Original Research Article

Enhancing anatomy comprehension through competency-specific formative assessments: A study on the effectiveness of pre and post lecture multiple-choice questions in CBME

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ABSTRACT

Background: Modern medical education was required to include clear, tailored and regular formative assessments, especially for Millennials. Competency-Based Medical Education (CBME) emphasized the objective assessment of anatomical competencies. Question-answer and viva-voce tests were considered subjective and resource-intensive. This research was conducted to examine how competency-specific formative assessments using multiple-choice questions and photos before and after competency-based medical lectures improved anatomy comprehension.

Materials and Methods: The research involved 150 first-year MBBS students who were enrolled in online anatomy courses. Competency-specific, picture-based, clinical scenario-based and multiple-choice pre-questionnaires were distributed. The questions were reviewed and attempted by students before attending the theory classes. Lecture classes were conducted according to the curriculum and competencies of the National Medical Council. After the lecture, the questions and answers were reviewed and a feedback questionnaire was administered. The feedback survey included Likert scale responses and open-ended questions to gauge students' opinions on the teaching and learning methodology.

Results: It was observed that the method was effective, stimulating curiosity, motivation and engagement. Participants expressed that the approach facilitated memorization, imparted clinical knowledge and reinforced theory. Clinical scenario-based multiple-choice questions were found to enhance memory, spark interest and improve understanding of anatomy's clinical relevance. Students believed that this method would benefit them in university exams. Overall, 89.7% of participants found the methods highly satisfactory, 50% satisfactory and 10.3% unsatisfactory.

Conclusion: Competency-specific formative assessments using multiple-choice questions and photos before and after lectures were found to improve anatomy knowledge. The strategy was found to promote engagement, memory and clinical understanding, reinforcing anatomical concepts. The results of this study suggested that competency-specific formative assessments added value to the current CBME-based medical education by increasing learning and practical application.

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1. Introduction

Medical education needed to be transparent, personalized and incorporate frequent formative assessments for modern learners, especially Millennials. This method allowed modern medical students to learn and be assessed based on competencies.[1] Formative assessment was found to improve anatomy students' teaching, professionalism and communication. Managing the challenges and opportunities

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of modern medical education required formative anatomy assessment.[2] Competency-based medical education and critical care education needed to operationalize teaching and assessment competencies.[3]

Competency-based medical education required the objective evaluation of anatomy competencies.[4] Question answers, spotters and viva voce assessments had been used in anatomy education, but they were subjective, resource-intensive and limited. These limitations prompted educators to consider alternative assessment methods for a more comprehensive assessment of anatomy students. Conventional methods suffered from subjectivity, time constraints, limited scope, lack of standardization and inadequate representation.[5,6] Brightwell and Grant (2012) discussed the need for competency-based training and flexibility in medical schools to set measurable goals.[7] Raubenheimer et al. (2016) recommended a comprehensive evaluation that included all domains of expertise and a scoring framework for assessing undergraduate preclinical anatomical knowledge.[8] Walter and Morris (2016) used transition matrices to assess student understanding through diagnostic exams, showing that multiple-choice questions could reveal learning outcomes.[9]

Multiple-choice questions with visual aids were found to effectively assess student comprehension and memorization of anatomical concepts, which was crucial to medical education.[10] Langlois et al. (2016) identified that spatial multiple-choice questions were essential for assessing students' anatomical understanding.[11] Hussey et al. found that visual aids positively impacted assessment tools like multiple-choice anatomy tests.[10] Formative assessment using multiple-choice questions with photographs to evaluate medical students' anatomy learning was considered crucial. The assessment of students' anatomical knowledge and competencies using spatial elements, competency-based education and innovative educational modalities was deemed comprehensive. The pre-test and post-test provided valuable insights into the impact of educational approaches and interventions, making them essential tools for evaluating and enhancing learning outcomes.[12–14]

This study aimed to investigate the effectiveness of formative assessment using multiple-choice questions with photographs before and after lectures (pre-test and post-test) for medical students in anatomy, focusing on testing the students' learning outcomes.

2. Materials and Methods

The research incorporated a sample of 150 medical students in their first professional year of MBBS who were enrolled in online anatomy courses. Pre-questionnaires were distributed to students before the lecture class day. The questions were competency-specific, picture-based, clinical scenario-based and multiple-choice. A Google form was utilized to generate eight to ten multiple-choice, picture-based, or clinical scenario questions, which were distributed to students the day before class. They were directed to review the questions in advance, attempt to answer them and receive one point for each correct response in the coded Google form. They were also required to attend the theory class the following day. Lecture classes were then conducted according to the curriculum and competencies of the National Medical Council. After completing the lecture class, the questions and answers from the pre-class questionnaire were reviewed, covering all the competencies associated with the specific topic.

The questions and answers were re-distributed to the students. After reviewing the questions and answers, participants were requested to complete a feedback questionnaire. The feedback survey comprised a total of ten inquiries. The first eight questions required students to provide responses using a five-point Likert scale ranging from "Strongly agree" to "Strongly disagree." These questions inquired about the formative assessment of anatomical skills within CBME, which employed picture-based multiple-choice questions to elucidate anatomical principles and the anatomical foundation for clinical scenarios.

In contrast, the final two questions were open-ended and sought responses that reflected the respondents' opinions, ideas, or perceptions regarding the teaching and learning methodology. Feedback was gathered before the lecture concerning both the class and the novel teaching-learning approach of arousing students' interest in the subject matter through multiple-choice or picture-based questions. The inclusion of open-ended questions aimed to gather student feedback, gain insight into their level of engagement and refine the methods used to foster student participation during lecture classes. All responses to the Google forms-based feedback questionnaire were collected and compiled for the study. Based on the students' responses, it was observed that encouraging students to review the questions before class piqued their interest in the subject matter and underscored the importance of acquiring prior knowledge before the lecture. Table 1 shows the feedback questionnaire administered for the students.

Students' perspectives on teaching, learning and assessment tools and methods were gathered using a five-point Likert scale: "Strongly agree (5), Agree (4), Neutral (3), Disagree (2), Strongly disagree (1)." The outcome of the study is evaluated by calculating the median for each individual question and estimating the proportion.

3. Results

Based on the compilation of all feedback responses, the study observed that the teaching method was effective. Based on the students' responses, it was observed that encouraging students to review the questions before class piqued their interest in the subject matter and underscored

the importance of acquiring prior knowledge before the lecture. Generally, the participants expressed that the approach stimulated their curiosity and motivated them to investigate further and amass knowledge about the subject matter. The method not only fostered engagement but also facilitated memorization and imparted preliminary clinical knowledge. The students articulated their perspectives as follows: "This method was surely an excellent way to learn anatomy. In fact, this was the way to learn," "Theory was important, no doubt about it, but when we were able to process that theory and apply it to a clinical scenario, it reinforced the theory we had learned and also helped us use our problem-solving skills to narrow down the problem which is essential for a physician" and "This method of learning from earlier on helped us build a foundation for approaching clinical scenarios and thinking like a physician, which would be of great use in the future and in clinical settings." The statements made by the students suggested that the method had become a crucial endeavor for comprehending the fundamental concepts of anatomy covered in lectures and fulfilled its principal objective of preparing students to understand the anatomical basis for clinical conditions.

Compared to the conventional teaching method, the one utilizing clinical scenario-based MCQs assisted students in enhancing their memory. Most students reported that clinical scenario-based MCQs sparked their interest in anatomy. Although they used Google and their anatomy textbook to find answers to the pre-class questionnaire, the students found the lecture class more comprehensible as they progressed through the book. Furthermore, it engaged students in lecture classes by arousing their curiosity and fostering their interest in the subject. This approach helped the students understand the clinical relevance of anatomy. By using pre-sensitization and content reinforcement, students became interested in anatomy. Clinical-based MCQs improved students' knowledge and confidence. The students were convinced that this approach would be beneficial now and in the future, especially for university exams. This innovative, practical, and effective method made the concept easy to understand. A few students suggested that clinical scenario-based and multiple-choice questions should be done "after" class to focus on assessment rather than student participation in lecture classes. Students found the clinical scenario-based MCQs difficult but understood the clinical conditions better with standardized questions. Most students were satisfied with this learning approach and completed the pre-questionnaire. In general, clinical scenario-based MCQs were easy to learn.

Out of 150 participants, 89.7% (n=135) of the students opined these methods to be highly satisfactory, 50% (n=75) satisfactory and unsatisfactory by 10.3% (n=16). The percentage wise student feedback is depicted in (Chart 1).
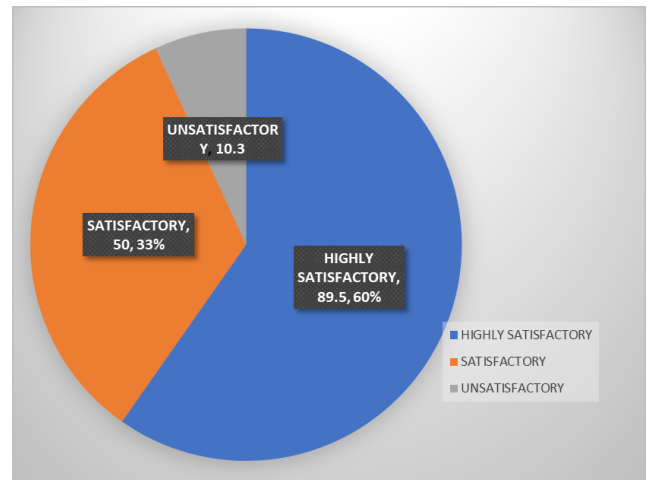

Chart 1: Percentage of student feedback

4. Discussion

The formative assessment, an integral component of medical school, comprised multiple-choice inquiries accompanied by visual aids. The assessment was administered to students before and after their anatomy lectures. The results of the present study revealed that the formative assessment, which utilized multiple-choice questions with photographs before and after lectures (pre-test and post-test), was practical and most students were satisfied with the approach.

Competency-Based Medical Education (CBME) employed formative assessment to drive learning, offer feedback and uncover knowledge gaps.[15] The strategy emphasized transparency, personalized learning and frequent formative assessment, which Millennials expected.[1] CBME focused on objective skill evaluation, operationalizing teaching and assessment competencies and addressing flaws in traditional assessment approaches(Chuang & Hsieh, 2018; Zhu et al., 2020; Holmboe, 2015).[3,16,17] Virtual and technology-enabled formative assessments were found to increase medical education learning outcomes and capacities.[18] Formative assessment was believed to assist CBME implementers in shifting from time-based to competency-based thinking.[17] CBME enhanced medical practice by developing and assessing skills through competency-based lectures and formative assessments, evaluating specialty-specific knowledge, attitudes and behaviors within broad skills.[19] Competency-based education involved defining training, creating quantitative measurements, monitoring performance and reporting results throughout a surgeon's career.[20]

The use of pre-lecture formative assessment was found to reduce cognitive strain and enhance understanding through flipped classrooms, video podcasts and pre-lecture aides. Pre-lecture online examinations and student-initiated

Table 1: Students feedback questionnaire form

Questions on perception of students on online assessment tool	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Did this clinical scenario based MCQs help in improving your memory?						
Was this clinical scenario based MCQs interesting?						
Did this clinical scenario based MCQs kindle your interest in anatomy?						
Was this clinical scenario based MCQs useful?						
Were the questions in the clinical scenario based MCQs challenging?						
Did you like this way of learning?						
Were you able to attend the questions?						
Was this clinical scenario based MCQs an easy way of learning?						
What do you feel about this method?						
Any other remarks?						

inquiry improved academic performance.[21] Students were reported to be happier and more engaged with pre-lecture tools.[22] Pre-lecture formative assessments promoted student engagement, understanding and academic success in medical education. Formative assessments in CBME courses provided students with feedback and identified problems.[1] Formative post-lecture exams measured comprehension and retention, demonstrating how educational techniques and interventions affected learning.[23] Comparing instructional approaches to pre-lecture testing indicated learning effects.[24] Formative post-lecture evaluations assessed usability and feedback quality using multiple-choice questions, questionnaires and post-intervention surveys.[23] Formative assessments after lectures improved high-stakes exam results, proving their value.[25] Flipped classrooms, video podcasts and pre-lecture aides minimized cognitive strain and increased understanding.[26] Pre-lecture online examinations and student-initiated inquiry improved academic performance.[21] Students were reported to be happier and more engaged with pre-lecture tools.[22] Formative post-lecture exams measured comprehension and retention, showing how educational techniques and interventions affected learning.[23] Comparing instructional approaches to pre-lecture testing indicated learning effects.[24] Formative post-lecture evaluations measured usability and feedback quality using multiple-choice questions, questionnaires and post-intervention surveys.[23]

According to feedback from the present study, the clinical scenario-based multiple-choice questions (MCQs) engaged participants and stimulated further study. This technique was claimed to help students remember baseline clinical information for future medical practice. Students claimed that the technique improved theoretical understanding and problem-solving skills for future physicians through preparation for practical situations.

Student memory and anatomical interest were enhanced with clinical scenario-based MCQs, making courses more accessible. Students appreciated the clinical relevance, pre-sensitization and content reinforcement provided by this teaching method. They believed it would aid them, particularly for university exams.

Many studies examined formative assessment using multiple-choice questions with pictures for medical students and declared that multiple-choice questions with visual aids could better assess student learning. An extensive review by Langlois et al. emphasized the effectiveness of spatial features in multiple-choice questions for assessing students' anatomical knowledge. The review highlighted the link between anatomical knowledge and spatial skills.[11]

Disadvantages of conventional methods included subjectivity in viva voce assessments, which relied on the judgment of the examiner and could introduce bias and inconsistency in evaluation.[22] Similarly, the assessment of written tests using questions and answers and spotters could be time-consuming, particularly in large classes and required significant resources for scoring and evaluation.[27] These assessment methods may not have comprehensively evaluated students' understanding of anatomical concepts, focusing instead on specific details rather than broader competencies.[6] The lack of standardization in viva voce assessments and spotters could lead to variations in grading and assessment, impacting the reliability of the evaluation process.[28] These methods might not have fully represented the diverse competencies required in modern anatomy education, such as clinical reasoning, problem-solving and the application of knowledge in clinical scenarios.[22] The use of spotters and viva voce assessments could have required significant resources, including cadaveric specimens and trained examiners, which may not have been feasible in all educational settings.[29] Therefore, there was a need for using picture-based multiple-choice questions for

diagnostic evaluation in anatomy classes. The assessment of medical students' anatomical knowledge and spatial awareness was improved by including spatial features, creative simulators and visual aids into multiple-choice questions. This contributed to a more thorough assessment of their anatomy skills.

5. Conclusion

In conclusion, while valuable insights into students' learning outcomes in anatomy are offered by multiple-choice questions with photographs, the limitations and criticisms associated with this assessment method must be considered. Further research and careful consideration of the design and implementation of multiple-choice questions are necessary to ensure that students' learning outcomes in anatomy education are effectively measured.

6. Limitations

It was argued that multiple-choice questions might have limitations in assessing higher-order cognitive skills and could allow guessing, which might inflate scores without accurately reflecting students' understanding. Additionally, multiple-choice questions have been known to overestimate candidates' abilities, raising concerns about their suitability for assessing clinical competence. Therefore, the results of the present study had to be viewed within the context of the inherent limitations of MCQs. However, the answers to the open-ended questions clearly stated, beyond reasonable doubt, that students readily favored this type of lecture combined with formative assessment consisting of pre-test, discussion and post-test.

7. Conflict of Interest

None.

8. Source of Funding

None.

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