 DOI: 10.18231/2394-6377.2019.0031

Study of competency to interpret biochemistry case scenarios by medical students in integrated Vs traditional curriculum

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Received: 13th August, 2018 **Accepted:** 24th October, 2018

Abstract

Introduction: Problem-based learning has been proposed as an alternative to learning by the traditional lecture method with advantages of assisting medical students to acquire and retain relevant information through integration of basic and clinical sciences. It is also proposed to motivate and improve students' ability to integrate theory and practice in clinical practice. Acquisition of diagnostic reasoning skills in Problem based learning curriculum is proposed to be better than in a conventional medical education.

Materials and Methods: Seventy students from AIMST University, Malaysia following an integrated hybrid PBL curriculum (hPBL) and seventy students from JSS medical college, India following a traditional curriculum (TC) were considered for the study. Twenty-five case scenarios in multiple choice formats were administered to both groups.

Results: Students from the hPBL curriculum showed a better performance with respect to all questions compared to students from TC. Statistically significant difference was found between the mean percentage score at AIMST (72.11%) compared to that at JSSMC (56.53%) ($P<0.002$).

Conclusion: Students studying in an hPBL curriculum developed better diagnostic competence to answer questions with respect to all major organ systems in the body compared to students from the TC. This is presumed to be because they are better able to integrate knowledge acquired from all of the basic sciences. Since most of the qualifying exams around the globe are objective oriented, training students to acquire medical knowledge in an integrated way and prepare them to develop a better diagnostic competence is the need of the hour.

Keywords: Integrated curriculum, Conventional curriculum, Problem based learning, Competency, Biochemistry, Medical students.

Background of Research

Health care in the 21st century requires well trained primary care physicians who are conversant in the practice of multidisciplinary and collaborative medicine. A comprehensive scientific foundation and critical thinking are projected to be important and implementation of effective educational strategies to improve foundational science education is proposed.[1] It is also suggested that to master each body of knowledge, students need to learn to use judgement in understanding, weighing and integrating many types of knowledge. To achieve the goal, teaching core topics across multiple courses is desirable. In response to this challenge, interdisciplinary curricula have been developed in multiple medical schools.[2-4]

In recent decades, Problem-based learning (PBL) has been proposed as an alternative to learning by the traditional lecture method. PBL has its own merits by assisting students to acquire and retain relevant information through integration of basic and clinical sciences. This increases retention, interest, and motivation.[5] PBL is also shown to be effective in increasing students' ability to integrate theory and practice in clinical practice. Schmidt and others have proposed that acquisition of diagnostic reasoning skills in a PBL curriculum is to a larger extent better than in a conventional medical education.[6]

At AIMST (Asian Institute of Medicine, Science and Technology) University, Malaysia, the MBBS (Bachelor of Medicine and Bachelor of Surgery) program is a five-year course wherein integrated hybrid PBL curriculum is followed throughout. Basic science subjects including anatomy, physiology, biochemistry, pharmacology, pathology, microbiology and biostatistics integrated horizontally are taught in the first year. These subjects are reintroduced in year 2 in a system based approach along with relevant clinical lectures (Medicine, surgery, pediatrics, etc). Biochemistry curriculum in the 1st year includes enzymes, chemistry of major metabolic molecules with their metabolism, molecular biology and nutrition. Year 1 teaching learning activities are mainly didactic lectures supplemented by relevant practical. System-based, integrated hybrid PBL curriculum in year 2with all basic science subjects are taught under six systems: cardiovascular (CVS), respiratory (RS), gastrointestinal (GIT), central nervous system (CNS), endocrine and reproduction (ERS) and renal-hematology (REH). Year 2 teaching learning methods include didactic lectures complimented by relevant practical associated with2 PBL cases of three sessions each, self-directed learning, special study module, clinical skills demonstrations by mannequins and hospital rotations for two weeks. Basic biochemistry is taught in the first year and reinforced in the second year, emphasising its role and relevance to understanding organ functions and its role in identifying organ dysfunctions. By this, students get an opportunity to recapitulate biochemistry information in the 2nd year.

Year 3 starts with an introduction to clinical subjects as well as hospital rotations.

At JSS Medical College (JSSMC), a constituent college of JSS University, Mysore, India, traditional teaching, mainly through didactic lectures, is followed. Biochemistry is intensively taught during the first ten months of first year of the MBBS program along with Anatomy and Physiology as per Medical Council of India (MCI) guidelines. The Biochemistry curriculum includes cell biology, enzymes, chemistry and metabolism of major biomolecules as well as nucleotides, molecular biology and nutrition. Teaching learning methods to deliver biochemistry curriculum is teacher-centered and includes didactic lectures complimented by practical wherever applicable. They are also exposed to case-based learning and problem-solving exercises during their training in biochemistry. However, the summative assessments essentially do not test higher levels of cognitive domain. Once students pass out of the first year, their exposure to Biochemistry remains very limited in the ensuing four and half years as students are not exposed to Biochemistry subject later in the course of second and final year MBBS.

In view of different teaching/curriculum models being followed at AIMST University and JSSMC, the authors were interested to compare the diagnostic competency of students to interpret biochemistry based clinical case scenarios using knowledge gained while studying biochemistry in a traditional Vs an Integrated curriculum before being exposed to clinical training.

Hypothesis: The students in the integrated curriculum, having been exposed to basic biochemistry in the 1st year followed by the system based approach with simultaneous PBL sessions, clinical skills sessions (CS), short hospital rotations and lectures from clinical departments faculty during 2nd year,were expected to be more competent to interpret clinical case scenarios using biochemistry knowledge compared to students in a traditional curriculum.

Materials and Methods

At AIMST University, Malaysia, the study was conducted in September 2014 on year 3 MBBS students immediately after returning from vacations following their year 2 professional exams. 70 students (38% of the total class strength) aged 20-23 years (mean age 21), participated in the study. Thirty-four were male students and thirty-six were female students. The "test" with twenty-five clinical scenarios in multiple choice questions format was administered to student volunteers of the above mentioned group following a written informed consent, assuring anonymity as well as no individual grades would be revealed. The cases were constructed bearing in mind that at least one question from each system of year 2 was represented (4 CVS, 1 RS, 6 GIT, 1 CNS, 8 ERS, 5 REH) and cases most commonly seen in practice, irrespective of global location was considered. Since few systems had more number of contact hours for biochemistry, compared to others, representing all systems equally in the questions was not possible.

Cases were presented with patient presentations, complaints and physical examination findings. Students were expected to diagnose the disease based on biochemical changes or predict the biochemical changes in a given disease. Reference values for all biochemical parameters in the questions were provided. Students answered on Optical Mark Recognition (OMR) sheets mentioning their age, sex and Identity number only. The test was conducted for 25 minutes (1min /MCQ).[7]

At JSSMC, India, the study was conducted on first year medical students in August 2014, on completing first year MBBS examinations. One hundred and seventy nine students (87 male students and 92 female students) of the 200 in class (89.5%) aged between 17-19 years (mean age 18) participated in the study following written informed consent, assuring anonymity and assuring that no individual grades would be revealed. However, to keep both the groups equal, a random sampling of 70 student grades were used to compare the results. Exit exams for year one at JSSMC includes biochemistry along with anatomy and physiology. Once students pass out of first year, their exposure to Biochemistry remains very limited in the ensuing four and half years of undergraduate studies in medicine. Since the target group for the study were students completing biochemistry, it was inevitable to use year 1 completing students from JSSMC (just before entering year 2 with clinical postings), unlike in AIMST, where the study was conducted on year three students (just passed out of year 2) after completing all the basic sciences and just before entering clinical subjects. These students were exposed only to preclinical basic sciences and not to the para clinical subjects including pharmacology, pathology and microbiology. The same questionnaire used at AIMST was used at JSSMC after approval by the biochemistry faculty there and making sure that the students were exposed to the topics being tested.

The study was approved by Faculty of Medicine Research, Human and Medical Ethics Committee (FoMRHAEC) of AIMST University, Malaysia with internal grants number AURGC/50/FOM/2013.

Results and Discussion

Mean score of the test at AIMST was 18.00 with standard deviation 3.22 (18 ± 3.22) and 14.75 at JSSMC. The maximum score was 24 (96%) and minimum 8 (32%) at AIMST, whereas 23 (92%) was the maximum and 5 (20%) minimum at JSSMC. A statistically significant difference was found between the mean percentage score at AIMST (72.11%) compared to that at JSSMC (56.53%) ($P<0.002$). A comparison between the percentages of students answering each question correctly in the test (Difficulty index) at AIMST University Vs JSSMC is shown in Fig. 1. Students at AIMST showed better performance in all questions of the test except three questions related to ERS, two questions related to GIT and one question related to CNS compared to students at JSSMC (Table 1). Nineteen of 25 questions (76%) were answered better by students in the hPBL curriculum (15 statistically significant and 4 not significant) compared to 6 questions answered better by students in TC (3 statistically significant and 3 not significant (Table 1 & Fig. 1).

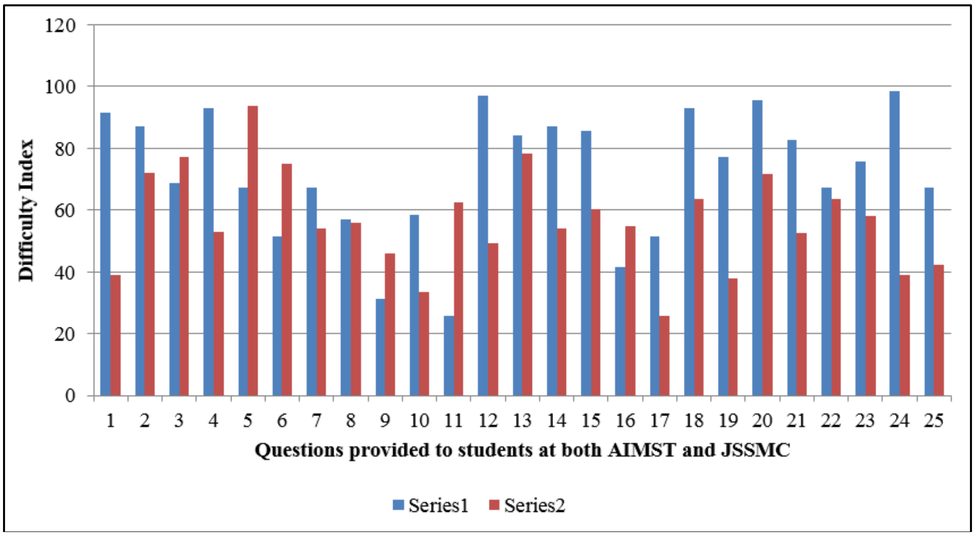

Fig. 1: Difficulty index of all questions between AIMST and JSSMC

Table 1: Performance of students at AIMST University and JSS medical College with respect to each question (Mean ± SD)

Question No.	AIMST	JSS	Significance
1	0.92±0.25	0.41±0.49	0.000*
2	0.87±0.33	0.72±0.44	0.035
3	0.70±0.46	0.78±0.41	0.249
4	0.92±0.25	0.52±0.50	0.000*
5	0.68±0.46	0.98±0.11	0.000*
6	0.51±0.50	0.70±0.46	0.024
7	0.67±0.47	0.58±0.49	0.297
8	0.57±0.49	0.50±0.50	0.400
9	0.31±0.46	0.44±0.50	0.119
10	0.58±0.49	0.35±0.48	0.007
11	0.25±0.44	0.64±0.48	0.000*
12	0.97±0.16	0.47±0.50	0.000*
13	0.84±0.36	0.74±0.44	0.146
14	0.87±0.33	0.64±0.48	0.001*
15	0.85±0.35	0.61±0.49	0.001*
16	0.41±0.49	0.57±0.49	0.064
17	0.51±0.50	0.21±0.41	0.000*
18	0.92±0.25	0.58±0.49	0.000*
19	0.77±0.42	0.44±0.50	0.000*
20	0.97±0.16	0.68±0.46	0.000*
21	0.82±0.37	0.48±0.50	0.000
22	0.67±0.47	0.61±0.49	0.484
23	0.80±0.40	0.62±0.48	0.025
24	0.98±0.11	0.32±0.47	0.000*
25	0.68±0.46	0.32±0.47	0.000*

**P<0.01*

Table 2: Grades of students at AIMST and JSSMC in the test (n=70).

Grade	Grade range	Number of students scoring each grade at AIMST(n=70)	Percentage of students (n%) scoring each grade at AIMST	Number of students scoring each grade at JSS (n=70)	Percentage of students (n%) scoring each grade at JSS
A	90.00 - 100.00	6	8.57	0	0
B	80.00 - 89.99	20	28.57	6	8.57
C	70.00 - 79.99	13	18.57	11	15.71
D	60.00 - 69.99	23	32.86	21	30
F	0.00 - 59.99	8	11.43	32	45.71

To cope up with the amount of information being added in medicine, knowledge must be gained and understood if it has to be applied to a clinical scenario and ultimately serve the future patients effectively.[8]

According to Fincher and others, many medical schools in this competitive setting have taken steps to integrate basic and clinical sciences more meaningfully to emphasize the importance of fundamental science in clinical decision making. They also suggest that the integration of fundamental sciences with clinical sciences is essential as both are interconnected and propose that attention should be paid not only in assessing students' mastery of knowledge from the fundamental sciences but also meaningful integration into the context of clinical decision making.[1]

Haranath in his review article on integrated teaching in medicine states that integrated teaching offers several advantages: basic sciences are simplified without needless details and taught along with clinical disciplines (9).

Having been exposed to basic biochemistry in first year followed by system based approach in year 2, with understanding the relevance of biochemical laboratory investigations in diagnosis of various diseases during PBL sessions, students at AIMST University were expected to have a thorough knowledge of biochemistry with its application and significance in diagnosis of diseases compared to students at JSSMC following TC.

In the current study, students in the hPBL curriculum answered questions related to CVS, RS and REH very well compared to those at JSSMC. However, the performance with respect to ERS, GIT and CNS was poor and, on comparing with a TC, the performance also was significantly low with students from the hPBL. More than 50% of students in the hPBL curriculum answered all the questions right except three compared to students in TC with eight questions being answered by <50% of the class emphasizing that >50% of students in the hPBL curriculum understood concepts and applications of biochemistry and were well prepared to interpret clinical scenarios using biochemistry knowledge before entering clinics.

Unlike the study by Sultan Ayoub Meo, with small sample size (30 students in each group) and all male, the current study consisted of 70 students each in the hPBL and TC with both male and female students participating (10). Results in the current study are also in par with that seen with Meo SA wherein, students in PBL curriculum showed better performance in a test with MCQ than those in TC. Unlike the study by Meo SA where only the knowledge on respiratory physiology was tested, the current study tested ability of students to solve clinical scenarios related to all the systems of the body using biochemistry knowledge.

Study by Callis proved that students from a hybrid problem based learning curriculum were better able to apply basic science knowledge obtained during the first two years of dental school to a clinical scenario compared to students from a traditional curriculum.[11] They also concluded that using traditional assessment tools to measure the ability to integrate basic science information to clinical cases may not be appropriate and suggested considering problem based learning worth-while to increase retention and recall effects which is evident in the current study as well. Schmidt has concluded in his study that students showed better diagnostic competence when studied in problem based curriculum compared to those from the conventional curriculum which is obvious in the current study as well.[12]

It is also shown in other studies that students in the hPBL curriculum perform better with respect to MCQs than those in TC which is also seen with the current study. Since most of the qualifying exams around the globe (including USMLE step I and the NBME exams in the USA) are objective structured, which needs proper understanding, remembering, analyzing, applying and integrating the knowledge gained appropriately to patient presentation and findings, training the students to solve MCQs and testing them frequently using MCQs is urgently needed.

Williams JM in his review article has suggested that if exam performance is measured, PBL offers no advantage over TC, and concluded that PBL does not seem to result in greater performance compared with TC.[13] However, the current study demonstrates a better performance of students in hPBL curriculum compared to TC with respect to applying their biochemistry knowledge.

Clark CE in his review article has concluded that PBL is associated with better clinical and problem solving skills, promotes lifelong learning skills without sacrificing important areas of knowledge.[14] The same is also emphasized in the study by Schimdt that PBL and integrated curricula offer matter related to subject in an integrated fashion which encourages students to process information in an active way. This seems more important in attaining proficiency in diagnostic reasoning than the amount of self-directedness in a curriculum. Thompson AR and others found that an integrated learning environment facilitated student performance on questions that required information to be analyzed and/or applied.[15] This is also evident in the current study that students in hPBL curriculum performed better in most of the clinical problems with respect to all organ systems emphasizing that they will definitely be placed in a better position to solve real life clinical situations compared to students in TC.

To our knowledge, this study is the first of its kind wherein competency of students to interpret clinical case scenarios using biochemistry knowledge is being compared in an integrated curriculum with that of traditional curriculum in two different countries (Malaysia and India) compared to a study by Schmidt and others with close resemblance to the present one, where, though the subjects were from three different medical schools, they were from the same country, The Netherlands (Schmidt). The current study though compares the performance of students in TC versus those in hPBL similar to one by Callis et al however is different in testing the competency of students to diagnose 25 clinical scenarios using biochemistry knowledge, designed with respect to 6 systems in the body compared to testing the competence of students to answer questions related to all basic science subjects based on 2 clinical scenarios in the latter study.

The study has a few limitations. One is that the two groups were not equally educated with respect to their academics. Students from hPBL curriculum had completed two years of medical studies thus having knowledge on all basic sciences including anatomy, physiology, biochemistry, pharmacology, pathology, microbiology and statistics, whereas students from TC had completed only their first year with exposure to preclinical subjects including anatomy, physiology and biochemistry only. This was inevitable, as, by selecting students completing year 1 at AIMST, they would not have completed biochemistry course, which was one of the inclusion criteria for the study. On the other hand, it was not possible to wait for the students in TC to finish all their basic sciences (including pharmacology, pathology, and microbiology) which would be after an year and a half due to the highest possibility of them to forget biochemistry by then as well as they would have been exposed to clinical rotations simultaneously which was one of the exclusion criteria for the study. To meet the requirement for participation in the study, i.e., all students must have completed biochemistry, and students being from two different countries following different curricular models, the study design ended up in having different levels of academic exposure. A statistically significant performance in most of the questions by hPBL students compared to TC students points out the fact that preclinical basic science subjects need to be reinforced especially in the context of clinical cases or with respect to their importance in the functioning or pathophysiology of different systems to keep them better educated and prepare future doctors. The second drawback of the study was that students from hPBL and TC were not of the same age. This is because, students in India enter medical course after qualifying in medical entrance tests (comprising of physics, chemistry and biology) following pre-university studies at about 17 years of age. Thus on completing year 1 MBBS most of them were 18 years old. Unlike this, students in Malaysia complete their STPM comprising of physics, chemistry and biology (equivalent to pre-university in India) around 19 years of age and then enter medicine. Thus most of the students in hPBL curriculum from Malaysia were around 21 years old on completing their year 2 MBBS. Thus, though the student's age group in the two countries at the time of participation varied, their academic requirements to become eligible for medicine was the same as proposed by curriculum requirement studies by Schmidt and others.

The third drawback was that only 36% of the class completing year 2 in hPBL participated whereas almost all the students completing year 1 in TC participated in the study. Only the grades from 70 randomly selected students were used for comparison.

Students in hPBL curriculum answered all questions in CVS very well compared to those from TC. CVS was the first system in year 2 curriculum and had most of the biochemistry concepts repeated from year 1, notably the role of lipids and fatty acids in cardiovascular diseases (CVD) and the importance of enzymes in the diagnosis and treatment of CVD. RS, the second system, had one question related to acid base imbalance which was also answered very well by students in hPBL. Also there was another question in renal system related to acid base imbalance that was answered very well by the hPBL students compared to those from TC.

Of the six questions related to GIT, students from hPBL showed better performance in four compared to those from TC which was statistically significant ($p<0.001$, Table 1). This could be due to the fact that students in hPBL who had the knowledge of bilirubin metabolism in year 1 followed by studying its relevance with respect to GIT system in year 2 were better placed compared to students from TC who had only learnt metabolism but failed to correlate to clinical scenarios. hPBL students also had the advantage of revision compared to those from TC.

Performance of students from hPBL was better than students from TC in one question related to CNS, and was statistically significant ($p<0.001$ for Q 24). With respect to the question related to vitamin B12 deficiency as a part of fatty acid metabolism, students from TC having just finished metabolism were in a better position to answer the question compared to those from hPBL who had learnt metabolism one year earlier. Students in TC might have struggled with the medical terms and clinical correlations compared to students from hPBL who had a revision of these topics in year 2 following their introduction in year 1 (under vitamins in year 1 followed by their relevance in year 2 with respect to CNS).

Out of the eight questions related to endocrine and reproductive system, five were answered better by students in hPBL (Q 1, 14 & 17 statistically significant, Q7 and 13 better but not significant statistically) and three better by students in TC (Table 1) which included questions related to thyroid disorders, Cushing's disease and perimenopause (except Q 11 with $p < 0.001$, Q 3 and 16 were not significant statistically).

All the questions related to renal and hematology was answered better by students in hPBL.

Once students in TC enter the clinics, they will no longer be didactically exposed to biochemistry and its relevance/importance in patient diagnosis and care. So students in TC always feel that studying basic science a waste of time without realizing the importance of it. They need to have biochemistry reinforcement once again when they are exposed to the clinics to make them realize the importance of biochemistry in patient diagnosis and care and the application of knowledge gained in Biochemistry. Also it is evident that greater the duration of exposure in Biochemistry, the better is the performance and application of knowledge. In India, the MCI guidelines mandate examination in Biochemistry to be held at the end of first year before the students are exposed to clinical postings. Hence, the relevance of Biochemistry to medicine is not realized by a student which could be a limitation not just because of the traditional curriculum but due to the timing of assessment.

Conclusion

Based on the above findings it is evident that students from hPBL curriculum showed better competency to interpret clinical scenarios with respect to all systems.

Abbreviation: TC: Traditional curriculum, hPBL (hybrid Problem based learning).

Conflict of Interest: None.

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How to cite this article: Gowda VBS, Vishwanath P, Nagaiah BH, Sengodan B, Doddamani P. Study of competency to interpret biochemistry case scenarios by medical students in integrated Vs traditional curriculum. *Int J Clin Biochem Res* 2019;6(1):129-134.