RESEARCH PAPER

Analysis of Teaching–Learning Methodology and Assessments Among Undergraduate Medical Students in Biochemistry: An Observational Study

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ABSTRACT

Background: Biochemistry is often perceived by undergraduate medical students as abstract and content-heavy. Understanding students' preferences for teaching-learning methods and their perceptions of assessment practices can guide curriculum improvement in line with Competency-Based Medical Education (CBME). **Objectives:** To determine first-year MBBS students' preferred teaching-learning methods for different Biochemistry topics, to evaluate their perceptions of the current assessment system, and to gather feedback on the curriculum and student-teacher interaction. **Methods:** This cross-sectional observational study was conducted in the Department of Biochemistry, JGMMMC, Hubballi, after Institutional Ethics Committee approval. A structured, pre-validated 93-item questionnaire was administered via Google Forms to first-year MBBS students who had completed the Biochemistry curriculum. Of 150 students invited, 130 (86.7%) consented and completed the questionnaire. Descriptive statistics (frequencies, percentages, mean ± SD) were used for analysis. **Results:** Mean age was 19.88 ± 0.65 years. Didactic lectures were preferred for abstract topics (e.g., detoxification and nucleotide metabolism: 38.5%), while case-based learning and lectures were preferred for metabolism and enzymology, and lectures combined with video presentations for molecular biology. Formative assessment received the highest rating among assessment methods used. Prior knowledge was high for the Cell (84.6%) and Molecular Biology (61.5%), but low (~30%) for newer topics such as nutrition, minerals, and acid-base balance. Students rated interest (3.50 ± 0.76), conceptual understanding (3.50 ± 0.65), and audio-visual aids (3.15 ± 0.92) favourably, more so than blackboard teaching (2.42 ± 0.98); student-centred activity frequency was rated lowest among the positive-leaning items (2.81 ± 0.94). **Conclusion:** Students favour interactive, audio-visual, and case-based teaching-learning methods and formative assessment in Biochemistry, with preference varying meaningfully by topic. Strengthening student-centred activities and targeting comparatively unfamiliar topics for additional support, in line with CBME, may enhance engagement and competency acquisition.

Key words: *Biochemistry education; Teaching-learning methods; Assessment; Competency-based medical education; Undergraduate medical students.*

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INTRODUCTION

Medicine is an extensive field of study, and medical students often find it challenging to complete the required syllabus within the allotted time. To make the learning process more meaningful, educators must explore innovative strategies. Along with traditional teaching approaches, the integration of modern technologies can greatly enhance students' comprehension of a subject and its clinical relevance. Over the past decade, medical education has undergone a major transformation, shifting from teacher-centred instruction to a more student-focused model.[1] Medical educators therefore have a

responsibility to address each learner's unique academic needs, since students vary widely in their knowledge base, skills, attitudes, preparation, backgrounds, comprehension abilities, and access to new technologies. Understanding students' preferred teaching methods has accordingly become essential.[2]

Biochemistry forms a foundational pillar of undergraduate medical education, bridging basic sciences with clinical application. However, traditional teaching-learning methods in Biochemistry have often been perceived by students as content-heavy, abstract, and less clinically relevant, leading to reduced engagement and superficial learning. In recent years there has been a paradigm shift toward student-centred learning approaches — including self-directed learning (SDL), problem-based learning (PBL), and closer integration with clinical contexts — aimed at enhancing understanding, retention, and application of knowledge. Contemporary teaching-learning approaches available to achieve this include video excerpts, problem-based learning, seminars, early clinical exposure, hospital and laboratory visits, debates, quizzes, and group discussions.

Assessment methods play an equally crucial role in shaping learning behaviour, since "assessment drives learning."[3] Conventional assessment strategies that rely heavily on summative examinations may not adequately capture higher-order cognitive skills or promote continuous learning. In contrast, formative assessment, structured feedback, and the competency-based evaluation framework advocated by the National Medical Commission (NMC) seek to align assessment with the desired learning outcomes of the Indian Medical Graduate.[4]

Understanding students' perceptions of teaching-learning methodologies and assessment practices is essential for curriculum improvement, since learner feedback provides valuable insight into the effectiveness, acceptability, and limitations of current educational strategies. An observational study conducted after completion of an academic year allows a comprehensive evaluation of cumulative learning experience and assessment exposure, and may also reveal differences in preference for a particular teaching-learning method depending on the topic at hand.

With these considerations in mind, the present study was carried out among first-year MBBS students to explore their preferences regarding the teaching-learning strategies used for various Biochemistry topics, following completion of their academic year. The objectives were: (a) to determine which teaching-learning methods students favour for different content areas of Biochemistry; (b) to evaluate students' perceptions of the current assessment system; and (c) to gather structured feedback from first-year MBBS students on the existing curriculum and on student-teacher interaction, in line with Competency-Based Medical Education (CBME) principles.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional observational study was conducted in the Department of Biochemistry, Jagadguru Gangadhar Mahaswamigalu Moorusaviramath Medical College (JGMMMC), Hubballi, among first-year undergraduate medical students who had just completed the Biochemistry curriculum. The study was initiated after obtaining approval from the Institutional Ethics Committee.

Study Participants

All 150 first-year MBBS students of the batch were invited to participate. Participation was voluntary, and informed consent was obtained prior to data collection. Of these, 130 students (86.7%) consented and completed the questionnaire; their responses were included in the final analysis. Students who did not provide consent or submitted incomplete responses were excluded.

Data Collection Tool

Data were collected using a structured, pre-validated questionnaire comprising 93 items, developed following a review of the literature and Competency-Based Medical Education (CBME) guidelines. The questionnaire was reviewed and validated by two internal and two external senior faculty members prior to administration. It covered the following domains:

- Preferred teaching-learning method for individual Biochemistry topics
- Preferred/most useful assessment method among those used through the year
- Self-rated prior knowledge of individual topics before starting the MBBS curriculum
- Perception of, and satisfaction with, teaching-learning methods and assessment practices, recorded on a 5-point Likert scale (strongly disagree to strongly agree)
- Open-ended items for qualitative feedback

Data Collection Procedure

The questionnaire was administered electronically via Google Forms at the end of the academic year. Anonymity and confidentiality of responses were maintained throughout. Data were exported to Microsoft Excel for analysis.

Statistical Analysis

Descriptive statistics were computed, including frequencies and percentages for categorical items, and

mean ± standard deviation (SD) for Likert-scale items. Where relevant, Likert-scale responses were grouped into three categories (agree, neutral, disagree) for ease of interpretation. Graphical representations, including bar charts, were used to depict response distributions. Missing data were excluded from item-wise analysis.

Ethical Considerations

The study was conducted in accordance with ethical principles for biomedical research. Institutional Ethics Committee clearance was obtained prior to study initiation. Participation was voluntary, and no personal identifiers were collected, in order to maintain confidentiality.

RESULTS

Participant Characteristics

Of the 150 first-year MBBS students in the batch, 130 (86.7%) consented to participate and completed the questionnaire; all 130 responses were complete and included in the final analysis. The mean age of participants was 19.88 ± 0.65 years, reflecting a relatively homogeneous cohort typical of first-year medical students.

Preferred Teaching-Learning Method by Topic

Preferences for teaching-learning methods varied by topic area (Table 1). For topics such as detoxification and nucleotide metabolism, students preferred didactic lectures (38.5%), followed by group discussions (30.8%). Case-based learning and lectures were the preferred modes for metabolism and enzymology topics. Molecular biology was preferred to be taught through lectures combined with video presentations. Vitamin and mineral nutrition, organ function tests, cancer biology, and acid-base balance were preferred to be taught using a combination of lectures and case-based learning.

Table 1: Preferred teaching-learning method by Biochemistry topic area (n = 130)

Topic area	Preferred teaching-learning method
Detoxification, Nucleotide metabolism	Didactic lectures (38.5%); Group discussion (30.8%)
Metabolism, Enzymology	Case-based learning and lectures
Molecular Biology	Lectures with video presentations
Vitamins & Mineral Nutrition, Organ Function Tests, Cancer Biology, Acid-Base Balance	Lectures and case-based learning

Preferred Assessment Methods

Several assessment methods were used through the academic year, including formative assessments, summative assessments, seminars, viva voce, MCQ tests, and tutorial/short tests. Among these, formative assessments — conducted monthly on topics covered — received the highest rating from students.

Self-Rated Prior Knowledge by Topic

Students reported varying levels of prior knowledge across topics before starting the MBBS curriculum (Figure 1, Table 2). A large majority (84.6%) reported good prior knowledge of the Cell, while only about 30–35% reported good prior knowledge of the chemistry of lipids and carbohydrates, and 30.8% of enzymology. Notably, 61.5% of students reported good prior knowledge of molecular biology. In contrast, topics such as nutrition, vitamins, minerals, free radicals and antioxidants, organ function tests, extracellular matrix, and acid-base and fluid-electrolyte balance were comparatively newer to students, with only about 30% reporting good prior knowledge.

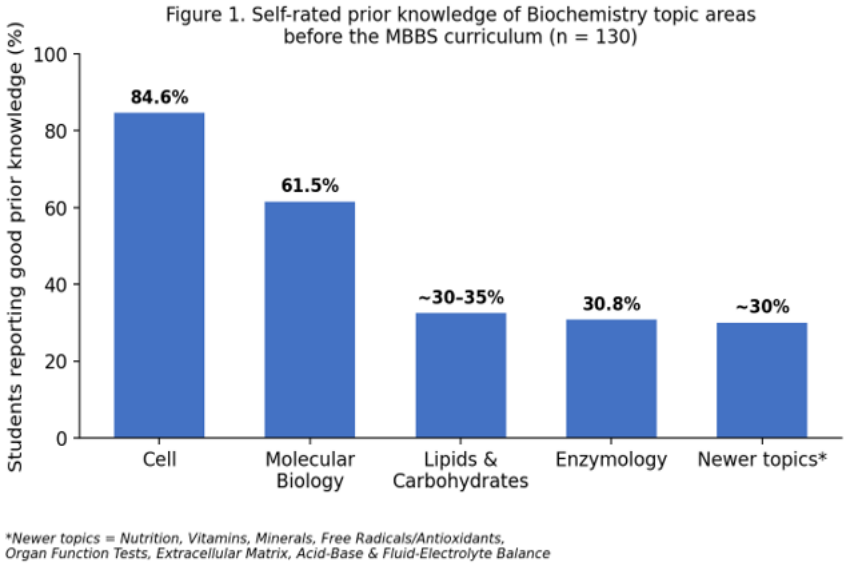


Figure 1: Self-rated prior knowledge of Biochemistry topic areas before the MBBS curriculum (n = 130)

Table 2: Self-rated prior knowledge by topic area (n = 130)

Topic area	Students reporting good prior knowledge
Cell	84.6%
Molecular Biology	61.5%
Chemistry of Lipids and Carbohydrates	~30–35%
Enzymology	30.8%
Nutrition, Vitamins, Minerals, Free Radicals/Antioxidants, Organ Function Tests, Extracellular Matrix, Acid-Base & Fluid-Electrolyte Balance	~30%

Perception of Teaching-Learning Methods and Assessment (Likert-Scale Items)

Students demonstrated a moderately positive perception of the teaching-learning methods used (Table 3, Figure 2). The mean score for interest in Biochemistry was 3.50 ± 0.76, indicating favourable engagement, and conceptual understanding was similarly rated (3.50 ± 0.65). Audio-visual (AV) aids received a mean score of 3.15 ± 0.92, notably higher than blackboard/whiteboard teaching (2.42 ± 0.98). Group discussions were positively rated (3.15 ± 0.78), while the frequency of student-centred activities scored lower (2.81 ± 0.94), suggesting scope for improvement. Among specific teaching modalities, the overall ideal-teaching-method score was 3.62 ± 0.57, tutorials scored 3.23 ± 0.71, and assignments scored 3.27 ± 1.04 (the higher SD for assignments indicating more variable student experience). Responses regarding assessment practices clustered between mean values of 3.0 and 3.6, indicating general, if not uniform, agreement with their effectiveness.

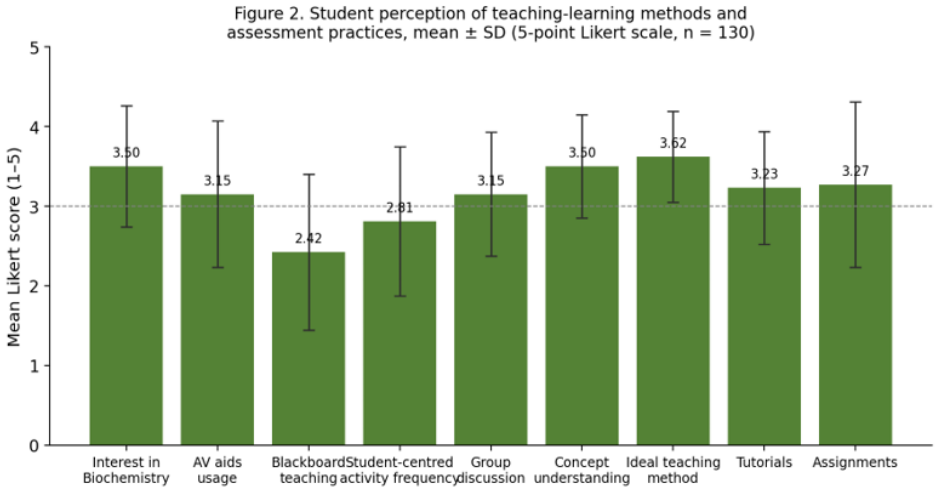


Figure 2. Student perception of teaching-learning methods and assessment practices, mean ± SD (5-point Likert scale, n = 130)

Table 3: Descriptive statistics of student perceptions regarding teaching-learning and assessment methods (n = 130)

Variable	Mean ± SD
Interest in Biochemistry	3.50 ± 0.76
AV aids usage	3.15 ± 0.92
Blackboard teaching	2.42 ± 0.98
Student-centred activity frequency	2.81 ± 0.94
Group discussion	3.15 ± 0.78
Concept understanding	3.50 ± 0.65
Ideal teaching method	3.62 ± 0.57
Tutorials	3.23 ± 0.71
Assignments	3.27 ± 1.04

DISCUSSION

The present study evaluated undergraduate medical students' perceptions of teaching-learning methodologies and assessment practices in Biochemistry following completion of their academic year, and additionally explored how these preferences varied by topic. The findings indicate an overall moderately positive perception, with clear preferences for interactive, audio-visual, and case-based learning approaches over traditional didactic and blackboard-based teaching for most topics — though didactic lectures remained preferred for more abstract, fact-dense topics such as detoxification and nucleotide metabolism.

A key observation is the favourable student interest (mean 3.50 ± 0.76) and good conceptual understanding (3.50 ± 0.65) in Biochemistry overall, despite the subject's reputation as abstract and content-heavy. This suggests that appropriately chosen teaching strategies — matched to topic, as our topic-wise preference data suggest — can meaningfully enhance engagement. Harden similarly emphasised the importance of integrating teaching methods to improve learner motivation and comprehension.[5]

Students showed a clear preference for audio-visual aids (3.15 ± 0.92) over traditional blackboard teaching (2.42 ± 0.98), consistent with Mayer's observation that multimedia learning enhances understanding by engaging multiple cognitive pathways.[6] This is further reflected in the topic-wise data: molecular biology, a topic many students already felt relatively confident about (61.5% reporting good prior knowledge), was nonetheless preferred to be taught using lectures combined with video presentations rather than lectures alone — suggesting that, even for familiar content, multimedia reinforcement is valued.

Interactive strategies such as group discussions (3.15 ± 0.78) and tutorials (3.23 ± 0.71) were positively perceived, and case-based learning emerged as a preferred method for metabolism, enzymology, and several other topic areas. This reinforces the principle of constructive alignment described by Biggs, wherein teaching methods are aligned with desired learning outcomes to promote deep learning.[7] However, the moderate rating for the frequency of student-centred activities (2.81 ± 0.94) indicates that, although such approaches are valued by students, they may not be sufficiently implemented in the current curriculum — a gap also visible in the preference data for the more abstract early topics (detoxification, nucleotide metabolism), where lectures still predominate, possibly by default rather than genuine preference.

Assessment practices were perceived as moderately effective, with most Likert responses clustering between 3.0 and 3.6, and formative assessment — conducted monthly on topics covered — rated as the single most valued assessment method. This is in

keeping with the principle that "assessment drives learning,"[3] and supports Nicol and Macfarlane-Dick's emphasis on the role of formative assessment and timely feedback in promoting self-regulated learning.[8] The variability in Likert responses on assessment items, however, suggests inconsistencies in how feedback is delivered or perceived across topics, pointing to an area for structured improvement.

The self-rated prior-knowledge data add an additional, topic-specific dimension often missing from perception studies of this kind. Topics such as nutrition, vitamins and minerals, free radicals and antioxidants, organ function tests, extracellular matrix, and acid-base and fluid-electrolyte balance were consistently identified as newer to students (~30% reporting good prior knowledge), in contrast to the Cell (84.6%) and, interestingly, molecular biology (61.5%) — likely reflecting prior exposure through school-level biology and increasing general familiarity with molecular biology concepts, respectively. These comparatively unfamiliar topics represent a logical priority for additional teaching-learning support (for example, structured case-based sessions, peer-assisted learning, or short targeted remedial sessions) rather than spreading limited curricular time evenly across all topics.

Taken together, these findings align with the Competency-Based Medical Education (CBME) framework advocated by the National Medical Commission, which emphasises student-centred learning, horizontal and vertical integration, and continuous assessment.[4] The observed gaps — in the frequency of student-centred activities and in prior knowledge of specific newer topics — highlight concrete areas where CBME implementation in Biochemistry can be strengthened.

LIMITATIONS

This study was conducted at a single institution within a single batch of first-year MBBS students, which may limit the generalisability of the findings to other settings or cohorts. Self-reported Likert-scale data are subject to recall and social-desirability bias, particularly as the questionnaire was administered retrospectively after completion of the academic year. The topic-wise preference data, while informative, were not uniformly quantified across all topic areas in the instrument used, limiting direct statistical comparison between topics. Future multi-centric studies with longitudinal follow-up and a fully quantified topic-wise instrument would help confirm and extend these findings.

CONCLUSION

The present findings reinforce the growing evidence that active, learner-centred strategies — audio-visual aids, case-based learning, and group discussion — combined with well-aligned, formative-assessment-led evaluation, are valued by undergraduate medical students and are associated with better self-reported interest and conceptual understanding in Biochemistry. Teaching-learning method preference was not uniform across topics: abstract, fact-dense topics leaned toward didactic lecture, while applied and clinically relevant topics favoured case-based learning, and topics with pre-existing exposure (molecular biology) still benefited from multimedia reinforcement. Topics identified as comparatively unfamiliar to students — including nutrition, minerals, free radicals/antioxidants, organ function tests, extracellular matrix, and acid-base/fluid-electrolyte balance — represent priority areas for additional, targeted teaching-learning support. Strengthening student-centred activities and structured formative feedback, in line with CBME principles, will likely improve both student satisfaction and competency development in Biochemistry.

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