Medical Education

Designing effective scenario-based multiple-choice questions for health professionals

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INTRODUCTION

In recent years, India's medical education system has experienced major transformations, primarily characterized by a transition towards competency-based learning and the incorporation of innovative assessment techniques.[1] Scenario-based multiple-choice questions (SBMCQs) are becoming increasingly popular because they provide a comprehensive assessment of students' understanding of concepts and real-world situations.[2,3] With the use of SBMCQs, educators can assess application of knowledge, critical thinking, and problem-solving abilities of the students.[4,5] Such an assessment emphasises practical application and fosters a deeper understanding of the subject.

Considering the potential of SBMCQs to assess students' higher order of thinking, a competency-based curriculum for undergraduate (UG) medical students has up to 20% of the evaluation using SBMCQs.[6] Many universities in India are now using SBMCQ assessments to assess the ability of students to apply theoretical knowledge to practical settings.[7] A recent analysis of the national eligibility cum entrance test for postgraduation (NEET-PG) 2023 revealed that about 60% of questions were clinical scenario-based with only 10%–15% single-line questions. Further, it had over 35 picture-based questions.[8]

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Hence, it is imperative to prepare students for this high-stakes examination by integrating SBMCQs into both formative and summative assessments throughout their UG course. Students would become more familiar with the format and gain valuable practice, increasing their chances of success in the examination. For this purpose, the faculty should be able to prepare clinical scenario-based questions addressing a higher level of knowledge in Bloom's taxonomy. The faculty need to be able to surpass fact recall, and encourage students to analyse, evaluate, and synthesize information.[9,10]

However, there is a gap in training medical educators to design SBMCQs that target higher-order cognitive abilities.[11,12] Our aim is to address the proficiency gap among faculty in creating SBMCQs effectively. A group of 32 faculty members from various medical colleges in India developed SBMCQs. We reviewed and validated the questions and present them here. We highlight common mistakes to avoid during this process.

KEY CONSIDERATIONS

Designing effective SBMCQs involves considering the course or competency objectives. Questions should revolve around important concepts, and common or serious clinical problems encountered in practice.[2,13] Avoid trivial or rare topics that may interest clinicians but are not feasible for this type of assessment. The salient features to be considered are:

1. Develop a Blueprint
2. Match the complexity of the case to the learner's level
3. Align questions with the intended learning objectives
4. Focus questions on common or potentially catastrophic problems
5. Create scenarios that mirror real-world situations
6. Encourage higher order thinking
7. Provide precise references for the question
8. Determine the allocation of marks or scoring system
9. Review, pilot test

Structure of scenario-based multiple-choice question (SBMCQ)

The SBMCQ consists of four components[14,15]

1. Stem: Presents the scenario or problem with context.
2. Lead-in: Intimates students on what is asked or expected.
3. Key: Represents the best answer or response.
4. Distractors: Plausible choices that distract from key.

SBMCQs help students relate their thinking to real-world situations, and promote critical thinking in their answers. However, adding a scenario without proper integration can lead

to redundancy and failure to achieve the intended learning and assessment outcomes.[16]

A redundant SBMCQ

A 33-year-old man was brought to the emergency department following a road traffic accident. On examination he had a pulse of 110 beats per minute, respiratory rate of 20 breaths per minute, and systolic blood pressure of 90 mmHg, along with oliguria (reduced urine output). To stabilize his condition, he was started on a blood transfusion. The production of red blood cells begins how many hours after blood donation?

A. 12
B. 24
C. 36
D. 48

Comment: The SBMCQ can be answered without the scenario.

Scenario-based MCQs should meet the 'cover test', meaning that if a student knows the answer, he/she will have a key in mind even without seeing the answer options.[12,13]

Cover test

A 32-year-old woman presents with weight loss of 5 kg, nervousness, increased sweating, and fatigue for the past 3 months. Her neck examination shows a firm diffuse, non-nodular swelling in front of her neck that moves on swallowing. She has mild exophthalmos. Her resting pulse is 100/minute and her blood pressure is 135/90 mmHg. The patient's thyroid function tests are as follows (normal values in parentheses):
Serum TSH 0.2 mU/L (0.5–5.0 mU/L)
Total thyroxine (TT4) 14 µg/dl (5–12 µg/dl)
Which of the following is the most likely diagnosis?

A. Subacute thyroiditis
B. Graves' disease
C. Plummer's disease
D. Hashimoto's disease

EXAMPLES OF SBMCQS

Here are some examples of SBMCQs, which will be valuable for understanding their key elements and structure.

Stem

The stem provides the scenario. The scenario can be based on a clinical case or a concept.

Clinical scenario. The clinical case may begin with the presentation of a problem and followed by relevant signs, symptoms, results of diagnostic studies, initial treatment, and subsequent findings (the relevant components are added, it's not mandatory to add all clinical details and here we are pointing to the addition of irrelevant clinical details):[14,17]

- Complete sentences
- Relevant to the learning objective
- Single-themed
- Grammatically consistent
- Avoid abbreviations and acronyms
- Avoid textbook, verbatim phrasing

Incomplete stem

A 22-year-old adult visits a dental clinic with a complaint of discoloration of teeth. On clinical examination, it was observed that the premolars and molars with small, opaque, paper white areas scattered irregularly over the tooth enhanced near tips of cusps, with bilaterally symmetrical presentation. Which of the following is the most likely diagnosis?

The stem needs more details for better clarity

1. Duration: since when are the white areas present?
2. Texture of the opaque areas: hard/soft
3. Is the white area visible or not after water spray?

Nevertheless, it is important to be mindful of window dressing the question redundantly. It involves adding unnecessary details or over-complicating the stem, which can confuse and mislead students. The purpose of the stem is to provide the students with a quick, clear, and accurate picture or idea about what they are asked to answer.

Concept based scenario. SBMCQs do not always require specific patient details or clinical vignettes. While clinical scenarios are commonly associated with SBMCQs, they can be concept-based too.[2,18]

First and second-year medical students are building foundational knowledge and understanding core concepts. SBMCQs can be designed to assess these without involving detailed patient scenarios.[4] It's important for educators and assessors to recognize the flexibility of SBMCQs and develop these to achieve the assessment goals.

Concept-based SBMCQs[7]

A patient was administered a neuromuscular blocker before a surgical procedure to produce skeletal muscle paralysis. This drug caused initial skeletal muscle fasciculations before the onset of paralysis. The effect of this drug could not be reversed with neostigmine. Which of the following neuromuscular blockers was most likely administered to this patient?

A. Cisatracurium
B. Succinylcholine
C. Rocuronium
D. Tubocurarine

Watson and Crick state that the double helix of deoxyribonucleic acid (DNA) is stabilized by the bonds between complementary nitrogenous bases. Which of the following bonds maintain the double helical structure of DNA?

A. N-glycosidic
B. Phosphodiester
C. Esther
D. Hydrogen
E. Disulfide

The assessor must not provide any hints to the answer when writing the question stem. Even with limited knowledge of the topic, astute students might deduce the correct answer by spotting repeated words or using grammatical clues such as a/an, is/are, etc. It is crucial to phrase the questions carefully to ensure a fair and unbiased assessment.

Test wiseness/clues in stem

In a 46-year-old postmenopausal woman who presents with backache and diffuse bone pain all over the body, X-ray reveals diffuse loss of bone density. Considering the underlying pathophysiology, which treatment approach would be the most rational?

A. Exposure to sunlight during normal day time activities.
B. Calcium rich food along with vitamin D supplementation.
C. Intranasal calcitonin supplement along with dietary calcium and vitamin D3.
D. Selective oestrogen receptor modulator with supplement of calcium and vitamin D3.

Comment: Postmenopausal in the stem and oestrogen hormone in the key may provide clues to the right answer. Mentioning a '65-year-old woman' is appropriate. Avoid giving clues using faulty grammatical construction.

Lead-in

The lead-in question should[17,18] be (i) unambiguous and straightforward, (ii) provide clear directions to understand the intended objective, (iii) align with the scenario stem and the key (learning outcome), and (iv) avoid the use of negatives, abbreviations, and double negatives, ensuring clarity in the question.

Focus in lead-in

After a thyroidectomy, a 35-year-old female singer visits the clinic for a postoperative evaluation. She reports no hoarseness but has lost her ability to sing high notes since the surgery a week ago. She describes her voice as 'weak'. Which nerve is most likely injured, and which muscle is not functioning as a result?

A. Recurrent laryngeal nerve, cricothyroid
B. Superior laryngeal nerve, cricothyroid
C. Vagus nerve, cricothyroid
D. Superior laryngeal nerve, cricothyroid

Comment: Base each item on an educational or instructional objective and focus on a single problem. In this scenario either the lead-in could pose the question on the injured nerve or the dysfunctional muscle.

Distractors

These should[2,12] (i) be homogeneous in content and style, (ii) be plausible, without any obviously incorrect options, (iii) be similar in construction and length to the correct answer, (iv) be grammatically consistent and related to the stem (avoid clang associations), (v) avoid 'All of the above' and 'None of the above' options, and (vi) arrange numerical values in a logical sequence.

Heterogenous distractors

A 26-year-old pregnant female, in her second trimester of pregnancy, reported to the dental outpatient with a growth in the inter-dental papilla of the right mandibular molar. The growth is 1×2 cm, red, soft in consistency, pedunculated lesion with spontaneous bleeding on probing. Which of the following is the most likely diagnosis?

A. Pulpal polyp
B. Pyogenic granuloma
C. Periapical abscess
D. Tuberculous ulcer

Comment: The distractors in the MCQ have a consistent relationship to the stem, are uniform in length, and maintain grammatical consistency.

Homogeneous distractors

A 26-year-old pregnant female, in her second trimester of pregnancy, reported to the dental outpatient with a growth in the inter-dental papilla of the right mandibular molar. The growth is 1×2 cm, red, soft in consistency, pedunculated lesion with spontaneous bleeding on probing. Which of the following is the most likely diagnosis?

A. Giant cell granuloma
B. Pyogenic granuloma
C. Haemangioma
D. Squamous cell carcinoma

Key

The key should be clear, unambiguous, and distinct to avoid confusion. It should not consistently appear in a particular position within the list of choices to prevent reliance on position recognition. Ambiguous options can compromise the validity and reliability of the assessment.

Plausible distractors with key

A 45-year-old man visits the outpatient department with difficulties in language comprehension and expression. During the examination, he exhibits trouble finding the right words and uses incorrect or novel words. Additionally, he struggles to comprehend the meaning of spoken or written words. Given these findings, which type of aphasia is most likely affecting the patient?

A. Broca
B. Wernicke
C. Global
D. Conduction

Reference: Ganong WF. *Review of medical physiology*. 23rd ed. McGraw-Hill Education; 2019:297.

Comment: Key should be distinct and unambiguous and referenced precisely.

By providing a complete reference, you not only ensure the accuracy of the information in the question but also facilitate the review and validation process by making it easier for others to access the source. It should include the following:[17] Name of Author(s); Title of the book; Edition; Year of Publication; Publisher; Page number(s)

Allotment of marks

In scoring SBMCQs, it is essential to consider both the difficulty level and the time taken. Negative marking is a contentious

matter, requiring a delicate balance to discourage guessing while maintaining a fair and supportive assessment experience for all students. It's useful in screening tests. However, in formative assessment negative marking should be avoided.

Image-based SBMCQ

Using image-based scenarios in assessments offers a more authentic and contextually rich experience.[17,18] Visuals should prompt students to go beyond memorization and lower-order thinking, encouraging analysis and synthesis of information. To enhance higher-level thinking skills, design scenarios with images such as those used in lectures, but with slight variations to challenge students further.

Image-based scenario

A 30-year-old man who is known to be HIV positive, presented with chest tightness and breathlessness for 30 days, along with a dry cough for 10 days. He was not on antiretroviral therapy and his latest CD4 count was 120/dl. His chest X-ray[19] revealed bilateral interstitial infiltrate spreading from the hilum. Which of the following is the most likely diagnosis?

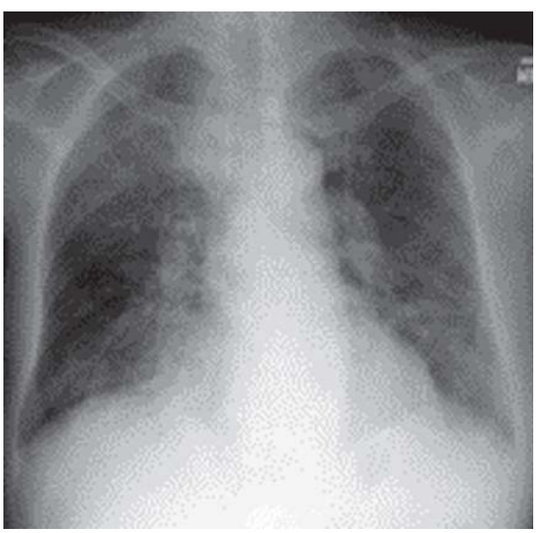

FIG. A chest X-ray of the patient with abnormalities in the lung[19]

A. Pneumocystis jirovecii pneumonia
B. Streptococcal pneumonia
C. Pulmonary tuberculosis
D. Pulmonary cryptococcosis

Comment: X-ray findings have already been described in the stem of the MCQ, an image may not provide any new information.

DISCUSSION

SBMCQs in health professional education is useful in the context of the new competency-based medical education (CBME) curriculum and the National Exit Test (NEXT) system. Moreover, SBMCQs can assess the analytical and problem-solving capabilities of the examinees. However, designing such questions is challenging for developers and requires proper planning along with appropriate training. In the absence of proper training, the process can lead to redundant questions or incomplete stem or ambiguous distractors.[2]

Most teachers of basic medical sciences are aware of and have good knowledge of SBMCQs, but regular training and workshops are recommended for practicing the same.[20]

Using the right tool, in the right context, at the right juncture, supplemented by other tools, and backed by constructive feedback, can help nurture the good intent ingrained in the CMBE curriculum for the development of an assessment toolbox for judging the competencies of Indian medical graduates.[5]

The major challenge in designing MCQs are lack of training in construction, most were prepared as context-free in the last minutes, with minimal process of vetting or review the quality of questions and lack of any standardized question format, lack of accountability and underestimation of the use of blueprint of assessment by medical teachers. It is important to use a realistic clinical setting, routinely practiced, and relevant clinical findings in assessment to make the student demonstrate the intended knowledge or skill. However, without attention to detail, the scenario in a clinical science question will only lead to frustration among candidates, reading of unnecessary materials and threaten the reputation of the assessment.[14,16]

In the present conditions where competitive examinations are on the rise and the assessment process is getting more inclined to SBMCQs, increasing the number of scenario questions will certainly mean the inclusion of wider course content.[20]

Conclusion

Well-designed SBMCQs can promote critical thinking and revolutionize the way we assess knowledge. Therefore, it is essential to train faculty in constructing meaningful questions. By using SBMCQs as a means of assessing students, educational institutions can establish a comprehensive evaluation framework that combines efficiency and efficacy. This approach enhances the student's learning experience and contributes to improvement of the educational process.

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Conflicts of interest. None declared

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Assessment of perceptions, barriers and enablers towards uptake of research activities among undergraduate medical students: A mixed methods study

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ABSTRACT

Background. Medical research, even though, an integral part of medical education, remains the most neglected domain in the medical curriculum in most medical colleges across India. Research, when introduced in the medical curriculum, gives an early opportunity to medical students to participate in it. We did a study to gain an insight into the perceptions of medical students and explored barriers and enablers towards uptake of research activities.

Methods. A mixed methods study was done over 9 months using a pre-tested semi-structured questionnaire and a focus group discussion among medical students. First, a quantitative survey was done using Google forms to assess students perception and attitude towards research. This was followed by 2 focused group discussions to explore the barriers and enablers towards uptake of research activities. Descriptive analysis was done for quantitative data and manual thematic content analysis for qualitative data.

Results. A total of 350 participants responded to the survey out of which 168 (59.1%) were women. Most students (339; 96.9%) perceived research to be important. Also, 313 (89.4%) and 245 (70%) showed willingness to attend research methodology workshops and conduct research studies, respectively. A manual thematic content analysis of the focus group discussion revealed two main themes: (i) barriers to conduct of research and (ii) enablers towards uptake of research. The major barriers were lack of knowledge about conducting research and lack of time and financial constraints. The enablers were conduct of periodic research methodology workshops and adequate mentoring by faculty.

Conclusion. There is a gap in the existing knowledge and practice in undergraduate medical research. Our study ascertained potential barriers as well as enablers for enhancing research activities by medical students. Adequate institutional support including funding for research coupled with proper mentoring by faculty and family support is crucial to foster a positive research culture among undergraduate medical students.

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INTRODUCTION

The goals prescribed for an Indian medical graduate (IMG) are that of a clinician, leader, communicator, lifelong learner,