

A NOVEL ANALYSIS TO UNDERSTAND THE VARIABLE IN MULTIPLE RESPONSE MCQ (MR) SCORE

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ABSTRACT

Background: In the light of certain deficiencies of MCQs Type A, multiple correct response MCQs (MR) came into existence. However, MR format is not in common use, possibly because of difficulties in its marking scheme. We have reflected upon the approach of the students while solving the MR format and put forth a hypothesis about unintentional passive response which results into higher score in MR format. To prove this hypothesis the present study was planned. **Material and methods:** An adequate experimental design was used where same questions were created in MR and modified multiple true and false (MTF) formats. Same batch of the students solved both the formats in one sitting. **Results:** Mean score in MR format (13.33 ± 2.38) was significantly higher compared to MTF modified format (9.66 ± 2.78), thus proved the hypothesis. **Conclusion:** Higher score in MR format is attributed to unintentional passive response. Study highlights the importance of analysis of approach of the students while handling a particular format of MCQs.

Keywords: MCQ, Multiple Response MCQ, MTF MCQs, modified MTF, marking scheme

INTRODUCTION

Multiple choice questions (MCQs) are introduced long back and have distinct advantages. (1, 2) Reliability, superior validity, objectivity, accuracy are important features of MCQs besides easy and rapid scoring. (3, 4) Commonly used MCQs Type A have one option as correct or most appropriate; called as 'key' and other options being wrong or inappropriate, known as 'distracters'(5,6). However, there are certain limitations of MCQ Type A (7, 8); hence other formats of MCQs are introduced subsequently.

Multiple (correct) Response (MR) format MCQs have more than one correct option in a question. In a recent publication Siddiqui et al (9) have pointed out that a good quality questions, suitable to test higher cognitive skills with wider coverage of topics can be constructed using this format. However, possibly, because of issues related to the marking schemes, this format is not in common use. So a practically applicable marking scheme is suggested by Siddiqui et al (9)

Approach of the students while solving the questions in MR format is different than that of MCQ Type A. Student reads each option in the MR format and makes the decision about its correctness. Decision about individual option is not influenced by the decision taken for the other options; that is not so in case of MCQ Type A. This aspect has led us to present a hypothesis about the process of responding to options in MR format.

In MCQ Type A, student selects one option out of 4 as correct one and then indicates his selection by putting a tick mark at the space provided against the option. Thus we consider two components (a) making decision and (b) executing that decision by putting a tick mark. In MR format student reads each option, makes decision that the option is correct and then executes his response by putting a tick mark. We consider this is an active response. If he decides that the option is not correct (considers it as distracter) then he executes it by avoiding the tick mark; we consider it also as a response but label it a passive response as the process of putting a tick mark against the option is not involved. At certain options, the student because of confusion about correctness of options avoids a tick mark against the option. This will be like a passive response. If this particular option happens to be a 'key', the student will be deprived of the credit; but if this option happens to be 'distracter' then the student will get the credit (will score certain marks). In this case it is not the intention of the student to consider this particular option as distracter and purposefully avoid putting a tick mark against this option; but de facto, it results into gaining a credit if the option happens to be a distracter. We consider it as unintentional passive response.

Multiple True and False (MTF) is another format of MCQs where, instead of one, more options are 'true'. Thus, MR and MTF formats are much similar; with a difference that MTF is lacking the point of our hypothesis: unintentional passive response. We hypothesize that there is possibility of higher score in MR format because of unintentional passive response. This study plans to prove (or disprove) this hypothesis.

If the hypothesis is proved then, this study opens another tactic to analyze the evaluating instrument from different angle. Peculiarities of the question

format and approach of the students can be realized by the kind of analysis involved in this study. This will also make us aware about the additional factors which may affect the outcome of the test system.

MATERIALS AND METHODS

This study was carried out in second year MBBS students after approval from the institutional ethics committee. They were informed 2 weeks in advance about the MCQ test to be conducted on the topic (General Pharmacology) which was covered in the lectures. This gave them time for the preparation. It was scheduled as formative evaluation.

A set of 20 questions was selected; same questions were written in both formats, MR and MTF (modified, as detailed below), reviewed and pre-validated. In MR format, each question had 4 options, out of which 1, 2 or 3 options were correct options (keys). Marking scheme is based on the ability of student to tick mark the key/s and avoiding a tick mark on distracters/s. Students were given the questions-sheets where hollow circles (bubble) were provided against each option. Active response is supposed to be executed by darkening the bubble; referred as 'bubble-marking'. Thus bubble-marking on 'Key' or, avoiding bubble-marking on 'Distracter' would result into gaining ¼ marks. Each question carried 1 mark as illustrated by Siddiqui et al. (9)

Illustration of MR format:

Instruction for students: For each question there are four options out of which 1, 2 or 3 may be correct options (but not all 4); bubble-mark at the correct option/s.

Question:

Following statement are related to active transport of a drug across the biological membrane.

O	A	It is pH dependent
O	B	It requires energy
O	C	It is against the concentration gradient
O	D	It is common way of absorption of most drugs

Other format is a MTF format where each option has two responses as 'true' and 'false'. Student has to put a tick mark both for either selecting 'true' or 'false'; thus active response is involved. Even in a state of dilemma about correctness of an option putting a tick mark against 'true' or 'false' is involved; this is also an active response. Thus there is no situation like unintentional passive response in MTF format. Cronbach (10) has used term "acquiescence score" about the approach of the students while solving MTF format. Term "acquiescence" indicates acceptance or agreement unwillingly. It means that when there is no alternative but to mark the option as 'true' or 'false', there is tendency to guess the option as 'true' rather than 'false'. This guessing behavior is called "acquiescent" tendency and to avoid its interference, we made some modification in MTF format in our study.

Modification is in form of a provision of three possible 'responses' for each option in the question; one for 'True', other for 'False' and third one is for rejection of the option ('Not sure'). Each option if bubble marked correctly would result into ¼ marks; a negative mark would be minus 1/8 for each incorrectly marked option. Bubble-marking at 'not sure' would not get any mark. Negative marking and 'not sure' were meant to minimize the tendency of guessing.

Illustration of MTF modified format:

Instruction for students: For each question there are four options. Select the statements as True or False and fill up the bubble-marks appropriately. There will be negative marking; so if not sure about the correctness of the option you may use 'not sure' response.

Question:

Following statements are related to active transport of a drug across the biological membrane.

True	False	Not sure		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	a	It is pH dependent
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	b	It requires energy
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	c	It is against the concentration gradient
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	d	It is common way of absorption of most drugs

As a part of study, each student was supposed to attempt both the formats in one single sitting; thus each student was supposed to handle the same questions twice. When one solves a set of same questions in two formats in one sitting, there is a valid question if the first attempt of solving the questions would affect the performance at subsequent attempt with other format. To get the answer to this query, students were divided in two batches.

Study design

Batch of students	MCQ format solved first	MCQ format solved later
Batch 1	MR format	MTF modified format
Batch 2	MTF modified format	MR format

All precautions were taken to avoid any unfair means while solving the MCQs. Students were asked to note their opinion regarding preference of MR format or MTF modified format.

Scores in both formats were tabulated and compared on student's t test. Analysis was also extended to study other variables.

RESULTS

Though 97 students participated in the study, 11 students who did not attempt more than 20% options were not considered for further analysis, so the present analysis is pertained to 86 students.

Analysis of effect of solving the questions with two formats in one sitting:

Comparison of scores of both the groups (Batch 1 and Batch 2) in MR format and MTF modified format are shown in table 1 and table 2 respectively. Analysis on student's t test (11) showed that there is no statistically significant difference in the means of the scores in both the groups in MR and MTF format. This suggests that the first attempt of solving a set of the questions did not affect the performance at subsequent attempt with another format. In the light of above results the students from both batches were merged; thus each group had 86 subjects for further analysis.

Comparison of the scores with MR format and MTF modified format:

Mean score \pm SD with MR and MTF formats were 13.33 ± 2.38 and 9.66 ± 2.78 respectively as shown in table 3. Analysis on student's paired t test exhibited that score was significantly higher with MR format as compared to MTF format (Student's paired t test =16.81, df= 85; $p < 0.001$). On an average each student secured 18.35% more marks with MR format.

Analysis to speculate the reasons for the higher score with MR format:

A. Credit due to bubble-marking 'Key' (in MR format) or 'True' (in MTF modified format):

Mean score \pm SD in MR format was 8.55 ± 1.53 while with MTF modified format score was 8.44 ± 1.43 . Analysis on student's paired t test exhibited that there was no difference in the score with both the formats (Student's paired t test $t = 0.58$, $df = 85$ and $p > 0.1$). So the results indicate that change in the format of MCQ did not affect in selection as 'Key' or 'True'.

B. Credit due to **avoiding** bubble-marking the 'Distracter' (in MR format) or **selecting** bubble marking 'False' (in MTF modified format):

Score related to avoiding the 'Distracter' (MR format) was 4.79 ± 1.16 and score due to selecting 'False' (MTF modified format) was 3.11 ± 1.3 . Analysis exhibited that score with MR format was significantly higher as compared to the score in MTF modified format (Student's paired t test: $t = 10.4$, $df = 85$ and $p < 0.001$). These results showed that students had a higher total score in MR format; because of the component related to avoiding bubble-marking the 'Distracter'.

Attempt is made to find if there was any correlation between (a) difference in the total scores of individual student in the two formats and (b) difference in score of individual student, related to the component of avoiding bubble marking the 'Distracter' in MR format and selecting bubble-marking 'False' in MTF modified format. It is observed that correlation is significant (coefficient of correlation is 0.74).

Analysis of use of 'not sure' response in MTF modified format:

Large numbers of students have used this response ranging from 0 to 38 as shown in figure 1.

Opinion of the students on preference of the format:

An opinion was collected from the students about acceptability of the MR format or MTF modified format. No doubt, the collected opinion is not after a meticulous analysis by the students but it is a global expression about acceptability of the format in general. About 65% students preferred MTF modified format. This large difference pointing out the preference for MTF modified format may not be by chance only; however no comment can be made on the reason for the higher preference.

DISCUSSION

This study shows a comparison between two MCQs formats and also highlights a peculiar aspect of MR format. A concept of active, passive and unintentional passive response in MR format is elaborated in introduction and a hypothesis is put forth that with MR format there is possibility of higher score due to unintentional passive response. The comparison in two formats helped to prove this hypothesis.

Present study was carefully designed, taking into consideration the various aspects. Same students solved the same questions, in two different formats, in one sitting. This was done to analyze if the first attempt of solving the questions would affect the performance at subsequent attempt with other format. Data showed that the first attempt of solving a set of questions did not interfere with the performance at subsequent attempt with another format.

Results showed that students had a higher total score in MR format. Analysis of different components of scores in both the formats pointed out that the format did not affect the selection of 'Key' or 'True' in respective formats. However, when scores due the component related to avoiding bubble-marking the distracters in MR format and bubble-marking 'False' were compared, the score in MR format was higher. Thus our hypothesis seems correct. Low score in MTF modified format may be related to negative marking as

well as using 'Not sure' response. It appears that students are not consciously avoiding bubble marking the distracters; as the same student did not mark the same options as 'False' in MTF modified format. Thus the phenomenon appears as unintentional.

This analysis points out that there is a need to consider the students' approach while handling the MCQ format; this factor may affect the outcome, in the form of final score. As additional outcome of this study, following points are worth noting. Higher score because of unintentional passive response in MR format should not matter much when MR format is used for the formative evaluation. This analysis leads to suggestion that to minimize this effect, the number of distracters should be reduced to 2 or 1 and they are replaced by 'keys'; thus each MR item should have 2 to 3 keys out of 4 options.

This study also points that as the same questions of MR format can be written in MTF format, quality of the questions would be equivalent. It is to be noted that the MTF format elicits four responses per question (12) and thus more ideas related to one topic can be tested. (13) Dudley (14) has documented validity of the MTF as testing tool and Frisbie and Druva (15) have commented about reliability of MTF. In the light of these features MTF format can be an alternative to MCQ Type A to overcome certain shortcomings. Albanese et al. (16) had considered MTF format easier, more reliable and more valid as compared to complex multiple choice (CMC) questions; and had urged long back to the National Board Medical Examiners to explore alternative item formats in place of CMC items.

With MTF modified format provision of 'not sure' response is unique. For a given option when student is not certain about the correctness of the statement, instead of taking the chance he uses 'not sure' response. When large numbers of students are using 'not sure' response more often, may indicate the difficulty level of the question paper itself. It is observed that a large number of students have given favorable opinion for MTF modified format, which is of interest in the light of non popularity of MTF format. Well, true, their opinion is not based on an analytical basis but it is a statement of general acceptance of the format. After a good analytical

protocol Mobalegh A and Barati H (17) also have observed, that the students had opinioned regarding acceptability of MTF format.

In the light of above points, we believe that MTF modified format should be suitable for evaluation of higher cognitive skills and; needs its promotion. Acceptability from students may not be a problem.

Incidentally, because of functional similarities with MR format, MTF format was included in our study; no doubt to avoid possible "acquiescent" tendency the format was modified by introducing 'not sure' response to avoid the compulsion for guessing. These aspects would ensure the score on MTF modified format to be more realistic. Further study with this modified format is indicated, to understand its peculiarities.

CONCLUSION

Reflections on marking scheme of MR format led us to put forth the hypothesis that unintentional passive response is likely to result into higher score and the study proved this hypothesis and thus a peculiar aspect of marking scheme of MR format is manifested. This analysis points out that there is a need to consider the students' approach while handling the MCQ format; this factor may affect the outcome in the form of final score. Such analysis is possible if one looks into the components of the final score; it may appear peculiar but its importance should be realized by the senior experts in field of education.

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Table 1: Scores with MR format of both the groups

Group (number of students)	Mean Score (out of 20) ± SD with MR Format
Batch 1: MR format first (n=46)	13.09 ± 2.44
Batch 2: MTF modified format first (n= 40)	13.59 ± 2.28

t = 0.96, df = 84 and p = 0.34

Table 2: Scores with MTF modified format of both the groups

Group (number of students)	Mean Score (out of 20) ± SD with MTF modified Format
Batch 1: MR format first (n=46)	9.23 ± 2.8
Batch 2: MTF modified format first (n= 40)	10.16 ± 2.6

t= 1.55, df = 84 and p < 0.10

Table 3: Comparison of MR and MTF modified format

	MR format (n=86)		MTF modified format (n=86)		Test of significance		
	Mean	SD	Mean	SD	Student's paired t test		
					T	df	P
Mean Score (out of 20)	^a 13.33	2.38	9.66	2.78	16.81	85	< 0.001
Credit due to Key/True	8.55	1.53	8.44	1.43	0.58	85	> 0.1
Credit due to avoiding 'Distracter' / selecting 'False'	^b 4.79	1.16	3.11	1.3	10.4	85	< 0.001
Number of students opinioned the preference of the format	27		56		Chi square test $X^2 = 20.26$ df = 1 P < 0.00001		

^aMean score of MR format is significantly higher than that of MTF modified format

^bCredit due to avoiding 'Distracter' in MR format is higher as compared to selecting 'False' in MTF modified format

^cNumber of students preferred MTF modified format is significantly higher.

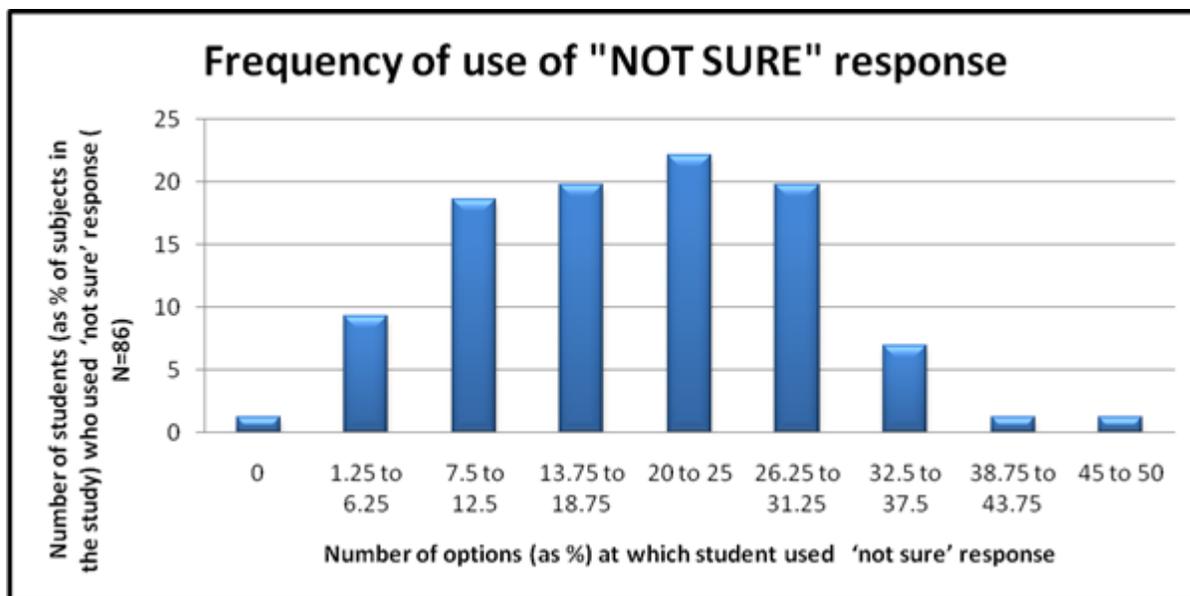


Figure 1: Frequency of use of response as 'not sure' with MTF modified Format

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