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Effectiveness of Incorporation of MCQs in Traditional Didactic Lecture of Phase I MBBS Students

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ABSTRACT

Background: The introduction of Competency-Based Medical Education (CBME) by the National Medical Council in 2019 aimed to modernize and standardize medical education in India, prompting the adoption of holistic and innovative teaching methods. Among the fundamental subjects, Biochemistry presents significant challenges for first-year MBBS students due to its complex concepts. Traditionally, didactic lectures have dominated the curriculum but often fail to engage students effectively. Integrating multiple-choice questions (MCQs) within lectures could potentially enhance student engagement and learning outcomes.
Objectives: The primary objective was to evaluate the impact of interactive lectures with MCQs versus Traditional Didactic Lectures (TDL) on student performance in Biochemistry among first-year MBBS students. The secondary objective was to assess student perceptions of MCQ interactive lectures compared to traditional lectures as learning methods for Biochemistry.
Methods: This prospective study was conducted at Chamarajanagar Institute of Medical Sciences, involving 150 first-year MBBS students randomly divided into two equal groups. Group I received interactive lectures with MCQs, while Group II received TDL without MCQs. Both groups completed pre-test and post-test MCQs to assess performance. Student perceptions were evaluated using a Likert scale. Data were analyzed using SPSS version 22 and Epi-info version 7.2.1, with chi-square tests for categorical data and p-values <0.05 considered statistically significant.
Results: Pre-test comparisons showed no significant differences between groups in baseline knowledge. Post-test results revealed several significant differences favoring the SLO group, particularly in identifying specific biochemical functions and liver disease markers. The SLO group demonstrated significantly better performance in identifying correct responses ($p < 0.05$ for several questions). Perception analysis indicated higher positive responses in the SLO group, particularly in questions related to the effectiveness and engagement of the teaching method ($p < 0.05$).
Conclusion: The incorporation of MCQs in traditional didactic lectures significantly improved student performance and satisfaction in Biochemistry education. These findings support the use of interactive teaching methods to enhance learning outcomes. Future studies should explore the long-term effects and applicability across different medical subjects.

Keywords: *Competency-Based Medical Education, MCQs, Didactic Lectures, Biochemistry, Medical Education, Student Performance, Student Perceptions, Interactive Learning.*

INTRODUCTION

The introduction of Competency-Based Medical Education (CBME) by the National Medical Council in 2019 aimed to modernize and standardize medical education in India, prompting medical institutions to adopt holistic and innovative teaching methods[1]. Across the country, medical educators are now exploring new approaches to train well-rounded and competent medical graduates[2].

The first year of the medical curriculum poses a significant challenge to MBBS students as they delve into the realms of human Anatomy, Physiology, and Biochemistry for the first time. Mastering medical terminology and concepts becomes paramount. Among the fundamental subjects, Biochemistry delves into the intricacies of various bodily mechanisms at cellular and genetic levels, both in health and disease[3]. Teaching this subject effectively is not only interesting but also presents challenges[4].

Traditionally, didactic lectures have dominated, constituting approximately 34% of the total teaching hours in the latest curriculum[5]. However, this passive teaching method often struggles to captivate students' attention and promote content retention[6]. Introducing interactive elements within these lectures can enhance their effectiveness, though engaging a large group can pose logistical challenges[7]. Integrating multiple-choice questions (MCQs) at the conclusion of lectures serves multiple purposes. Not only does it highlight key topics for students to focus on, but it also stimulates their cognitive processes, encouraging them to recall and consolidate what they have learned[8].

Despite MCQs being a staple in summative assessments, their potential within didactic lecture sessions remains under-explored[9]. Thus, this study seeks to explore the feasibility and benefits of incorporating MCQs into large group didactic lectures, aiming to enhance student engagement and learning outcomes.

Hence, this study was conducted with the primary objective of evaluating the impact of interactive lectures with MCQs versus Traditional Didactic Lectures (TDL) on student performance in Biochemistry among first-year MBBS students. The secondary objective was to assess student perceptions of MCQ interactive lectures compared to traditional lectures as learning methods for Biochemistry.

MATERIAL AND METHODS

This prospective study was carried out at Chamarajanagar Institute of Medical Sciences, Chamarajanagar, following approval from the Institutional Ethics Committee. Four faculty members from the Department of Biochemistry conducted the study. Three faculty members were assigned to prepare MCQs and internally validate the protocol. One faculty member provided technical assistance, including Google form uploading and documentation. The didactic lecture topic was determined by the teaching schedule for the day of the study. Ten application-based and higher-order thinking MCQs were given to both groups before and after the TDL sessions.

Following the TDL session, 150 students were randomly selected using a computer program and split into two equal groups. After the lecture, five additional SLO-based multiple-choice questions (MCQs) and a TDL were given to 75 students (Group I). MCQs based on SLO were not integrated for the additional 75 students (Group II). In two sessions, the MCQ scores for each group were recorded.

After recording their scores on ten baseline multiple-choice questions, Group 2 students underwent the same process as Group 1 to participate in the interactive lecture with MCQs mentioned above.

For perception analysis, both groups were assessed using the Likert scale. Students with incomplete MCQ answers and Supplementary batch students of Ist MBBS were excluded from the study.

Data were entered into Microsoft Excel and analyzed using SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) and Epi-info version 7.2.1 (CDC Atlanta) software. Categorical data were represented as frequencies and proportions, and the chi-square test was used to determine the significance of qualitative data. Continuous data were represented as mean and standard deviation. Graphical representations, including bar diagrams, were created using MS Excel and MS Word. A p-value of <0.05 was considered statistically significant, adhering to all rules of statistical tests (10,11).

RESULTS

Table 1: Profile of students in both groups

		Group				P value
		Cases (SLO)		Controls (Conventional)		
		Count	%	Count	%	
Age	19.00	62	82.7%	60	80.0%	0.675
	20.00	13	17.3%	15	20.0%	
Gender	Male	38	50.7%	34	45.3%	0.513
	Female	37	49.3%	41	54.7%	

Pearson Chi-Square Tests

The age and gender distributions between the SLO and Conventional groups showed no significant differences, with p-values of .675 for age and .513 for gender, indicating comparable profiles across groups.

Table 2: Response to Questions comparison between two groups at Pre-test

		Group				P value
		Cases (SLO)		Controls (Conventional)		
		Count	%	Count	%	
1.Patient with infective hepatitis have all the following findings, except:	Absence Of Bile Salts In Urine	47	62.7%	48	64.0%	0.805
	Bilirubinuria	6	8.0%	4	5.3%	
	Elevated AST	10	13.3%	13	17.3%	
	Hyperbilirubinemia	12	16.0%	10	13.3%	
2. Following are the synthetic function of liver, except:	Bile Salts	7	9.3%	4	5.3%	0.208
	Cholesterol	16	21.3%	8	10.7%	
	Clotting Factor- Iii	40	53.3%	49	65.3%	
	Plasma Proteins	12	16.0%	14	18.7%	
3.Liver enlargement occurs in	All Above	72	96.0%	70	93.3%	0.147
	Fatty Liver	0	0.0%	3	4.0%	
	Hepatitis	1	1.3%	2	2.7%	
	Tumours Of The Liver	2	2.7%	0	0.0%	
4.Conjugated hyperbilirubinemia with raised alkaline phosphatase levels are characteristics of	Haemolytic Jaundice	15	20.0%	12	16.0%	0.579
	Obstructive Jaundice	48	64.0%	52	69.3%	
	Physiological Jaundice	1	1.3%	3	4.0%	
	Viral Hepatitis	11	14.7%	8	10.7%	
5.An increase in serum unconjugated bilirubin occurs in:	Defect In Intestinal Absorption	4	5.3%	4	5.3%	0.897
	Glomerulonephritis	1	1.3%	1	1.3%	
	Haemolytic Jaundice	54	72.0%	50	66.7%	
	Obstructive Jaundice	16	21.3%	20	26.7%	
6.All are features of Obstructive jaundice, except:	Clay Coloured Stools	17	22.7%	14	18.7%	0.332
	Increased Excretion Of Urobilinogen In Urine	29	38.7%	24	32.0%	
	Increased Level Of Conjugated Bilirubin In Blood	15	20.0%	25	33.3%	
	Presence Of Bile Salts In Urine	14	18.7%	12	16.0%	
7. Which enzyme test is more specific for parenchymal liver disease?	Acid Phosphatase	16	21.3%	14	18.7%	0.547
	Alanine Aminotransferase	48	64.0%	52	69.3%	
	Amylase	3	4.0%	5	6.7%	
	Lactate Dehydrogenase	8	10.7%	4	5.3%	
8.All the following biochemical parameters are indices of liver function, except:	Albumin	11	14.7%	22	29.3%	0.159
	Bilirubin	4	5.3%	3	4.0%	
	Cholesterol	14	18.7%	9	12.0%	
	Creatinine	46	61.3%	41	54.7%	
9. following enzymes are markers of liver diseases, except:	ALP	3	4.0%	1	1.3%	0.634
	AST	8	10.7%	9	12.0%	
	CPK	37	49.3%	33	44.0%	
	GGT	27	36.0%	32	42.7%	
10. Clinical jaundice occurs when serum total bilirubin is more than	1 mg/dl	16	21.3%	17	22.7%	0.612
	2 mg/dl	44	58.7%	37	49.3%	
	5 mg/dl	11	14.7%	14	18.7%	
	10 mg/dl	4	5.3%	7	9.3%	

Pearson Chi-Square Tests

The comparison of responses between the SLO and Conventional groups at pre-test across ten questions revealed no significant differences. For question 1, 62.7% of SLO and 64.0% of Conventional participants correctly identified the absence of bile salts in urine as not a finding in infective hepatitis (p = 0.805). For question 2, 53.3% of SLO and 65.3% of Conventional participants correctly identified clotting factor-III as not a synthetic liver function (p = 0.208). For question 3, 96.0% of SLO and 93.3% of Conventional participants correctly indicated liver enlargement occurs in all conditions listed (p = 0.147). In question 4, 64.0% of SLO and 69.3% of Conventional participants correctly chose obstructive jaundice for conjugated hyperbilirubinemia with raised alkaline phosphatase (p = 0.579). The remaining questions also showed no significant differences in responses, indicating comparable baseline knowledge between the two groups across all assessed liver-related topics, as indicated by p-values greater than 0.05 for all comparisons.

Post Test analysis:

Table 3: Response to Questions comparison between two groups at Post-test

		Group				P value
		Cases (SLO) n = 66		Controls (Conventional) N = 67		
		Count	Column N %	Count	Column N %	
1.Patient with infective hepatitis have all the following findings, except:	Absence Of Bile Salts In Urine	2	3.0%	1	1.5%	0.124
	Hyperbilirubinemia	0	0.0%	1	1.5%	
	Absence Of Bile Salts In Urine [Correct Answer]	53	80.3%	40	59.7%	
	Bilirubinuria	4	6.1%	8	11.9%	
	Elevated AST	3	4.5%	7	10.4%	
	Hyperbilirubinemia	4	6.1%	10	14.9%	
2. Following are the synthetic function of liver, except:	Bile Salts	2	3.0%	10	14.9%	<0.001*
	Cholesterol	1	1.5%	11	16.4%	
	Clotting Factor- Iii [Correct Answer]	63	95.5%	41	61.2%	
	Plasma Proteins	0	0.0%	5	7.5%	
3.Liver enlargement occurs in	All Above	66	100.0%	67	100.0%	-
4.Conjugated hyperbilirubinemia with raised alkaline phosphatase levels are characteristics of	Haemolytic Jaundice	2	3.0%	2	3.0%	1.000
	Obstructive Jaundice [Correct Answer]	63	95.5%	64	95.5%	
	Viral Hepatitis	1	1.5%	1	1.5%	
5.An increase in serum unconjugated bilirubin occurs in:	Glomerulonephritis	1	1.5%	1	1.5%	0.694
	Haemolytic Jaundice [Correct Answer]	61	92.4%	64	95.5%	
	Obstructive Jaundice	4	6.1%	2	3.0%	
6.All are features of Obstructive jaundice, except:	Clay Coloured Stools	6	9.1%	9	13.4%	0.032*
	Increased Excretion Of Urobilinogen In Urine [Correct Answer]	57	86.4%	47	70.1%	
	Increased Level Of Conjugated Bilirubin In Blood	1	1.5%	0	0.0%	
	Presence Of Bile Salts In Urine	2	3.0%	11	16.4%	
7. Which enzyme test is more specific for parenchymal liver disease?	Acid Phosphatase	0	0.0%	1	1.5%	0.03*
	Alanine Aminotransferase	0	0.0%	7	10.4%	
	Lactate Dehydrogenase	0	0.0%	2	3.0%	
	Acid Phosphatase	3	4.5%	6	9.0%	
	Alanine Aminotransferase [Correct Answer]	60	90.9%	46	68.7%	
	Amylase	0	0.0%	1	1.5%	
	Lactate Dehydrogenase	3	4.5%	4	6.0%	
8.All the following biochemical parameters are indices of liver function, except:	Albumin	2	3.0%	4	6.0%	0.096
	Cholesterol	2	3.0%	8	11.9%	
	Creatinine [Correct Answer]	62	93.9%	55	82.1%	
9. following enzymes are markers of liver diseases, except:	AST	2	3.0%	1	1.5%	0.313
	CPK	64	97.0%	64	95.5%	
	GGT	0	0.0%	2	3.0%	

10. Clinical jaundice occurs when serum total bilirubin is more than	1 mg/dl	5	7.6%	18	26.9%	0.002*
	2 mg/dl [Correct Answer]	61	92.4%	46	68.7%	
	5 mg/dl	0	0.0%	3	4.5%	

Pearson Chi-Square Tests

The post-test comparison of responses between the SLO and Conventional groups revealed several significant differences:

1. **Patient with infective hepatitis have all the following findings, except:** A higher proportion of SLO participants (80.3%) correctly identified the absence of bile salts in urine compared to the Conventional group (59.7%), but the difference was not significant ($p = 0.124$).
2. **Following are the synthetic function of liver, except:** A significantly higher proportion of SLO participants (95.5%) correctly identified clotting factor-III compared to the Conventional group (61.2%) ($p < 0.001$).
3. **Liver enlargement occurs in:** All participants in both groups correctly identified that liver enlargement occurs in all conditions listed ($p = -$).
4. **Conjugated hyperbilirubinemia with raised alkaline phosphatase levels are characteristics of:** Both groups had an equal proportion of correct answers (95.5%) ($p = 1.000$).
5. **An increase in serum unconjugated bilirubin occurs in:** Both groups had high proportions of correct answers, with 92.4% for SLO and 95.5% for Conventional ($p = 0.694$).
6. **All are features of obstructive jaundice, except:** The SLO group (86.4%) performed better than the Conventional group (70.1%) in identifying the correct feature, with a significant difference ($p = 0.032$).
7. **Which enzyme test is more specific for parenchymal liver disease?:** The SLO group (90.9%) had a higher proportion of correct answers compared to the Conventional group (68.7%), with a significant difference ($p = 0.03$).
8. **All the following biochemical parameters are indices of liver function, except:** The SLO group (93.9%) had a higher proportion of correct answers compared to the Conventional group (82.1%), but the difference was not significant ($p = 0.096$).
9. **Following enzymes are markers of liver diseases, except:** Both groups had similar proportions of correct answers, with 97.0% for SLO and 95.5% for Conventional ($p = 0.313$).
10. **Clinical jaundice occurs when serum total bilirubin is more than:** The SLO group (92.4%) had a significantly higher proportion of correct answers compared to the Conventional group (68.7%) ($p = 0.002$).

Overall, the SLO group demonstrated significantly better performance in identifying correct responses to several questions compared to the Conventional group.

Table 4: Perception Comparison between two groups

		Group				P value
		Cases (SLO) n = 66		Controls (Conventional) N = 67		
		Count	Column N %	Count	Column N %	
Q1	May be	0	0.0%	3	4.5%	0.135
	No	1	1.5%	0	0.0%	
	Yes	65	98.5%	64	95.5%	
Q2	May be	2	3.0%	14	20.9%	0.004*
	No	1	1.5%	0	0.0%	
	Yes	63	95.5%	53	79.1%	
Q3	May be	1	1.5%	3	4.5%	0.369
	No	1	1.5%	0	0.0%	
	Yes	64	97.0%	64	95.5%	
Q4	May be	3	4.5%	8	11.9%	0.188
	No	1	1.5%	0	0.0%	
	Yes	62	93.9%	59	88.1%	
Q5	May be	2	3.0%	6	9.0%	0.210
	No	0	0.0%	1	1.5%	
	Yes	64	97.0%	60	89.6%	
Q6	May be	4	6.1%	12	17.9%	0.006*
	No	0	0.0%	5	7.5%	
	Yes	62	93.9%	50	74.6%	
Q7	May be	5	7.6%	15	22.4%	0.057*
	No	1	1.5%	1	1.5%	
	Yes	60	90.9%	51	76.1%	

Q8	May be	4	6.1%	10	14.9%	0.096
	Yes	62	93.9%	57	85.1%	
Q9	May be	3	4.5%	4	6.0%	0.558
	No	1	1.5%	3	4.5%	
	Yes	62	93.9%	60	89.6%	
Q10	May be	2	3.0%	10	14.9%	0.057
	No	2	3.0%	2	3.0%	
	Yes	62	93.9%	55	82.1%	
Q11	May be	3	4.5%	4	6.0%	0.713
	Yes	63	95.5%	63	94.0%	
Q12	May be	5	7.6%	4	6.0%	0.933
	No	4	6.1%	4	6.0%	
	Yes	57	86.4%	59	88.1%	
Q13	May be	9	13.6%	16	23.9%	0.311
	No	7	10.6%	7	10.4%	
	Yes	50	75.8%	44	65.7%	
Q14	May be	4	6.1%	10	14.9%	0.144
	No	0	0.0%	1	1.5%	
	Yes	62	93.9%	56	83.6%	
Q15	May be	4	6.1%	9	13.4%	0.210
	No	0	0.0%	1	1.5%	
	Yes	62	93.9%	57	85.1%	
Q16	May be	6	9.1%	10	14.9%	0.585
	No	1	1.5%	1	1.5%	
	Yes	59	89.4%	56	83.6%	
Q17	May be	11	16.7%	22	32.8%	0.054
	No	28	42.4%	18	26.9%	
	Yes	27	40.9%	27	40.3%	
Q18	May be	4	6.1%	7	10.4%	0.348
	No	43	65.2%	47	70.1%	
	Yes	19	28.8%	13	19.4%	
Q19	May be	0	0.0%	4	6.0%	0.130
	No	54	81.8%	52	77.6%	
	Yes	12	18.2%	11	16.4%	
Q20	May be	2	3.0%	7	10.4%	0.191
	No	1	1.5%	2	3.0%	
	Yes	63	95.5%	58	86.6%	

The perception comparison between the SLO and Conventional groups revealed several significant differences. For question 1, the majority of both groups responded affirmatively, with no significant difference ($p = 0.135$). Question 2 showed a significant difference, with 95.5% of SLO and 79.1% of Conventional participants responding positively ($p = 0.004$). Question 6 also revealed a significant difference, with 93.9% of SLO and 74.6% of Conventional participants responding positively ($p = 0.006$). Although questions 7 and 10 approached significance, differences were not statistically significant ($p = 0.057$ each). Most questions did not show significant differences, indicating similar perceptions across groups. Specifically, questions 3, 4, 5, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20 showed no significant differences in responses between the two groups, with p-values greater than 0.05. Overall, the SLO group generally had higher positive perceptions compared to the Conventional group, particularly in questions 2 and 6.

Table 5: SLO Questions

		Count	%
1. When Serum Total Bilirubin	Jaundice	75	100.0%
2. Post Hepatic Jaundice Is	Regurgitation jaundice	74	98.7%
	Retention jaundice	1	1.3%
3. In Hepatocellular Injury	Alanine aminotransferase Unconjugated bilirubin	75	100.0%
4. Haemolytic Jaundice, ELE	Unconjugated bilirubin is more than	75	100.0%
5. Kernicterus Or Bilirubin Encephalopathy Occurs When:	10 mg/dl.	2	2.7%
	25 mg/dl.	73	97.3%

The majority of students demonstrated good understanding of the SLO-based questions. All students (100%) correctly answered questions related to serum total bilirubin, hepatocellular injury, and haemolytic jaundice. Nearly all participants (98.7%) correctly identified post-hepatic jaundice, with only 1.3% responding incorrectly. Similarly, 97.3% correctly identified the bilirubin level associated with kernicterus, while 2.7% selected an incorrect option. Overall, the results indicate strong conceptual clarity with minimal misconceptions.

DISCUSSION

This study aimed to evaluate the impact of incorporating interactive lectures with MCQs on student performance and perceptions compared to Traditional Didactic Lectures (TDL) among first-year MBBS students in Biochemistry. The primary objective focused on assessing student performance, while the secondary objective evaluated student perceptions.

The findings indicated no significant differences in age and gender distributions between the SLO and Conventional groups, ensuring comparable baseline characteristics ($p = 0.675$ for age; $p = 0.513$ for gender). This similarity allowed for a fair comparison of the educational interventions.

Pre-Test Comparison: The pre-test comparison revealed no significant differences between the groups across ten questions, suggesting comparable baseline knowledge in Biochemistry prior to intervention. Similar methodological approaches ensuring homogeneity between groups have been reported by Patel et al.[2]

Post-Test Comparison: The post-test results demonstrated several significant differences favouring the SLO group. The SLO group significantly outperformed the Conventional group in identifying clotting factor-III as not a synthetic liver function ($p < 0.001$) and in recognizing the most specific enzyme test for parenchymal liver disease ($p = 0.03$). These findings are consistent with previous research by Prince et al. and Brame & Biel et al., which suggest that interactive learning strategies, including MCQ integration, enhance student engagement and knowledge retention[7,8].

Additionally, the SLO group demonstrated significantly better performance in understanding features of obstructive jaundice ($p = 0.032$) and the criteria for clinical jaundice ($p = 0.002$). These findings highlight the effectiveness of interactive lectures in facilitating deeper conceptual understanding and application of complex biochemical principles.

Perception Analysis: The perception analysis revealed significant differences in selected domains, indicating a generally more favourable perception of the SLO method. Specifically, Question 2 ($p = 0.004$) and Question 6 ($p = 0.006$) showed statistically significant differences, with higher satisfaction reported in the SLO group. These results are in agreement with findings by Epstein et al., where interactive teaching approaches were associated with improved student satisfaction and perceived learning effectiveness[9].

However, most perception-related items did not show statistically significant differences, suggesting that while interactive lectures enhance certain aspects of learning experience, they may not substantially modify all dimensions of student perception. This observation is consistent with the work of Biggs et al., who emphasized that although innovative teaching strategies improve engagement, traditional lectures continue to play a meaningful role in structured content delivery[6].

CONCLUSION

Overall, this study supports the incorporation of MCQs in traditional didactic lectures as an effective strategy for improving student performance and satisfaction in Biochemistry education. Future studies should explore the long-term effects of such interventions and their applicability across different medical subjects and educational contexts.

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