Research Article

Effect of training on formulation of multiple choice questions: a cross-sectional study amongst faculty in the department of biochemistry of a Medical Institution in India

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ABSTRACT

Background: Multiple choice questions (MCQs) are an important tool for assessing whether learning objectives are being achieved. A formal training is necessary to have high standards in preparing MCQs. the effect of a training program on the quality of MCQs, amongst the faculty of Department of Biochemistry was assessed.

Methods: A training program was designed with the main focus on how to construct appropriate MCQs' by participants based on sound scientific standards and guidelines. Topics from biochemistry syllabus for first year MBBS course were selected for the study. All the study participants were newly appointed lecturers and had not undergone any formal training program in medical education technology. Training was carried out by three experts who were formally trained in medical education and were fellows of foundation for advancement of International Medical Education and Research (FAIMER). Knowledge gained by the study participants was tested by pre-test post-test comprising objective questions. The quality of MCQs before and after intervention was assessed with a validated (checklist) containing 60 items.

Results: Eight faculty members participated in the study. A statistically significant improvement was observed in the knowledge of appropriate formulation of MCQs (P<0.05) and the overall quality of MCQs (P=0.004), following training of the study participants. Especially, marked improvements were observed in providing directions for MCQs, highlighting of negative stems in the MCQs and providing keys to MCQs after the training. No significant changes were observed either in the quality of subject content or in the types of formulation of MCQs.

Conclusions: A significant improvement in knowledge of how to construct appropriate MCQ items and the quality of MCQs following training program was noted. Such training program to be administered to the teaching staff early in their career was recommended.

Keywords: MCQ, Assessment tool, Medical education

INTRODUCTION

Multiple choice questions (MCQs) are selected response questions and are one of the preferred methods of assessment worldwide, due to high reliability and objectivity.[1,2] A typical MCQ consists of a question, commonly referred as the stem, and a choice of options wherein the student is expected to select the best option for that specific question. "Keyed option" is the best correct option and all other choices are referred as "distracters".[3] Previously, MCQs were also developed in

the form of true or false questions. However, such formats are associated with various drawbacks like high chance of guessing the correct answer and poor discriminating factor for high and low performers.[4] The other types of MCQs are either the single best option MCQs that consists of one correct option from several choices or extended matching questions, which are preferred now-a-days.[5] MCQs primarily test the critical thinking which is one of the most important concepts involved in the field of education that helps the academies and universities in surviving and developing scientific societies.[6] The following advantages have been claimed for MCQs by the teachers that make these assessment tools as one of the most commonly used ones: Easy scoring of the tests; MCQs control cheating and wide topics can be covered in the curriculum.[7]

To meet the quality standards in framing MCQs, it is important for the teachers to undergo formal training. Abdulghani et al have shown that faculty development programs improve the quality of MCQs in Saudi Arabia.[8] Considering the lacunae of formal training for the medical teachers in our hospital, we carried out a training program and assessed the ability of the faculty in framing MCQs. Here, we present the details of the training program and the impact of the program on the faculty's performance in framing MCQs.

METHODS

Study ethics

The study was carried out after obtaining clearance from Institutional Ethics Committee in accordance with the principles laid down in Declaration of Helsinki 2008. The participants were informed that the results of the questionnaire will be used for publication without revealing their identity and a written informed consent was obtained from each accordingly.

Study procedure

The study was conducted in the Department of Biochemistry in a medical college from a metropolitan city in India. A training program was designed with the main focus on how to construct appropriate MCQ items by the participants based upon sound scientific standard and guidelines and then we assessed the knowledge gained and skills acquired accordingly. Topics from Biochemistry syllabus for first year MBBS course were selected for the study. A total number of eight faculty members from the department of biochemistry were selected as trainees. All the study participants were newly appointed lecturers and had not undergone any formal training in medical education technology. Training was carried out by three experts who were formally trained in medical education and were Fellows of Foundation for Advancement of International Medical Education and Research (FAIMER). A questionnaire containing 60 items (checklist) was devised to assess the subject content

and overall quality of MCQs (Appendix 1). The questionnaire was developed as a modified tool from Haladyna et al.[9] Content validity of the questionnaire was carried out by the above mentioned experts in the field of medical education. Two assessors were assigned the task of assessing overall quality and two for subject content.

Statistical tests

Descriptive statistics was used to represent the demographic details of the study participants and kappa statistics was used to assess the degree of agreement between the assessors. Cohen's kappa statistics was used to assess the significance of agreement as follows: ≤0-no agreement, 0.01-0.20 as slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial and 0.81-1.00 as almost perfect agreement.[10] Chi-square test for independence was used to assess the significance of the changes in knowledge gained and improvement in general quality and subject content of MCQs before and after the training program.

RESULTS

Demographic details

A total of eight faculties (5 males and 3 females) were involved as study participants. Five participants were in the rank of assistant professors and three were tutors. Mean (SD) age (in years) of the study participants was 30.4 (1.5). The highest qualification amongst the study participants were as follows: MD (four participants); PhD (one participant); MBBS (two participants) and MSc (one participant).Teaching experience amongst the study participants was ranging between 2 and 3 years.

Effect of intervention on the general/overall quality of MCQs

A statistically significant improvement was observed with the overall quality of the MCQs following training of the study participants (Table 1) (P=0.004). Especially, marked improvements were observed in providing directions for MCQs, highlighting of negative stems in the MCQs and providing keys to MCQs after the training.

Effect of intervention on the subject content of MCQs

Table 2 depicts the effect of training program on the subject content of MCQs. Although improvements were observed in terms of avoiding imprecise words and use of over specific knowledge, no statistically significant changes were observed in the overall subject content in the MCQs after the training program (P=0.9).

Effect of intervention on the types of formulation of MCQs

The types of MCQ formulation was classified as simple, question type, negative form, double negative form and

case history types. Figure 1 depicts the number of study participants framing MCQs in each of the above mentioned types and no statistically significant changes were observed in the proportion before and after the training program for any of the types of MCQs. However, assessment of knowledge of the study participants showed a significant improvement in the formulation of MCQs post-training (Figure 2).

Table 1: Comparison of assessment of general quality of MCQs before and after intervention and between the assessors.

Criteria	Assessor 1		Assessor 2	
	Number of MCQs with the defined criterion before training	Number of MCQs with the defined criterion after training	Number of MCQs with the defined criterion before training	Number of MCQs with the defined criterion after training
Clear and simple language	24	24	24	24
Bullets are alphabetic	24	24	24	24
Direction provided	0	24	0	24
Time allotment provided	0	0	0	0
Parts of MCQs complete	24	24	24	24
Length of stem is long while choices short	24	24	17	22
Length of key and distracteris same	24	24	19	24
Grammatical mistakes	4	2	8	2
Inappropriate abbreviations/acronyms	3	0	5	1
Negative stem with highlighting	1	8	2	8
Double negative stem with highlighting	0	0	0	0
Choices numeric	2	1	2	1
Neither an ascending or descending order followed	0	2	1	1
Key provided with MCQs	9	24	9	24
Use of all or none of the above options	0	0	0	0

Chi-square test – 0.004 for both the assessors before and after training; Inter-rater agreement for both the assessors before and after training was kappa- 0.8- (almost perfect agreement)
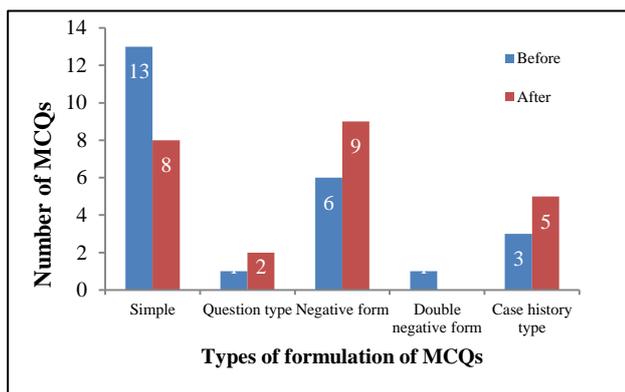
Chi-square test for independence-P = 0.5 (not significant). No significant differences in the proportion of types of formulation of MCQs were observed before and after the training program amongst the study participants.

Figure 1: Comparison of number of MCQs in various formulations before and after the training program.
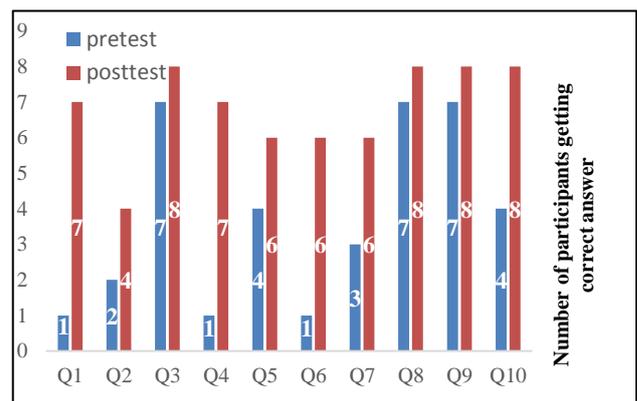
Chi-square test-P <0.05. A significant improvement was observed in the knowledge of the study participants about MCQs.

Figure 2: Assessment of knowledge gained by the study participants subjected to pretest posttest comprising ten objective questions.

Table 2: Comparison of assessment of subject content of MCQs before and after intervention and between the assessors.

Criteria	Assessor 1		Assessor 2	
	Number of MCQs with the defined criterion before training	Number of MCQs with the defined criterion after training	Number of MCQs with the defined criterion before training	Number of MCQs with the defined criterion after training
Recall level of domain	15	19	17	16
Comprehension level of domain	1	0	2	3
Application level of domain	8	5	5	6
An important learning objective has been addressed	24	24	21	19
Use of clinical scenario	4	5	3	5
Superfluous information provided	1	1	0	0
Unambiguous key/s provided	17	22	18	23
Distracters are based on common errors and misunderstandings	20	24	19	23
Distracters are different from key	21	24	23	24
Distracters are related to question	21	24	23	24
Options mutually exclusive and non-overlapping	22	24	21	23
MCQ will take more time and effort	4	3	3	0
The key is obvious	1	0	8	2
The key is debatable	3	0	3	1
Clue is given in the same MCQ	1	0	0	0
Guess work applicable	2	0	2	1
Student friendly language for better understanding of subject matter	24	24	24	24
Use of undefined or imprecise words avoided	15	24	19	24
Options are irrelevant or non- homogenous	1	0	3	2
Use of over specific knowledge avoided	20	24	18	21
There is use of verbatim phrasing from textbook descriptions	5	0	3	0
Misleading stem	3	1	2	0
Any clue provided in another MCQ	0	0	0	0
Focus on single problem	24	24	24	24

Chi-square test for independence (P-0.9)-not significant; Inter-rater agreement for both the assessors before and after interventions (kappa-0.7-substantial agreement)

DISCUSSION

The present paper is a presentation of changes observed in the overall quality and subject content of MCQs amongst faculty members of a Department in a medical school in India after MCQ training. We observed that the training improves the overall quality of MCQs significantly. However, with the single training program, we have not observed any significant improvement in the quality of the subject content nor in framing various types of MCQs. MCQs are useful tool especially when large numbers of students are to be assessed and large field of subject has to be tested.[11] Although a relatively easier way of assessment of the learning, MCQs have to be prepared very carefully to reduce the associated pitfalls. While devising MCQs, it is important to avoid the cueing effect that results when the student recognizes the correct option, rather than generating the answer spontaneously.[12] In addition to content, formatting of the MCQs and the choices should also be given equal consideration.[13] This forms the science of assessment to keep up the standards of MCQs. It is important that faculties in all the disciplines are well trained and equipped to enhance their potential in teaching, assessment of the papers, research and administration.[14] Paradigm shift in the ways of learning and teaching as well as their assessment calls for high standards to be incorporated by the teachers in framing MCQs. Various other studies have found poor quality in devising MCQs by medical and para-medical fraternity. A study from Nursing and Midwifery that evaluated 1793 MCQs in 37 exams and 7062 items in 101 exams in other faculties in

different subjects has concluded that instructors need to improve, especially in terms of quality of the MCQs.[15] Similarly Battista D et al found out that nearly 30% of the questions in the undergraduate paper were unsatisfactory.[16] We found out that proper training of teaching staff will improve his/her ability to frame high quality MCQs similar to the results by Abdulghani et al.[8] New teaching staff should have opportunities to undertake such training program and the higher management authorities or medical education committee of the institution should organize such activities at the college level. Additionally, various research articles are available through online surfing that can aid in understanding the science of assessment through MCQs. One such is by Sadaf et al where the authors have devised tips for framing MCQs that helps in the development of a reliable and valid MCQs bank.[17] Medical teachers should imbibe the skill of devising high standard MCQs as excellent assessment skills, which is an important attribute of an academic scholar.[18] In addition to assessment of the overall quality, it is also important to assess the difficulty index of the questions pertaining to the students. Tools to assess difficulty in MCQs exist although the utility of the best tool is still debated.[19]

Our study is limited in not having assessed the difficulty index of the MCQs, future studies should focus on this element. Additionally, the results of this study have to be considered with the limitations of few study participants. To conclude, we noted a significant improvement in the quality of MCQs following a single training session to the teaching medical staff. We recommend such training programs to be provided to the teaching faculty early in their career.

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Appendix 1: Questionnaire used to assess the appropriateness and quality of MCQs amongst the study participants.

Check list No	Criteria	Tick √ YES	NO	NA	Remarks
	Checklist for the general quality of MCQs				
1	Is the language used clear and simple?				
2	Are letters used in front of options instead of numbers?				
3	Is the item used of "completion" format?				
4	If yes then; is the blank for completion left in the beginning, middle or end of the stem?				
5	Is direction provided for the MCQ? a) If yes, is it appropriate for the content b) If no, what is lacking?				
6	Is time allotment for each MCQ provided?				
7	If yes, Will the time provided for the MCQ appropriate?				
8	Is the a) stem b) lead- in c) one key and d) three distracters provided?				
9	Is the length of stem long and the choices short?				
10	Is length of response and distracters same?				
11	Is the correct answer very lengthy?				
12	Are there any mistakes related to grammar, punctuation, spelling?				
13	Is there any repetition of words in stem?				
14	Is there any repetition of words in options?				
15	Is any word or phrase repeated in the stem as well as option?				
16	Are there abbreviations/eponyms/acronyms?				
17	Is the stem negative?				
18	If yes to the above mentioned question, has the word capital and bold/ underlined				
19	Are double negative terms avoided?				
20	Are the choices numeric				
21	If yes, are they arranged in ascending/descending order?				
22	Is the stem one word?				
23	Is the correct answer very lengthy?				
24	Is the key provided with the MCQ?				
25	Are phrases like: "None of the above" or "all of the above "been used?				
26	If yes to the above mentioned question, what is the percentage?				
Checklist for the appropriateness of the MCQ in terms of its content					
27	What level of cognitive domain is assessed?				
28	Can the item assess higher order thinking?				
29	Does the item check only trivial information?				
30	Is it based on an important learning objective?				
31	Is clinical scenario used instead of statement as the stem?				
32	Has superfluous information (window dressing) been provided as an introduction to the question?				
33	Are too many things being tested in a single question?				
34	What type of knowledge is tested with this MCQ? Comprehension/ Application /Analysis /Synthesis /Evaluation				
35	Is the key of the MCQ provided unambiguous?				
36	Are distracters based on common student errors misconceptions and misunderstandings?				
37	Are the distracters adequately different from the answer "Key"?				
38	Do distracters have meaning and are they related to question?				
39	Are options mutually exclusive and non-overlapping?				
40	Will answer take more time and great effort?				
41	Is the key obvious?				
42	Is the key debatable?				

43	Whether any clue is given in the same MCQ?
44	Is the construct prone to guessing?
45	Is the vocabulary and usage of language consistent with the student level of understanding of the subject matter?
46	Is there use of undefined or imprecise words like abundant, mild etc. avoided?
47	Are options irrelevant or nonhomogeneous?
48	Is use of over specific knowledge avoided?
49	Has any verbatim phrasing from textbook descriptions been used?
50	Is there any attempt to mislead or deceive test takers into answering incorrectly?
51	Does it provide clue by using faulty grammatical construction?
Checklist for overall Question Paper	
52	Is direction provided for the MCQ?
	a) If yes, is it appropriate for the content
	b) If no, what is lacking?
53	Considering the time for each MCQ, will the time for complete MCQ paper appropriate?
54	Whether any clue is provided in other MCQs?
55	If along with SAQ/LAQ, whether any clue is provided in them?
56	Questions with varying levels of difficulty included?
57	Is there focus on a single problem or idea for each test item?
	Is the direction provided again if there are any specific question demands?
	a) If yes is it appropriate for the content?
	b) If no what is lacking?
58	Are easy types MCQs being introduced in the beginning of the question paper?
59	Is the overall subject matter included in the paper?
60	Are the percentages in sub-table appropriate?
	How will you grade the MCQ Paper?
	a) Easy
	b) Moderate
	c) Difficult

Sub table			
Sr No	Types of questions	Number	Percentage
1	Recall		
2	Comprehension		
3	Application		
4	Easy		
5	Intermediate		
6	Difficult		
7	Single completion type		
8	Negative Form Type		
9	Case History Type		
10	Multiple Completion Type		
11	Independent True False Type		
12	Matching Type		
13	Assertion Reason (Relationship Analysis Type)		
14	Pictorial Type		