

## ORIGINAL ARTICLE

# STRUCTURED VETTING PROCEDURE OF EXAMINATION QUESTIONS IN MEDICAL EDUCATION IN FACULTY OF MEDICINE AT UNIVERSITI SULTAN ZAINAL ABIDIN MALAYSIA

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## ABSTRACT

*The question vetting is an ongoing process that essentially is a teamwork represented by right combination of experts from within the teaching faculty. It is considered mandatory to maintain quality standard of any examination. Vetting sessions are not only used for screening of questions towards technical and language problems but vetting is also used to generate the content-related validity of assessment questions. The role of vetting committee has been emphasized in literature. However, implementation of question vetting in specially convened meetings is not without errors and problems are encountered if the faculty indulged in vetting does not adheres to an appropriately set vetting protocol. The objective of the study was to identify the percentage of errors to improve the quality of examination questions and to appraise the protocol of vetting at Faculty of Medicine, Universiti Sultan ZainalAbidin Percentage errors in current practice of question vetting were recorded and the need of adequately practiced vetting using a protocol was identified. A protocol based on different level of question evaluation was established. Two levels of vetting committee were identified with chairpersons and members selected from within the faculty. The role of committee members in vetting was established. However, a third level of vetting was exclusively practiced considering FM (UniSZA) a new medical school. Each level of vetting observed 10-30% changes suggested in originally structured questions by the experts with consensus of entire members of the vetting committee. This error was the initiative factor to subsequently design the formation of vetting committee with duly represented members. The vetting of question practiced with appropriate committees and prescribed guidelines was found important to improve the quality of items in assessment employed in second professional examination of MBBS program in Faculty of Medicine at Universit Sultan ZainalAbidin, Malaysia.*

**Keywords:** assessment questions, vetting, committee for vetting, quality questions.

## INTRODUCTION

A valid assessment consistent with global standard depends upon quality questions written by the teaching faculty. Ensuring and maintaining high quality standards in medical schools have become a mandatory task<sup>1</sup>. Vetting of examination questions is an ongoing process in medical institutions and is considered important to maintain quality standard of any examination<sup>2</sup>. A medical education program cannot afford to overlook this important procedure of examination process. It is the process of reviewing and evaluating question items according to specified criteria with the intention to detect flaws and to edit them accordingly to improve items quality<sup>3</sup>. Poorly structured items are the major threat to validity of assessment and it may directly reflect on students failing rate besides their proficiency and preparation for examination. It was found that non-violated items were associated with lower passing and higher failure rate than violated (flawed) items<sup>4</sup>. Such items are frequently encountered in many in-house tests<sup>5, 6</sup>. This ultimately leads to strong recommendation to establish review or vetting committees to improve item quality<sup>7</sup>. A subsequent evaluation conducted to investigate the effectiveness of the vetting

committee showed significant improvement in the quality of in-house examinations<sup>8</sup>. Some other study has established that there is no remarkable difference between edited and unedited items<sup>9</sup>. However, limitation of such studies should also be viewed together with conclusion drawn. Adherence to vetting procedures and reviewing weak items based on discrimination index is considered a source of improving the content and construct-related validity<sup>10, 11</sup>.

The roles of vetting committee have been described in literature<sup>12, 13</sup>. The review process must follow the prescribed principles and protocol to achieve the expected vetting outcome. The most important purpose of vetting is to review the item for its format to ensure item specific to assessment tool it belongs. Other purpose of items review is to determine the level of cognitive demand that the item intends to test and the content validity across the courses in curriculum. Besides these there are two more purposes of vetting of questions. Firstly, editorial review in which, items are checked for spelling, grammar and punctuation errors. Secondly, sensitivity and fairness review in which

personally, culturally and ethnically offensive terms are removed and substituted by suitable ones<sup>14</sup>. The initial evaluation of vetting of examination question practiced in the MBBS program of the Faculty of Medicine UniSZA was to identify the problems viewed as challenges in question vetting. Of these few common challenges were:

1. A chairperson either not identified to execute this important meeting or if appointed, he is not aware of term of reference as a well-written job description.
2. A regular member replaced by another member, who could not contribute as expected (e.g. content expert) in central vetting of questions meeting.
3. Module or end of posting assessment questions often are not vetted prior to central vetting, leading to compromises in technical and content aspects of vetting sessions that takes too long to accomplish the task. A question taking more than 15 minutes to be rectified is rather considered irreparable for correction.
4. The expectation to persuade every member to attend the vetting committee meeting is often not met due to lack of necessary protocol and practice of procedures in question vetting. This results in items poor quality.
5. The conflict of interest among the members, which leads to unnecessary arguments since a term of reference is not well defined for each member. Content experts, chairperson, coordinator and medical educationists must adhere to their defined role.
6. Vetting not being considered essential for in-house test such as continuous assessment or end of the clinical posting assessment is often not practised.
7. Another challenge that becomes imperative to practise is to determine the error of measurement to allow allowances to borderline students to minimize the impact of poor vetting and its associated flaws.
8. Finally the most encountered challenge, has been the one in which evaluation of assessment is either not performed or feedback based on item evaluation not provided to faculty engaged in question vetting. Evaluation of assessment adds to the vetting experience of members and should be incorporated with vetting process.

#### **Methods to Develop Question Vetting Protocol:**

The quality of vetting depends on, how the members prioritize their commitment to vetting. Whatever the reason it may be, the vetting

practice needs reforms and attention of hierarchy in medical institutions. A coordinator or chairperson alone cannot achieve the outcome expected of vetting if it is not practised with appropriate protocol and prescribed method. This raises a number of questions such as, how many levels of vetting do we need to ensure quality assessment questions. Who, when and how the vetting of examination questions should be done, is described below.

#### **Levels of vetting required:**

Ideally, the vetting of same examination questions should be carried out twice, first at course/module/posting/professional exam's coordinator level and then central level, involving two different vetting committees. Each item must be tested for technical, content and language aspects at module/posting level by those involved in delivering these modules/clinical postings before submitting it for central vetting. Phase or module coordinator can chair this vetting committee. An important task of this committee should include, observing the questions for its representativeness across the content taught in conjunction with relative amount of time spent in teaching/learning hours using blueprint of exam question. The next important job of this committee should include, looking into structure and principles of questions format and the language used. The vetted questions should then be sent to the academic office to be passed on to the chairperson of central vetting committee to relook into these items from technical, content and language aspects for fine-tuning.

#### **Who should do the vetting?**

The organization of vetting sessions implicates a teamwork comprising of teaching faculty members in different roles through equal contribution to improve the quality of test items. These interchangeable roles are. 1. Administrative aspect, primarily a responsibility of chairman or coordinator. 2. Technical aspects, taken care by medical educationists. 3. Content aspects with major input from subject experts, module coordinators and author of questions. 4. Language aspects contributed by all involved such as medical educationists, experts and coordinators. Ideally a review or vetting committee should comprise of a number of members in the panel depending on level of vetting (see table 1, 2 and 3). Usually two levels of vetting is recommended (table 1 and 2) however, considering Faculty of Medicine at UniSZA a new medical school extra precautions are taken to have an extra round of vetting under the Dean of Medical School to minimize the errors and optimize the quality of questions (see table 3). Review or vetting of the question should involve every level from continuous assessment to professional examination.

### **When should we do the vetting?**

The central vetting session should follow the course/module/departmental vetting committee meeting. The schedule should be issued by the academic office and sent out to all the members well before the date of the meeting. The members must mark their diaries and set their priorities to attend this meeting. For any valid reason that a member cannot attend the meeting, the relevant member or unit/department he/she belongs must provide a replacement. Academic office/chairman must be informed of this situation well ahead of time. The replacements should have similar expertise to take the responsibilities of person he/she is replacing.

The process involved in question vetting starts with the course/module/posting coordinator calling for questions from the lecturers involved in teaching of that module/posting few months before the semester or professional examination. Lecturers are informed of subject areas (module/discipline), type of questions and number of question to be submitted from each module/posting. Lecturers are also informed of definite date of submission and vetting committee meeting. All lecturers involved in setting of questions are also invited to attend the meeting, however, this should be optional. The number of questions from each module/discipline is invited according to weighting in curriculum determined by credit unit. A tabular form is preferred (see table 4). Phase coordinator, in case of professional examination and module/posting coordinator, in case of semester assessment will invite the questions on behalf of the academic office. Chairman central vetting committee, phase or module/posting coordinator will set the dates for central, module or clinical posting vetting sessions respectively. All members of vetting committee should be invited.

### **How should we do the vetting?**

The vetting of each question is carried out in a preselected venue on a scheduled date. Venue is provided with complete privacy, computer and screen to display questions, which is read by one of the coordinating person. Each member should mark attendance. Every one is allowed to comment on the questions with attention paid to technical, content and language aspects. The committee on the spot rectifies minor errors with one of the most suitable change suggested by the members. However, questions with major errors are referred back to question author for revision. The vetted questions are then submitted back to the chairperson, phase or module/posting coordinator depending upon the level of vetting committee. They are supposed to ensure the changes rightly accommodated before sending it to academic office for formatting into an examination paper draft. The draft is then sent to ultimate chairpersons such as deputy dean academic in case

of semester/professional examination and to head of department in case of module/end of clinical posting assessment for final review of technical or language compliance. After receiving it from the chairpersons, respective phase or module/posting coordinator sends it to the examination unit few days before the examination date for printing of question paper. The objective of present study is to identify the percentage of errors in initially submitted questions to rectify and improve the quality of examination questions at different levels of vetting with appropriately set protocol in undergraduate MBBS program at Faculty of Medicine, UniSA.

### **METHOD**

A comprehensive protocol (described in section who should do the vetting?) for vetting of exam questions in professional II examination was developed. The role of vetting committee member's (mentioned in section who should do the vetting?) besides when and how the vetting will be done was determined. A protocol depending on level of assessment was subsequently established and the individual member's role was also well defined (see tables 1-3). Three question vetting committees at different level of assessment were established with chairpersons and members identified from within the faculty. The experts with assigned role judged quality of questions on technique, content and language in vetting sessions. The vetting committees met one after another as per schedule released by the examination unit of Academic Office. The number of questions with major changes in content or format in the presence of experts was documented (highlighted). The record was subsequently used to calculate the percentage of errors in any one session. Minor changes in items were though numerous but were ignored after rectification.

The proper combination of members in the panel of vetting committee was provided and a perfect environment to learn vetting of questions techniques was created. Two different committees (see table 1 and 2) reflecting two levels of vetting depending upon the nature of assessment and faculty being involved to accomplish the task is usually considered sufficient. However, as mentioned before a third level (see table 3) of vetting was exclusively developed to ensure minimal errors in exam questions. Vetted questions from the module/clinical posting committee are forwarded to Academic office for central vetting. The same procedure is recommended for continuous or end of the posting assessment with an additional committee (see table 4). Example of information that a lecturer should be provided by coordinator when invited to write his part of examination questions is also provided (see table 5).

**Table 1: List of members and their number to be included in the panel of module/posting vetting committee for end of semester or end of posting assessment.**

No	Members Course/Module Vetting Committee	Number
1	Chairperson (preclinical or clinical phase coordinator)	One
2	Year coordinator of preclinical or clinical phase (with respect to course/module/posting under vetting)	One
4	Author of questions (from respective modules/discipline/posting)	One or more
5	All lecturers involved in teaching of respective module/posting	Optional

**Table 2: List and number of members to be included in the panel of central vetting committee.**

No	Members Central Vetting Committee	Number
1	Chairperson (senior faculty member/medical educationist)	One
2	Phase coordinator (preclinical or clinical phase of training)	One
3	Representatives from medical education unit/department	One
4	Paper/exam coordinator (MCQ, SAQ, OSPE/exam coordinators)	One
5	Subject experts (senior lecturers from modules/discipline)	Two or three
6	Question setters or authors (from respective modules/discipline)	Optional

**Table 3: List of members and their numbers to be included in the panel of ultimate vetting committee**

No	Members Ultimate Vetting Committee	Number
1	Chairperson (senior faculty member with experience of vetting)	One
2	Phase coordinator (preclinical or clinical phase of training)	One
3	Representatives from medical education unit/department	One
4	Module coordinators (also acting as experts of modules)	One or more
5	Paper/exam coordinator (MCQ, SAQ, OSPE/exam coordinators)	One
6	Subject experts (senior lecturers from modules/discipline)	Two or three
7	Question setters or authors (from respective modules/discipline)	Optional

**Table 4: List of members and their number to be included in the panel of vetting committee for continuous assessment.**

No	Members Vetting Committee for Continuous Assessment	Number
1	Chairperson (Course/module/posting coordinator)	One
2	Preclinical module or course coordinator or clinical posting coordinators (of respective course/posting under vetting)	One each
3	Author of questions (from respective course/modules/discipline)	All
4	Lecturers involved in teaching of respective course, module or respective clinical posting	Optional

**Table 5: Example of information provided to a lecturer for structuring the examination questions**

Preclinical Module/Clinical Posting	Meeting schedule of question vetting, 2014			
	Type of Question	Numbers	Submission date	Vetting date
MBBS Year I, Semester 2 Examination CVS Integrated Module	OBA	3	15 Feb	5 March
	MTF	3		
	PBQ	1		
	OSCE	1		
MBBS Year III, End of Clinical Posting Assessment	OBA	4	15 June	5 July
	MTF	4		
	PBQ	2		
ORL Clinical Posting	OSCE	1		

## RESULT

Errors followed by corrections were recorded at different levels of vetting from the initial submission of the questions by individual lecturers to three different levels of vetting committees (see table 1-4), reconsidering each item to improve the quality of questions in professional II examination.

10%-30% corrections were recorded (see table 6) to initiate restructuring of vetting committees that led to designing of appropriate vetting committees at different levels of expertise in medical institution. Emphasis nevertheless in this study was on, having appropriate vetting committees that may deliver to produce quality items for assessment in medical education.

**Table 6: % correction recorded from submission of raw questions at three different levels of vetting committees in clinical subjects of Professional II examination.**

Subjects	Vetting Level 1 % Correction	Vetting Level 2 % Correction	Vetting Level 3 % Correction
Internal Medicine	10-15	20-30	10-20
General Surgery	10-15	30-40	20-30
Orthopedic	10-15	10-15	10-20
Obstetric& Gynecology	Individual	10-20	20-30
Pediatric Medicine	Individual	20-30	20-30
Psychiatry	10-20	10-20	10-20
Family Medicine	Individual	20-30	10-20
ENT	10-15	10-20	10-20
Ophthalmology	Individual	20-30	10-20
Other Subjects*	Individual/10-20	10-20	10-20

\*Other subjects with few items only: Forensic medicine, Anesthesiology, Radiology and Dermatology

## DISCUSSION

The ability to write test questions requires knowledge of principle and technique of construction of test items besides skills of its application. The role of vetting has been well emphasized in literature and a short cut to this process often results in poorly structured question easily revealed on item analysis. Vetting sessions are not only used for screening of questions towards technical and language problems but vetting is also used to generate the content-related validity of assessment questions<sup>15</sup>. An exclusive session for content-related validity of question, if at all practiced, is done before the students actually take the examination. Arrangement of content validity session however, requires calling upon a number of subject experts, briefing them on purpose of assessment, program modules and outcome learning objectives to evaluate the content validity of items and measure. Most institutions do not find this process feasible and thus, as an alternative, responsibility goes to the vetting team whose job is to consider examination questions for compliance of technical and language as well as content aspects. This makes the vetting process a serious task for every faculty member in the vetting team, particularly those aiming to practice outcome-based education (OBE).

Vetting session held regularly therefore needs a sound system with prescribed structure that facilitates the procedure from writing of question to vetting of those questions. One of the most important objectives of vetting is to produce

quality items to ensure assessment of students' competency consistent with global standards. Vetting of questions is the responsibility of entire members of the vetting committee and not the job of an individual or a couple of persons. The role of vetting committee has been emphasized in literature<sup>16</sup>. Regularly conducted vetting is also important to meet the accreditation requirement. It has been experienced that the coordinator or the chairperson appointed for this task finds it difficult to deliver. The major problem for this difficulty is the lack of responsibility shown by the members who are not properly appointed as members of review or vetting committee. A vetting committee is strongly recommended to improve the items quality<sup>17</sup>. The aim is to treat the test items appropriately by removing flaws and making them as clear and understandable as possible<sup>18</sup>. Often the failure rates of students taking the examination is associated with flaws of poorly written items, which is a major threat to the validity of these assessments<sup>19</sup>. Vetting of questions applied in in-house or continuous assessment not only significantly improve item quality<sup>20</sup> but also provide training of vetting to junior lecturers at grass-root level.

It has been the experience of authors that in some disciplines the departmental vetting committee does not meet after the submission of initial questions. Also was noted that individual member who structured the question was not represented in central vetting committee meeting and the one

representing the department did not take the responsibility of questions under critical review with some major mistakes being identified by the committee members. It has also been reported in literature that the items written by experienced questions authors do have flaws<sup>21</sup>. Therefore it is not important who have written the question but more important is whether the constructed items have undergone a critical review by a vetting committee or not. The aim is to treat the test items and remove the flaws to make items as clear and as understandable as possible using a structured vetting program as part and parcel of assessment.

Knowing the importance of different levels of vetting, members should also take into account technical, content and language aspects of vetting of examination questions. They should be well aware of important guidelines that are specific to individual assessment instruments to be an effective evaluator in vetting. Important points of these aspects are:

#### **Technical Aspects:**

1. Each question should fit-in well in the recommended format required for its selected type.
2. The learning domain or the subject in question should aptly be suitable for the type of question it is selected.
3. Question should be appropriate for its time allocation to answer the question in each format.
4. Marks allocated for each question should be appropriate for its weighting compared to other questions in the format.
5. Key-words of command used should be appropriate for the type of question in assessment. Points to be specifically noted in each format are as under:

#### **Content Aspect:**

1. Questions should be very clear and comprehensible without any ambiguities on its face value.
2. Questions are representative of entire content from the subject area, module or discipline in curriculum with particular reference to these key-points:
  - a. Content covered in questions should be from the prescribed syllabus and have been taught by lecturers.
  - b. Information provided in questions should be valid, appropriate and current for subject in question.
  - c. There should be no significant overlap of content between the questions within the paper or across other papers in same examination.
  - d. Content tested should not violate the regulations or law of norms of real life situations.
  - e. The level of difficulty of questions should be

consistent with level of candidates' training.

- f. The range of questions should cover well from easy to difficult questions from the subject.
- g. The questions meet the learning objectives of the course in testing different cognitive dimension from factual recall of knowledge to comprehension, analysis application, synthesis and evaluation.
- h. Questions should also cover different dimension of knowledge, skills and procedures to test students' abilities.
- i. There should be no cueing effect in statement, problem, text or question that guides the students to a right or wrong answer.
- j. Content being tested should not culturally or racially provocative or sensitive to any group of students.

#### **Language Aspect:**

1. Standardized spelling of British orthography is preferred rather than a mix pattern of different orthography.
2. Language used in developing questions is simple, clear and direct, rather than words with indirect meaning and difficult to comprehend.
3. Colloquial language with inappropriate use of grammar and slang words should be avoided.
4. Spelling and typographic errors and grammar mistakes should be avoided.
7. Appropriate action-words such as discuss, describe, explain, illustrate or indicate should be used.
8. Punctuation marks used should be correct and proper that facilitates and improves reading than causing hindrance to flow in reading a statement.
9. Terminologies used should be current versions than those obsolete and out of fashion terms.

#### **Guidelines for Specific Assessment Instruments:**

There are numerous guidelines of item writing however, one of these is the revised taxonomy of multiple-choice item writing guidelines by Haladyna et. al., which is an extensive review of both educational textbooks and research studies<sup>22</sup>. Each assessment instrument has specific format that must be followed and maintained through out the multiple items examination paper by all question authors. For example OBA item must be ensured to have a well-written problem (clinical scenario) followed by a lead-in (question) and an option-list (multiple choices) from which to select the correct answer. Vetting process should ensure the formatting of individual assessment instrument as under:

- OTI (MTF):**
1. Each objective test item (OTI) popularly known as multiple true or false (MTF) items is structured with clear, short and precise stem to be able to answer in allocated time.
  2. Options covered in response list though heterogeneous should be integrated rather than discipline oriented.

3. All questions depict exclusively single problem rather than complex problem presented in the stem.
4. Items are avoided of cueing effect as far as possible.
5. It is encouraged to have some MTF items structured to test relatively higher thinking skills rather than simple recall of knowledge.

- MCQ (OBA):**
1. Problems in one best answer (OBA) items should be cleared of superfluous information.
  2. Questions should be answerable within the allocated time
  3. All questions should be with positive stems as far as possible and if negative words are necessary, they should be used with capital alphabets or turned bold.
  4. Words like not, never or except should be avoided as far as possible.
  5. Lead-in should be either in question form or as a statement.
  6. Problem is not repeated in lead-in or question is not raised in problem
  7. All options should have a reasonable chance of being selected as an answer
  8. Most of the options should be of similar length in each question.
  9. All options and the right answer should be homogenous and mutually exclusive options should be avoided.
  10. Options, which are synonymous, should also be avoided.
  11. Options should be presented in some logical order of clinical attributes, chronological order or alphabetical order.
  12. Option list should have one correct answer but distracters should not be obviously identifiable and should be approximate rather than opposite to correct answer
  13. Cues to key such as never, always or all should be avoided and vague qualitative modifiers such as many, large, most, much and important should be avoided too.

- PBQ:**
1. Problems-based question (PBQ) should trigger candidate's higher order thinking abilities.
  2. Questions developed from the clinical scenarios should depict different aspects of problem however, relevant to students level of training.
  3. Scenarios can be used to represent different clinical attributes that require clinical appraisal and test students' analytic reasoning, problem solving skills and decision-making abilities.
  4. Clinical scenario developed to depict different clinical attributes should be encouraged to represent real life situation from simple to a complex authentic case.

- OSCE:**
1. One should not be able to answer the question list provided with OSCE without looking at the exhibits.
  2. OSCE is the test of psychomotor dimension of skills rather than a written test that measures cognitive dimension of knowledge and it should be used to measure the practical or clinical skills.
  3. Developing OSCE question as test of knowledge without a clinical context to exhibit should be avoided.
  4. Interactive OSCE stations with checklist of yes or no should be preferred over rubric with multiple options of scoring, since it distracts examiners from gauging students' performance in an ongoing sequence of demonstration.
  5. Exhibits produced, like photographs, should be ensured to depict a clear picture and be well labeled.
  6. Duplicate stations in OSCE should be ensured to have a similar rather than different appearance.

## CONCLUSION

A vetting committee in medical schools should comprise of appropriate combination of members in the panel. Practicing vetting sessions with proper structure and procedure is considered a source of learning for those who may want to know, how to write test questions with knowledge of principle relevant to an item format, technique and skills of test construction it requires. Quality questions in assessment are judged on technique, content and language in vetting sessions. Vetting of question is an ongoing process that essentially is teamwork.

The quality of vetting depends on how the members prioritize their commitment to vetting. A coordinator or chairperson alone cannot achieve the outcome expected of vetting if it is not practiced with appropriate protocol and the prescribed method. All committee members must know their role and expertise that they are engaged in a vetting job. The vetting of examination questions with prescribed structure and protocol by faculty ensures to produce a consistently high standard of assessment question. In current experience at three different levels of vetting observed, 10-30% of correction to finally produce quality questions was an incentive to design the format of vetting committees for professional examinations of MBBS program in Faculty of Medicine at UniSZA. The vetting exercises conducted with appropriate protocol and documentation is of immense value in developing a question bank to serve as a source of vetted quality questions in assessment.

REFERENCES

- 1 Corrigan O, Ellis K, Bleakley A, Brice J. Quality in medical education. In: Swanwick T, editor. *Understanding Medical Education*. 1st ed: Wiley-Blackwell; 2010. p. 379 - 291.
- 2 Verhoeven BH, Verwijnen GM, Scherpbier AJJA, Schuwirth LWT, Van Der Vleuten CPM. Quality Assurance in Test Construction: The Approach of a Multidisciplinary Central Test Committee. *Education for Health: Change in Learning & Practice* (Taylor & Francis Ltd). 1999;12(1):49.
- 3 American Educational Research Association, American Psychological Association, National Council on Measurement in Education. *Standards for educational and psychological testing*. Washington DC: American Educational Research Association.; 1999.
- 4 Tarrant M, Ware J. Impact of item-writing flaws in multiple-choice questions on student achievement in high-stakes nursing assessments. *Medical Education*.
- 5 Downing S. Threats to the Validity of Locally Developed Multiple-Choice Tests in Medical Education: Construct-Irrelevant Variance and Construct Underrepresentation. *Advances in Health Sciences Education*. 2002;7(3):235-41.
- 6 Downing SM, Haladyna TM. Validity threats: overcoming interference with proposed interpretations of assessment data. *Medical Education*. 2004;38(3):327-33.
- 7 Lange A, Lehmann IJ, Mehrens WA. USING ITEM ANALYSIS TO IMPROVE TESTS. *Journal of Educational Measurement*. 1967;4(2):65-8.
- 8 Wallach PM, Crespo LM, Holtzman KZ, Galbraith RM, Swanson DB. Use of a committee review process to improve the quality of course examinations. *Advances In Health Sciences Education: Theory And Practice*. 2006;11(1):61-8.
- 9 Webb L, Heck W. The effect of stylistic editing on item performance. Paper presented at the annual meeting of the National Council on Measurement in Education, Chicago 1991.
- 10 Downing SM. Written Tests: Constructed-Response and Selected-Response Formats. In: Downing SM, Yudkowsky R, editors. *Assessment in Health Professions Education*. New York: Routledge; 2009.
- 11 Downing SM. The Effects of Violating Standard Item Writing Principles on Tests and Students: The Consequences of Using Flawed Test Items on Achievement Examinations in Medical Education. *Advances in Health Sciences Education*. 2005;10(2):133-43.
- 12 Hubbard JP. *Measuring Medical Education*, Philadelphia: Lea and Febiger; 1971.
- 13 Anderson J. *The Multiple Choice Question in Medicine* 2nd ed. London: PITMAN BOOKS LIMITED; 1982.
- 14 Haladyna TM. *Developing and validating multiple-choice test items*. 3rd ed: Lawrence Erlbaum; 2004.
- 15 Downing SM, Haladyna TM. Validity and Its Threats. In: Downing SM, Yudkowsky R, editors. *Assessment in Health Professions Education*. 1st ed. New York: Routledge; 2009.
- 16 Anderson J. *The Multiple Choice Questions in Medicine* 2nd ed. London: Pitman Books Limited; 1982.
- 17 Jozefowicz RFMD, Koeppen BMMDP, Case SP, Galbraith RMD, Swanson DP, Glew RHP. The Quality of In-house Medical School Examinations. *Academic Medicine*. 2002; 77(2): 156-61.
- 18 Verhoeven BH, Verwijnen GM, Scherpbier AJJA, Schuwirth LWT, Van Der Vleuten CPM. Quality Assurance in Test Construction: The Approach of a Multidisciplinary Central Test Committee. *Education for Health: Change in Learning & Practice* (Taylor & Francis Ltd). 1999; 12(1): 49.
- 19 Downing S. Threats to the Validity of Locally Developed Multiple-Choice Tests in Medical Education: Construct-Irrelevant Variance and Construct Underrepresentation. *Advances in Health Sciences Education*. 2002; 7(3): 235-41.
- 20 Wallach PM, Crespo LM, Holtzman KZ, Galbraith RM, Swanson DB. Use of a committee review process to improve the quality of course examinations. *Advances In Health Sciences Education: Theory And Practice*. 2006; 11(1): 61-8.
- 21 Baranowski RA. *Item Editing and Editorial*



Review. In: Downing SM, Haladyna TM, editors. Handbook of Test Development. Mahwah, NJ US: Lawrence Erlbaum Associates Publishers; 2006. p. 349-57.

- 22 Haladyna TM, Downing SM, Rodriguez MC. A Review of Multiple-Choice Item-Writing Guidelines for Classroom Assessment. Applied Measurement in Education. 2002;15(3):309- 33.