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RESEARCH ARTICLE

Use of multiple choice questions during lectures helps medical students improve their performance in written formative assessment in physiology

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ABSTRACT

Background: Multiple choice questions (MCQs) play a pivotal role in various types of assessment in medical schools, due to the ease with which these can be administered and evaluated. Although primarily employed for assessment, the direct role of MCQ-assisted teaching learning (MATeL) may be explored among teachers and students as an aid to learning. **Aims and Objectives:** The present study endeavors to evaluate how MATeL helps students improve their performance and to explore the correlation between MCQ and short answer questions (SAQ) performance of students on a given topic of instruction in physiology. **Materials and Methods:** For MATeL topics, a total of 25 MCQs, based on five specific learning objectives, were discussed with 94 students of the 1st year Bachelor of Medicine and Bachelor of Surgery course, and in-depth evaluation of each of the correct choices was done during the lectures. For the non-MATeL topics, the students were advised to read up the topic before the lecture which was followed by an exhaustive discussion on the same. At the end of the lecture series, a formative written assessment was carried, and the MCQ and SAQ scores were analyzed for each of the students. **Results:** Mean scores for both SAQs and MCQs was significantly higher in MATeL than the non-MATeL topics (SAQs 5.31 vs. 4.36, $t = 2.5$; MCQs 7.18 vs. 6.68, $t = 5.23$). There was a good correlation between total MCQ and total SAQ scores for the students ($r = 0.34$, $P < 0.05$, 95% confidence interval: 0.15-0.51). For the non-MATeL topics, SAQ scores correlated with the MCQ scores but not for the MATeL topics. Students show improved scores in their formative written assessment when the lectures are assisted with use of MCQs, than when MCQs are not employed before and during the lecture. **Conclusions:** MCQs may form a vital component during teaching when delivering important concepts, and their use may not be restricted to the traditional role during the assessment.

KEY WORDS: Multiple Choice Questions; Teaching Learning; Formative Assessment

INTRODUCTION

Medical education endeavors to impart holistic training and to deliver effective skills to its students, in a manner that encompasses five levels of Bloom's classification at all stages of education.[1] Due to vastness of syllabus and no one proven method to impart this knowledge, there is a need to determine the most acceptable and practicable method to assist trainers while they engage with their students for a topic of instruction. Multiple choice questions (MCQs) are used very often for assessment of cognitive domain. Since there are several choices in an MCQ and one or more correct answers need to be determined, it entails the students to critically analyze each of the choices. While doing so, he/she processes the information, applies it to a context and derives useful inference out of it. Although primarily employed for

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assessment, MCQs may find favor both among teachers and students as an aid to learning, if these are well constructed to engage higher order thinking skills of the student. Earlier studies have explored the role of MCQ supplementation in learning, and the results have been encouraging. However, in most of these studies, conclusions were drawn from MCQ-based tests or feedback questionnaire from students.[2,3] However, the influence of this assistance through MCQs, during teaching on the final ability to synthesize and apply knowledge during assessment via short answer questions (SAQs), has not been clearly delineated. Since SAQs are open-ended questions, the students are required to recall, process, and frame their answers in a rational manner. Very few researchers have explored the direct role of MCQ-assisted teaching learning (MATeL) in writing SAQs. Hence, the present study endeavors to evaluate MCQ-assisted SAQ performance and explore the correlation between MCQ and SAQ performance of students on a given topic of instruction in physiology. We hypothesized that MCQ and SAQ scores of students during formative assessment would be better in topics that are covered by MATeL, than the topics which were not covered by MATeL.

MATERIALS AND METHODS

Academic Setting

The study was conducted in a medical college in Pune, Maharashtra, India, from August 2014 to March 2015, where 4½ years Bachelor of Medicine and Bachelor of Surgery (MBBS) curriculum, as defined by Maharashtra University of Health Sciences, is followed. The physiology course is conducted in the 1st year of MBBS, with a year-end summative assessment consisting of MCQs, SAQs, and long answer questions.

Selection of Subjects

The participants comprised 1st year MBBS students, who were attending a regular physiology course in the college. 135 students, including 25 female students with a mean (±standard deviation [SD]) age of 18 (±0.72) years, were recruited for the study. Exemption of ethical clearance was sought from Institutional Ethics Committee. Written informed consent was obtained from the participants. The students who were absent during the lectures or during formative assessment based on MCQs and SAQs during the study were excluded from data analysis (Figure 1).

Administration of MATeL

Based on university's must-know areas in hematology, 10 specific learning objectives (SLOs) were grouped into two categories, the first group included five topics that were assisted with discussion of MCQs (MATeL topics), whereas the second group consisted of another five topics that were not

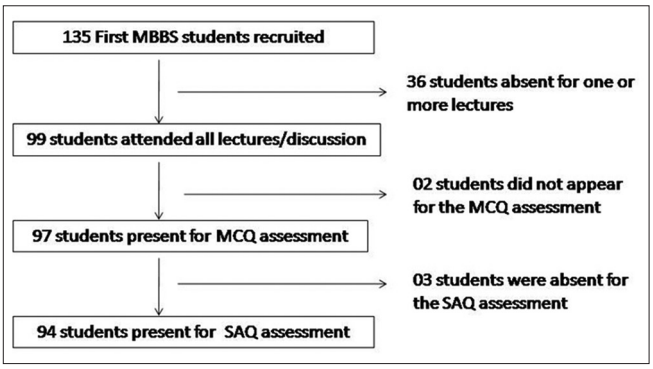


Figure 1: Flowchart to show recruitment of students: The line diagram represents the number of students eligible for the study and the reasons for non-participation at each stage

assisted with MCQs (non-MATeL topics) in the classroom. The reliability and validity of the questions were determined through peer review before the study. For the MATeL topics, a handout of five MCQs was handed over to students, a day before the scheduled class, on each of the selected SLOs to allow them to read about it or discuss among their peer group. This was followed by a lecture on the given topic and discussion in the classroom, of the MCQs already analyzed by the students. A total of 25 MCQs, based on five SLOs, were discussed with an in-depth evaluation of each of the correct choices. For the non-MATeL topics, the students were advised to read up the topic before the class and be prepared for an exhaustive discussion on the same. Another five SLOs were, thus, covered in this session of lectures, without any assistance of MCQs. At the end of the hematology lecture series, a formative assessment was carried out to ascertain the depth of understanding, and the ability to synthesize and apply this knowledge. The assessment consisted of twenty MCQs and four SAQs that were framed from SLOs of the two categories, with equal weightage to MATeL and non-MATeL topics. The students were allowed a maximum of 20 min each for MCQs and SAQs section and both the sections were of 20 marks each. Evaluation of answer scripts was done by the faculty, and the result was communicated to each of the students.

Statistical Analysis

MedCalc version 15.4 (MedCalc Software, Ostend, Belgium) software was used for statistical analysis. Descriptive statistics such as mean and SD were reported. Paired *t*-test was applied to detect a difference in mean scores in the MCQs and SAQs of MATeL and non-MATeL topics. Karl-Pearson's method was used to determine the correlation between MCQ and SAQ scores of each student for MATeL and non-MATeL topics. The results were taken as significant when $P < 0.05$.

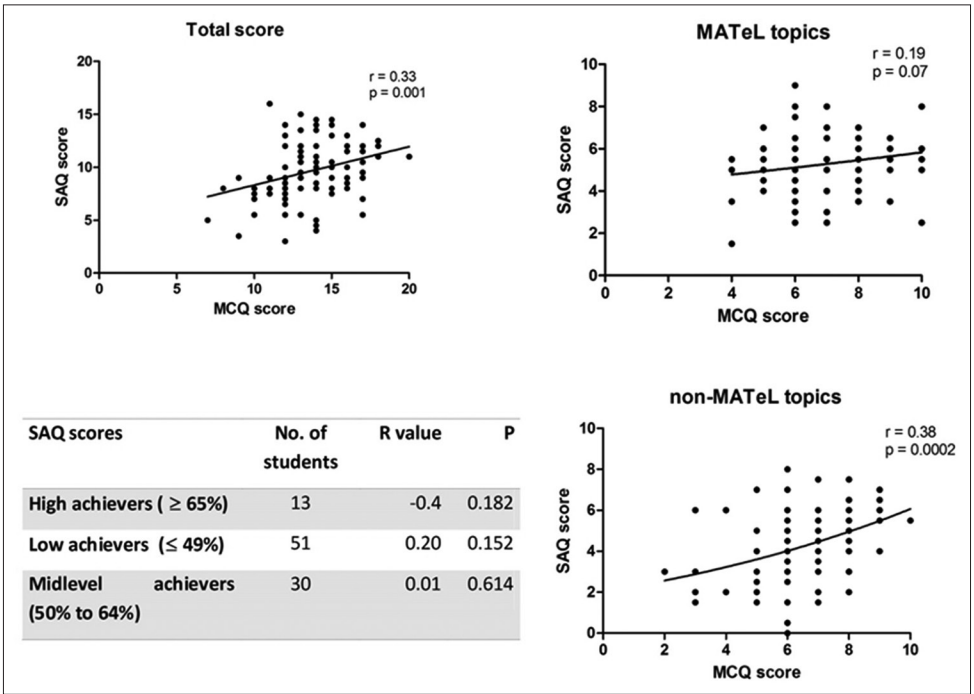
RESULTS

Of the 135 students recruited for the study, 41 students did not attend all the steps of the study, either due to absence during

lectures or during the formative assessment. Therefore, 94 students completed the study protocol and their scores from both MCQ and SAQ assessment were available for data analysis (Figure 1). Mean scores for both SAQs and MCQs were significantly higher in MATeL than the non-MATeL topics (Table 1). There was a good correlation between total MCQ and total SAQ scores for the students. For the non-MATeL topics, SAQ scores correlated with the MCQ scores but not for the MATeL topics (Figure 2). 13% of the total students had high scores in SAQ assessment, i.e., more than 65% marks, whereas 51% achieved <50% marks. In addition, when the students were grouped based on their level achievement in SAQs, their SAQ scores separately did not correlate with the MCQ scores when both the MATeL and non-MATeL topics were taken together.

DISCUSSION

Our study shows that students have significantly better scores in topics covered under the MATeL group than the non-MATeL group. These findings are significant in the backdrop of better performance in SAQs as well, which shows an improved ability of the students to analyze and interpret information, when aided with MCQs, during teaching. Well-constructed MCQs form an important tool to reinforce difficult concepts since it involves analysis of each of the choices and step-wise elimination of unacceptable possibilities.[4] Therefore, when MCQs are discussed during a lecture as part of instruction, the students get a chance to not only revise what has been taught but also to process the information in the given context. This phenomenon, thus, explains the finding that even SAQ



SAQ scores	No. of students	R value	P
High achievers (≥ 65%)	13	-0.4	0.182
Low achievers (≤ 49%)	51	0.20	0.152
Midlevel achievers (50% to 64%)	30	0.01	0.614

Figure 2: Graphic representation of correlation between scores: The graph depicts correlation (Pearson's method) between short answer questions (SAQ) scores and multiple choice questions (MCQ) scores obtained by students in the formative assessment based on both MCQ-assisted teaching learning (MATeL) and non-MATeL topics. The Table shows the break-up of students' scores based on their level of achievement in the SAQs and its correlation with their MCQ scores

Table 1: SAQ and MCQ scores of students in MATeL and non-MATeL topics

Score	Total score (score out of 20)	MATeL topics (score out of 10)	Non-MATeL topics (score out of 10)	Difference between means for MATeL and non-MATeL topics (95% CI) *t*-test statistic
SAQ scores	9.72±2.77	5.31±1.48	4.36±1.18	0.95 (0.6-1.31) 2.5*
MCQ scores	13.9±2.49	7.18±1.55	6.68±1.56	0.5 (0.05 to 0.95) 5.23*
Correlation between MCQ and SAQ scores: "*r*" value (95% CI)	0.34* (0.15-0.51)	0.19 (0.01-0.38)	0.38* (0.19-0.54)	-

All scores are represented as mean±standard deviation; difference between means is represented by the value (95% CI), *t*-test statistic; Correlation is shown by Pearson's correlation coefficient (95% CI); *$P \leq 0.05$. MCQs: Multiple choice questions, SAQs: Short answer questions, CI: Confidence interval, MATeL: Multiple choice questions-assisted teaching learning

scores in the MATeL topics were better than non-MATeL topics. SAQs consist of open-ended questions, where the student is required to comprehend, interpret, and synthesize the acquired information into a logical framework, for it to be clearly understood and applied in perspective. Thus, with our study, we show that all the aspects of knowledge application and comprehension are improved when students actively engage before and during the lecture with the help of MCQs.

Another vital aspect of our intervention was giving out the unsolved MCQs to the students before the class for MATeL topics and allowing them to read and discuss before the lecture. This gave direction to the students during their preparation before the lecture and resulted in better assimilation of the concepts. To avoid undue bias against the non-MATeL topics, the students were briefed about the study SLOs and the importance of reading before the scheduled lecture was reiterated. The choice of SLOs for the two groups was such that there was no overlap in the five topics under MATeL and non-MATeL groups, and each group was matched for level of difficulty. In addition, all the topics were chosen from hematology to avoid any confounder due to the wide difference in the type of topics discussed. Administration of MATeL was done by the same instructor, as the one who also covered non-MATeL topics.

Curriculum defines assessment and for assessing various domains of learning, different methodologies are being explored and practiced by educators. MCQs are the preferred mode of assessment for large-scale assessment such as entrance exams due to several reasons such as the ease of delivery, evaluation, and faster result compilation by software facilitated checking. We found a good correlation between the overall performance of students in MCQ and SAQ, which is in concurrence with a study done by Walke and coworkers, who concluded that since there is a strong correlation between MCQ and SAQ performance, SAQs are as effective as MCQs in assessing the performance of their students.[5] However, our study sheds light on the fact that this may not be true for all students since the inherent ability to process and imbibe knowledge is different in individuals. When we divided the students into groups based on their performance in SAQs, we found no correlation in their scores. Furthermore, any correlation ceased to exist for the MATeL topics since the student scores improved greatly for the SAQs than MCQs. This was surprising in light of the fact that the SAQs were never discussed during the lectures, and it was the pre-lecture initiation and in-class discussion of MCQs that helped the students perform better during the formative assessment. Therefore, it is worthwhile to include various types of questions in formative assessment since no one method of evaluation is completely valid; and a single score may not apply to differently - performing students in class.[6] Pepple et al., found a significant correlation during regression analysis of the average scores obtained in MCQ and SAQ irrespective of the level of achievement (MCQ scores versus long essay scores, $r = 0.62$, $P < 0.01$).[7] However, when they categorized data based on the level of performance, the value of Pearson's correlation coefficient was found to be less strong, thus suggesting that performance in one of the testing format has a stronger influence. In our study, Pearson's correlation between MCQs and SAQs was found to be greatest for overall average score, whereas a negative correlation was found for high achievers (level of performance based on SAQ scores). Thus, we would like to support the evidence that indicates that some students perform better in MCQs than SAQ, SEQ, LAQ, and long essay questions.[8] Bodkha also examined the effectiveness of MCQ, SAQ, and MEQ in assessing cognitive domain among high and low achievers. Their work suggests that all levels of the cognitive domain cannot be tested by a single form of assessment, instead assessment should include multiple modalities such as MCQ, MEQ, and SAQ.[9] Some studies dispute the importance of essay-type questions and SAQs in evaluating the performance of students during written summative assessment based on the argument that the scores obtained in MCQs correlate better with the student performance after graduation.[4] However, with our findings, we would like to stress upon the vital role of SAQs in evaluating the student performance during the formative assessment, and these should be included at all levels of assessment. Hijazi et al., have shown that for a holistic approach toward skill assessment, highest correlation existed between the outcome and short cases followed by MCQs, the long case, and essays. They concluded that short cases component of final exams in pediatrics is more effective than other components at discriminating among the skills.[10]

MCQs play a pivotal role in various types of assessment in medical schools, due to the ease with which these can be administered and evaluated. However, the supplementary role of assessment is to motivate students to assimilate the knowledge and introspect for further improvement. The strength of our study lies in our ability to incorporate MCQs as part of teaching and then evaluate their direct role in helping students have a better grasp of a given topic, by comparing student scores in MCQs and SAQs during formative written assessment. This approach will also allow the teacher to give appropriate feedback to the students, which is both, factual, and appropriate.[11] The only limitation of our study was that we could not expand the scope of our research to all topics of physiology. Future studies in this field may be directed to understand the wider implications of MATeL in other pre-clinical subjects.

CONCLUSIONS

Students show improved scores in their formative written assessment when the lectures are assisted with the use of MCQs, than when MCQs are not employed before and during the lecture. Total scores and score in the non-MATeL

topics correlate with the overall performance of students in written formative assessment. Thus, MCQs may form a vital component during teaching when delivering important concepts and their use may not be restricted to the traditional role during the assessment.

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