, India

Corresponding Author: Vidya S Patil, Professor and Head Department of Biochemistry, SDM College of Medical Sciences & Hospital, Dharwad, Karnataka, India, Phone: +919845641762 e-mail: vidyaspatil02@gmail.com

Several studies have identified tutorials and CBL as effective and interactive methods of teaching.⁴ Tutorials are very effective way of small group discussion which encourages active participation from students and helps students to interact with peers and teachers. This is a good platform to get feedback from teachers and peers, so that student will know his abilities and lacunae. It encourages the overall development of students' attitude toward learning.

Problem-based learning (PBL) requires ability to process and discuss; hence, PBL will be an unsuccessful program for students who have difficulty in communication.⁵ Case-based learning is a pedagogical method where case studies are used as active learning tools where in a case study is used to stimulate and express the acquisition of knowledge, skills, and attitudes.⁴ The CBL uses guided enquiry method and gives more structure during small group discussions in which the facilitator plays a major role, whereas PBL is open enquiry approach with least guided discussion and the role of the facilitator is minimal.^{6,7}

Recently, videos, animations, cinema, and models are being effectively used as simple and effective ways of making the students understand the complex concepts. Few selected topics can be taught using these technical aids, so that learning becomes enjoyable and will be retained better without rote memorization.

With this background, to overcome the shortcomings of DLs, we proposed to introduce periodical CBL, tutorials, VBIS with demonstrations right from the beginning of academic year, best suited according to the topics along with DLs. The combination of teaching tools used would be tailor made for each topic. To improve the credibility of learning process, formative assessments with effective feedback would be given.

AIMS AND OBJECTIVES

The aim of our present study regarding proposed changes in teaching methods is

- To formulate and implement two different modules using combination of multiple teaching tools;
- To evaluate the students' perception toward effectiveness of combination of tutorials, CBL sessions, VBIS with demonstrations when they were supplemented and coordinated with DLs at regular intervals;
- To evaluate the students' perception toward usefulness of formative assessments with effective feedback.

MATERIALS AND METHODS

This study was carried out in the Department of Biochemistry, SDM College of Medical Sciences & Hospital,

Dharwad, Karnataka, India. A total of 100 students from phase 1 MBBS were included in our study group. It was a quasi-experimental study. Informed consent was taken from the participants and institutional ethical committee approval was obtained.

Needs assessment: In an effort to improve on the present way of teaching, we took feedback from the students regarding the existing curriculum and pattern of teaching. Students felt that it is comparatively easy to understand, but difficult to remember and reproduce biochemistry. Students felt that regularity, discussion with teachers and peers would make it easier to understand. More than 75% students expressed that tutorials are the best way to understand and retain the contents. They also felt difficulty to follow the content delivered in DLs if there are no small group discussions later.

Based on the needs assessment, we included multiple teaching tools and modified our training methods as follows.

Teaching Learning Methods

After the completion of DL on a particular topic, a tutorial class was conducted on the same topic for better understanding and deep learning. In these tutorials, one trained tutor was assigned for a batch of 10 students. This gives a platform for interactive session for students on that topic.

This was followed by a CBL on the same topic (Fig. 1), e.g., diabetes mellitus in carbohydrate metabolism or myocardial infarction after lipid metabolism. Here again, the facilitator guided a batch of 8 to 10 students. In this, a small case history was given to students with specific learning objective for the case. This was followed by a detailed discussion with reasoning of the case by the facilitator.

At the end of each month, a class test was conducted on the topic covered in the lecture class. This formative assessment was a written test with either multiple-choice questions (MCQs) or short-answer questions (SAQs). Clinical case evaluation was done to assess clinical reasoning skills in the form of case reports according to the scoring system.⁸

During tutorials, in the first hour there was interactive, in-depth discussion for better understanding

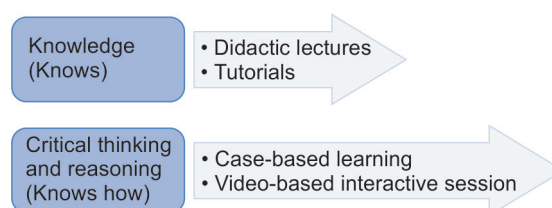


Fig. 1: Enhancing cognitive domain by introducing multiple teaching tools

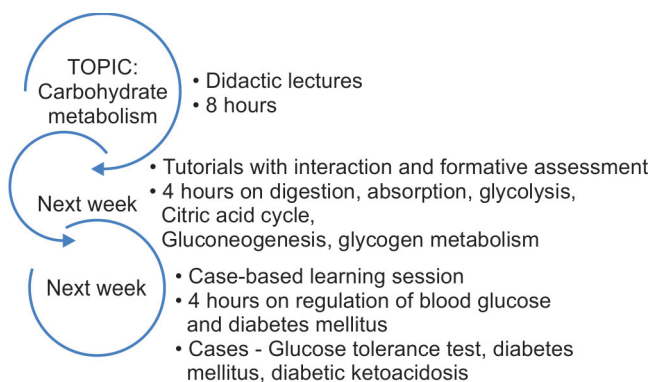


Fig. 2: Teaching methodology designed for carbohydrate metabolism

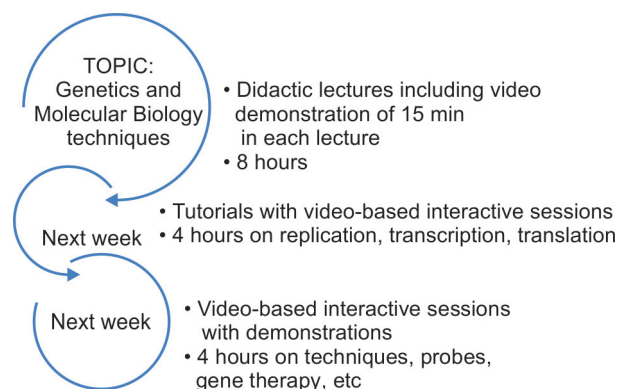


Fig. 3: Teaching methodology designed for genetics and molecular biology techniques

with active participation of students. In the next hour, student had to solve a set of 10 MCQs and 3 short-answer reasoning-type questions on the topic discussed. These were designed to assess the in-depth knowledge on the above topic (Fig. 2).

During CBL sessions, a case with specific learning objective will be discussed by facilitator followed by a case history with structured questions. After the session, students were assessed by MCQs and SAQs which were designed to assess the (a) basic knowledge of the case, (b) comprehension, and (c) clinical applicability of the learnt concept to solve the medical condition based on scoring system developed.⁸

Video-based Interactive Sessions

We used videos for active learning process for the topics where CBL was not applicable (feasible) like genetics, cancer, and molecular biology techniques (Fig. 3). At the end of DL, a 15-minute video clipping related to the same topic was shown. As the pathways (ex. replication) in these videos have stop-gaps where the student can choose the next step for continuation of the pathway, these were utilized in the tutorials for the interactive participation of students. Students' knowledge was assessed using video-based activities and animated question and answers. In addition, few demonstrations on molecular biology techniques like deoxyribonucleic acid (DNA) isolation, blotting techniques were given to make students understand the concepts clearly.

Formative Assessment

- *Regular assessment:* At the end of that month, a written test was conducted. Short-answer questions and MCQs were asked to assess the basic knowledge and also to check the reasoning skills. Oral feedback regarding what went very well and which aspects needed improvement was given to all the students

together in a group after evaluating their performance. Students were given a chance to reflect orally upon their own performance and abilities.

- *Periodical assessment:* Internal assessments at the end of each term formed the basis of periodical assessment. This included SAQs and essay-type questions in theory to assess the knowledge and reasoning. In practical, small case studies with laboratory findings and/or photos/pictures were used to assess the clinical applicability of basic concepts and reasoning skills. Feedback was given collectively to the group based on the test assessment and observation by the teacher.

In this manner, during their academic year, students were trained in biochemistry by using DL, tutorial, CBL, VBIS and formative assessment in a coordinated schedule.

Toward the end of their academic year, a feedback was taken from the students using prevalidated questionnaire on our modified method of teaching about coordinated use of multiple teaching tools and formative assessments.

RESULTS

The response of the students to our improvised method of teaching for two modules on carbohydrate metabolism and genetics is shown in Table 1.

Majority (90%) of students felt that the basic information given in DLs was appropriate, with proper link to clinical applicability (71%). They also opined that there was good coordination between DLs and practical (76%) as well as DLs and CBL (72%).

Most of the participating students suggested that tutorials helped them to plan their study (74%), focus on what is to be studied (82%), encouraged active participation with better retaining of subject (75%). A total of 76% of students expressed that CBL sessions gave an

Table 1: Students' perception toward utility of multiple teaching tools and formative assessment in learning biochemistry (numbers in percentage)

Questions	Agreed	Somewhat	Disagreed
DLs			
1 Basic information was appropriately given	90	6	4
2 Link to the case with clinical applicability was provided	71	20	9
3 Theory and practical topics coordinated well	76	18	6
4 Theory and CBL sessions coordinated well	72	19	9
Tutorials			
1 Tutorials helped us to plan our study	74	19	7
2 Tutorials helped us to focus on what is to be studied	82	17	11
3 Tutorials helped us to know how to answer in exams	75	20	5
4 Tutorials helped us to actively participate in the discussion	79	15	6
5 Tutorials helped us to clarify doubts easily with peers and teachers	70	18	12
6 Tutorials helped us to retain the subject better	75	18	7
7 Tutorials helped us to understand the subject better with deep learning	78	16	6
CBL sessions			
1 Cases discussed gave an insight to the biochemical basis of various conditions	76	21	3
2 Cases discussed showed clinical applicability of biochemistry to medicine	85	11	4
3 Case discussions helped to create interest in the subject	72	22	6
4 Case discussions helped in active participation	71	19	10
5 Cases discussed were near to real-life scenario	80	14	6
6 Case discussions helped to get involved in group discussion and gain good information	81	13	6
7 Case discussions helped us to improve on critical thinking and reasoning	74	19	7
8 Case discussions helped to retain and apply the knowledge in identifying the patients' problem	82	9	9
VBIS			
1 Videos were very informative	83	11	6
2 Videos made us understand complex processes in a simple way	77	17	6
3 Activities at the end of videos made us retain the content easily	68	22	10
4 Including videos in DLs made us concentrate more	76	18	6
Combination of improved teaching methodologies			
1 It was useful for us to understand better	83	10	7
2 It was useful to retain the subject better	79	13	8
3 It helped us in deep learning	74	17	9
4 It improved our communication skills	70	18	12
5 It was useful to prepare for course end examinations	83	12	5

insight into the biochemical basis of medical condition and showed the clinical applicability of biochemistry to medicine (85%). It also created interest in the subject (72%), motivated for active participation (71%), helped them to improve critical thinking and reasoning (74%), with better application of knowledge in identifying patient problem (82%).

Interestingly, students enjoyed VBIS, saying that it was informative (83%), simplified the complex steps (77%), and increased their concentration when they were included in DLs (76%).

The response of the students to our formative assessment with effective feedback is shown in Table 2.

Formative assessments motivated them for regular study (72%), helped them to self-assess their performance (69%), and prepare well for final university exams (72%).

Regarding coordinated approach with multiple teaching tools like DL, tutorial, practical, and CBL, most students felt that it was useful toward

- Better understanding of the subject (83%),
- Better retaining of the subject (79%),
- Better communication skills (70%), and
- Better preparation for course end exams (83%).

DISCUSSION

Medical education has changed significantly over the years. The theme is "shift from teacher-centered approach to a learner-centered approach." This is achieved by a learning facilitator replacing traditional didactic teacher and traditional didactic teaching methods by interactive small group teaching (CBL, tutorial).⁹

In the present study, the feedback given by participants clearly indicates that single method of teaching is

Table 2: Students' perception toward usefulness of formative assessment with feedback in learning biochemistry (numbers in percentage)

Formative assessment		Agreed	Somewhat	Disagreed
Questions				
1	Class tests helped us to read regularly	72	21	7
2	Class tests helped us to self-assess regarding our performance	69	23	8
3	Class tests helped us to prepare for final university exams	72	21	9
4	CBL assessment helped us to apply basic knowledge in reasoning	81	10	9
5	CBL assessment helped us to place ourselves as future doctors	85	6	9
6	Teacher and peer group feedback was helpful for self-assessment and improvement	69	20	11

no more attractive and informative. Didactic lectures, though age-old method of teaching for transferring information for mass communication and still the mainstream of teaching in all university curricula, alone fail to create enthusiasm and active participation among students. A subject like biochemistry needs judicious use of interactive and visual teaching tools for understanding of basic concepts.¹⁰ Visual pictures in the form of videos make the topics like molecular biology to be understood in a simple way. Subject retained was better with visual reinforcement which was very well appreciated by our students.

In order to overcome the above limitations and to reinforce the concepts covered in DLs, introduction of active and interactive small group discussion in the form of tutorials helped students to summarize, clarify their doubts, and understand the topic.¹¹ This helped to understand the subject in depth and created a fearless environment for the students to learn and express their views.

The utility of biochemical concepts which the student learns in MBBS phase 1 actually comes in diagnosing medical problems at a later stage. This enormous gap fades the knowledge of basic concepts learnt by the students, especially when it is required most. This lacuna is overcome by using CBL which motivates them to feel like future doctors and motivates them to learn to critically think and reason out the problem, so that effective treatment can be given. The CBL in biochemistry is an interesting and guided enquiry method, wherein by giving a small case history with relevant lab data and clinical photographs, students will be made to think, analyze, correlate, and solve the problem.^{12,13} This motivates them to participate, interact, and learn the concept with its clinical applicability which reduces the burden on students to memorize the facts.²

The VBIS along with demonstrations gave the students a clear concept in the field of genetics and molecular biology techniques. Since the present day is moving toward the era of genomics, proteomics, and metabolomics, where students have to not only understand the molecular basis of disorders, they should be able to critically think and use this basis as important points for diagnosis, therapy, or prevention. Using videos emphasized the actual processes

involving protein–protein/protein–DNA interactions which would otherwise not be possible with other teaching tools.¹⁴ This was an enjoyable learning experience for students as well as for teachers.

Formative assessment in the form of regular and periodical class tests not only keeps them abreast with subject, improves their presentation skill but also trains them to write final university exam. The way formative assessments were conducted systematically covering all the areas with effective feedback given each time, students were able to understand their shortcomings and improve upon it. This created an atmosphere for students to reflect upon and also to become self-directed learners. This helped the students to start inculcating the attitude of a lifelong learner.

CONCLUSION

Using a combination of multiple teaching tools separately for each topic would improve the understanding and retaining of the subject better as perceived by the students. In fact, students opined that it was helpful for them to prepare for exams also. Students appreciated the judicious use of CBL sessions and VBIS with demonstrations at the point where it is required during the process of learning of specified topics. This makes learning biochemistry an enjoyable experience without rote memorization of facts. Students felt that formative assessment with effective feedback has helped them to learn with credibility throughout the year, which is the foundation step toward becoming a lifelong learner.

WAY FORWARD

- In addition to multiple teaching tools, *interactive teaching* will be given more importance for enhancing active participation of students in learning process.
- *Constructive feedback* will be planned and given in a step-wise manner to each student individually which may have a positive impact on their learning behavior.
- *Motivational sessions* will be conducted including early clinical exposure for better understanding and inculcating the behavior of independent learning among students.

REFERENCES

1. Afshar M, Han Z. Teaching and learning medical biochemistry: perspectives from a student and an educator. *Med Sci Educ* 2014 Sep;24(3):339-341.
2. Joshi KB, Nilawar AN, Thorat AP. Effect of case based learning in understanding clinical biochemistry. *Int J Biomed Adv Res* 2014;5(10):516-518.
3. Hadimani CP. Effectiveness of small group discussion sessions in teaching biochemistry for undergraduate medical students. *South East Asian J Med Educ* 2014 Jun;8(1):77-81.
4. Salgar ST. Case based learning: an innovative student-centred methodology for teaching biochemistry. *Int J Biomed Res* 2014;5(1):25-27.
5. Carrera LI, Tellez TE, D'Ottavio AE. Implementing a problem-based learning curriculum in an Argentinean medical school: implications for developing countries. *Acad Med* 2003 Aug;78(8):798-801.
6. Srinivasan M, Wilkes M, Stevenson F, Nguyen T, Slavin S. Comparing problem-based learning with case-based learning: effects of a major curricular shift at two institutions. *Acad Med* 2007 Jan;82(1):74-82.
7. Setia S, Bobby Z, Ananthanarayanan P, Radhika M, Kavitha M, Prashanth T. Case based learning versus problem based learning: a direct comparison from first year medical students perspective. *WebmedCentral Med Educ* 2011 Jun;2(6):WMC001976.
8. Patil VP, Patil VS, Kulkarni SP, Trivedi DJ, Axita VC, Mudaraddi RT, Shetty P, Bargale AB, Kamble PS, Ingleshwar DG, et al. Case-based learning in biochemistry: an innovative criterion-based assessment module for effective learning among MBBS phase 1 students in India. *Indian J Med Biochem* 2017 Jan-Jun;21(1):62-68.
9. Dacre JE, Fox RA. How should we be teaching our undergraduates? *Ann Rheum Dis* 2000 Sep;59(9):662-667.
10. Vanderlelie JJ. Improving the student experience of learning and teaching in second year biochemistry: Assessment to foster a creative application of biochemical concepts. *Int J Innov Sci Math Educ* 2013;21(4):46-57.
11. Wilma DS, Suresh DR, Chandrakala MV. Evaluation of small group discussion as a teaching-learning method in biochemistry for first year MBBS students: a pilot study. *South East Asian J Med Educ* 2014;8(2):43-47.
12. Kulak V, Newton G. A guide to using case-based learning in biochemistry education. *Biochem Mol Biol Educ* 2014 Nov-Dec;42(6):457-473.
13. Chapman DM, Calhoun JG. Validation of learning style measures: implications for medical education practice. *Med Educ* 2006 Jun;40(6):576-583.
14. Ojennus DD. Assessment of learning gains in a flipped biochemistry classroom. *Biochem Mol Biol Educ* 2016 Jan-Feb;44(1):20-27.