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Original Research Article

Item analysis as tool to validate multiple choice question bank in pharmacology

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ABSTRACT

Background: Multiple choice questions (MCQs) are a common method for formative and summative assessment of medical students. Item analysis enables identifying good MCQs based on difficulty index (DIF I), discrimination index (DI), distracter efficiency (DE). The objective of this study was to assess the quality of MCQs currently in use in pharmacology by item analysis and develop a MCQ bank with quality items.

Methods: This cross-sectional study was conducted in 148 second year MBBS students at NKP Salve institute of medical sciences from January 2018 to August 2018. Forty MCQs twenty each from the two term examination of pharmacology were taken for item analysis A correct response to an item was awarded one mark and each incorrect response was awarded zero. Each item was analyzed using Microsoft excel sheet for three parameters such as DIF I, DI, and DE.

Results: In present study mean and standard deviation (SD) for Difficulty index (%) Discrimination index (%) and Distractor efficiency (%) were 64.54±19.63, 0.26±0.16 and 66.54±34.59 respectively. Out of 40 items large number of MCQs has acceptable level of DIF (70%) and good in discriminating higher and lower ability students DI (77.5%). Distractor efficiency related to presence of zero or 1 non-functional distrator (NFD) is 80%.

Conclusions: The study showed that item analysis is a valid tool to identify quality items which regularly incorporated can help to develop a very useful, valid and a reliable question bank.

Keywords: Difficulty index, Discrimination index, Distractor efficiency, Item analysis

INTRODUCTION

Multiple choice questions (MCQs) are a widely used tool in assessment of medical students. MCQs have the advantage of having a high degree of objectivity and reliability and can assess a large area of the content in a small time-span.[1] Medical education technology recommends the implementation of standard pre-validation and post validation protocols to increase the validity of MCQs. Pre-validation prevents errors in framing MCQs by using guidelines and checklists, post validation helps to identify MCQs with questionable validity so that they can be modified before reuse or discarded.[1]

One-best MCQs are a form of assessment where the student selects the best possible answer from the list provided. This form of assessment has become popular in educational institutions. A large portion of curriculum is assessed in a short period of time requiring less effort on behalf of the student, although it takes a lot of effort and time spent by the examiner to make high quality one-best MCQs, as compared to descriptive questions. One-best MCQ is an efficient tool in identifying the strengths and

weaknesses in students, as well as providing guidelines to teachers on their educational protocols.[1]

All this is possible if the examiner knows the correct method of formulating a question, commonly referred to as an item, consisting of a stem and several options.[2]

Properly constructed multiple choice questions assess higher-order cognitive processing such as interpretation, synthesis and application of knowledge, instead of just testing recall of isolated facts.[3,4] MCQs are preferred over other methods for its (a) objectivity in assessment, (b) minimization of assessor's bias, (c) precise interpretation for content validity, (d) assessing a diversity of content, and (e) can be used with all subject areas. Item analysis enables identifying good MCQs based on difficulty index (DIF I) also denoted by FV (facility index), discrimination index (DI), and distractor efficiency (DE).[4,5]

Item analysis is a valuable, yet relatively simple, procedure performed after the examination that provides information regarding the reliability and validity of a test item. In addition, item analysis is also valuable for increasing instructors' skills in test construction, and identifying specific areas of course content which need greater emphasis or clarity.[5]

It also tells how difficult or easy the questions were, the difficulty index, and whether the questions were able to discriminate between students who performed well on the test, from those who did not, the discrimination index.[6] Another important technique is analysis of distractors, that provides information regarding the individual distractors and the key of a test item. Using these tools, the examiner is able to modify or remove specific items from subsequent exams.[7]

METHODS

This cross-sectional study was conducted in 148 second year MBBS students at NKP Salve institute of medical sciences from January 2018 to August 2018. Institutional ethics committee approval was taken. Forty MCQs twenty each from the two term examination of pharmacology were taken for item analysis. A correct response to an item was awarded one mark and each incorrect response was awarded zero.

For item analysis results of paper were ranked in descending order form highest marks to lowest marks. Then they were divided in three groups. The upper third (49) and lower third (49) were included in study and designated as high scoring group (H) and low scoring group (L) respectively. The middle one third (50) medium marks were not taken, assuming they behaved in similar pattern. Each item was analyzed for DIF I, DI and DE and mean and standard deviation were calculated in Microsoft excel 2013. DIF I, DI, DE were calculated as follows.[8,9]

DIF I = [(H+L) / N] × 100,

H= Number of students giving correct response in high score group.
L= Number of students giving correct response in low score group.
N= Total no of responses in both group.

DIF I of an item range between 0-100%

Criteria for categorization of DIF I is,

- DIF I>70% =Easy
- DIF I b/w 30-70%= Acceptable
- DIF I b/w 50-60%= Ideal
- DIF I <30 =Difficult

DI is the ability of a MCQ to differentiate the students getting high scores from low scoring ones. Formula used to calculate DI is

DI = 2 x [(H-L) / N]

DI is categorized as,

- DI≤0.2 = Poor
- DI b/w 0.21-0.24 =Acceptable
- DI b/w 0.25-0.34=Good
- DI ≥0.35 =Excellent

DE is the ability of incorrect answers to distract the students. If <5% students the incorrect answers it is called non-functioning distractor (NFD) distractor selected by more than 5% of student is functional distractor The range of DE is 0-100%.

DE is categorized on the basis of number of NFD in MCQ.

- MCQ having 3 NFD DE =0%
- MCQs having 2 NFD DE=33.3%
- MCQs having 1 NFD DE =66.6%
- MCQ having 0 NFD DE = 100%

RESULTS

The aim of current study was to carry out post validation analysis of MCQs using Difficulty index Discrimination index and distractor efficiency so as to determine whether questions should be included modified or discarded.

In the present study mean and standard deviation (SD) for difficulty index (%) discrimination index (%) and distractor efficiency (%) were 64.54±19.63, 0.26±0.16 and 66.54±34.59 respectively (Table 1).

DIF I of an item ranges between 0% and 100% It indicates the percentage of student who answered the question correctly Higher the value of DIF I, Item is easy

one and if low item is said to be difficult one. Questions with difficulty indices in range of 30-70% are considered acceptable. Ideal difficulty index is between 50-60%.

Table 1: Mean with standard deviation of various indices of items in the test (n=40).

Parameter	Mean±SD
Difficulty index%(DIF I)	64.54±19.63
Discrimination index (DI)	0.26±0.16
Distractor index% (DE)	66.54±34.59

Out of 40 items DIF I of 28 (70%) items had excellent level of difficulty and whereas 8 (20%) items were easy and 4 (10%) of items were difficult. Total 28 items can be considered as good MCQ and stored in the question bank (Table 2).

Table 2: Distribution of items in relation to DIF I and actions proposed.

DIF I cut off	Items (%) (n=40)	Interpretation	Action
<30	4 (10)	Difficult	Revise/Discard
30-70	28 (70)	Acceptable	Store
>70	8 (20)	Easy	Revise/Discard

DI of an item ranges between 0-1. It describes the ability of an item to differentiate between student of higher and lower ability. If DI value is high for item it differentiate more effectively the student of higher and lower ability. DI of ideal item is 1 and perfectly discriminate the student of higher and lower ability.

Table 3: Distribution of items in relation to DI and action proposed.

DI cut off points	Items (%)	Interpretation	Action
<0.35	10 (25)	Excellent	Store
0.25-0.34	16 (40)	Good	Store
0.2-0.24	5 (12.5)	Acceptable	Store/Revise
>0.2	9 (22.5)	Poor	Revise/Discard

Table 4: Distractor analysis and distractor efficiency.

Parameter	No (%)
Number of items	40
Total distractors	120
Functional distractors (FD)	84 (70)
Non-functional distractors (NFD)	36 (30)
No of items with 0 NFD/3FD (DE=100%)	16 (44)
No of items with 1 NFD/2FD (DE= 66.6%)	13 (36)
No of items with 2 NFD/1FD (DE= 33.3%)	7 (19)
No of items with 3 NFD/0FD (DE=0%)	5 (13)

Out of 40 items in this study 10 (25%) items had excellent DI, 16 (40%) items had good DI, 5 (12.5%) had acceptable DI and 9 (22.5%) had poor DI. Total 9 items were having poor discriminating level. Total 31 items can be considered as excellent to acceptable items (Table 3).

Out of 40 items with 120 distractors 84 (70%) were functional distractors (FDs) whereas 36 (30%) were nonfunctional distracters (NFDs). DE was 100% for 16 (44%) for nil NFD, it was 66.6% 13 (36%) items with one NFD, DE was 33.3% for 7 (19%) items with 2 NFDs and DE was 0% for 5 (13%) items for with 3 NFDs (Table 4).

DISCUSSION

Single correct response type MCQ is an efficient tool for assessing students. This efficiency solely rests upon the quality of MCQ. Item analysis is a valuable, relatively simple procedure performed after the test, used for analysis of item and test as a whole that provides information regarding the quality of test Items.[10,11] Systematic multiple choice question design and use of valid and reliable multiple choice questions are vital if results of assessment are to be considered valid. Content and face validity should be established by expert panel review and construct validity should be established, based on DIF I, DI, and DE.[10] In this study, the item analysis of multiple choice questions was done to evaluate the Difficulty index and Discrimination index and Distractor efficiency of 40 items.

The present study showed that out of 40 test items DIF I of 28 (70%) items was in acceptable range of 30%-70% and were stored as MCQs question bank for future use were as 8 (20%) items were easy and 4 (10%) items were difficult.

The study findings are nearer to another study which showed 62% items had DIF I (30-70%) 23% were too easy (DIF I>70%) and 15% were too difficult.[12]

The eight easy questions were slightly revised and kept for future use to boost the confidence of students. Similarly difficult questions can be retained and used to select toppers. Four difficult items were checked for possible confusing language areas of controversy, for any incorrect key and after revision they were kept to develop MCQs bank.[13,14]

Item discrimination refers to the ability of an item to differentiate between students of higher and lower ability on the basis of how well they know the material being tested.

In the present study the mean DI was 0.26±0.16.Out of 40 MCQs 10 (25%) of MCQs had excellent DI, while 16 (40%), 5 (12.5%), 9 (22.5%) of the students demonstrated good, acceptable and poor discrimination ability respectively. A total of 31 (77.5%) items were with excellent to acceptable discriminating power and were

stored in MCQ bank for further use and 9 (22.5%) of MCQ with poor DI were revised and stored. In the present study a total of 77.5% of the items had acceptable to excellent discrimination index of >0.20. The DI values of present study when compared with item analysis study by Patil and Patil reported similar percent (76%) of items had good to excellent discriminating power >0.20 and 24% had poor discriminating power.[15] Another study by Mehta and Mokhasi also showed 70% of items with good to excellent discriminating power nearer to our study showing in 77.5% of items.[16]

While framing good quality MCQs the cardinal rule is that the distractors must be plausible i.e. closely placed to correct answer which will increase the chances of choosing these distractors over correct answer by the learner. Implausible distractors deny chances to test learner. A distractor analysis gives an opportunity to study the responses made by student on each alternative of the item. NFD should be removed from item or it should be replaced with a more plausible option.[17] Our study sh**o**ws that out of total of 120 distractors 84 (70%) were functional distractors and 36 (30%) were NFDs. Items with NFDs were 25 (68%) out of which 13 (36%) items had DE of 66.6% and 7 (19%) had DE of 33.33% and items with DE 0 were 5 (13%). The remaining 15 (32%) item had DE of 100% with three functioning distractors. In a study conducted on 514 items and 1542 distractors, 35.1% were NFDs, 52.2% were functional distractors and 10.2% were not chosen by any student. [18] Another study by Mehta and Mokashi showed MCQs with 150 distractors 53 (35.33%) were found to be NFDs, 28 (18.66%) were functional distractors and 69(46.01%0 distractors had nil response. Student's performance depends on how distracters are designed. Analysis of distractors identifies their errors so that they may be revised replaced or removed.[19]

Assessment of MCQs by these indices highlights the importance of assessment tools for the benefit of both students and teacher. Item analysis when regularly incorporated can help to develop a very useful, valid and a reliable question bank with MCQs categorized into easy, difficult and ideal questions.

CONCLUSION

In the present study, large number of MCQs have acceptable level of DIF I (70%) and good in discriminating higher and lower ability students DI (77.5%). Distractor efficiency related to presence of zero or 1 NFD is 80%. This study highlights importance of item analysis. Through item analysis, standardized MCQs having average DIF, high discrimination power with large number of functioning distractors can be developed for use in future tests. Thus it is an effective way to improve the validity of examination and to efficiently assess the student performance.

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