

## Original Research



# Comparison of emergency medical residency pre-board and board exams among universities of medical sciences in Iran

Mohammad Barzegar<sup>1,2</sup>, Reza Ghaffari<sup>2</sup>, Farzad Rahmani<sup>3</sup>, Amir Ghaffarzad<sup>3</sup>, Hamid Soltani Zangbar<sup>4</sup>, Solmaz Fallahi<sup>5</sup>, Amir Hossein Jafari-Rouhi<sup>1,2\*</sup>

<sup>1</sup>Department of Pediatrics, Tabriz University of Medical Sciences Tabriz University of Medical Sciences, Tabriz, Iran

<sup>2</sup>Medical Education Research Institute, Tabriz University of Medical Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>3</sup>Department of Emergency Medicine, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>4</sup>Department of Neuroscience and Cognition, Faculty of Advanced Medical Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>5</sup>Department of Physiology, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran

## Article info

### Article History:

Received: 10 Feb. 2020  
 Accepted: 18 Apr. 2020  
 ePublished: 6 June 2020

### Keywords:

Board exam, Difficulty factor, Discrimination index, Residency pre-board exam, Structural principles, Taxonomy

## Abstract

**Background:** Designing and conducting residency exams have been the province of type I universities since 2005, based on the plans of the Medical Education Council. This study compared emergency medical residency pre-board and board exam results among the universities of medical sciences in Iran.

**Methods:** This cross-sectional descriptive study consisted of 600 questions from residency pre-board exams and 150 questions from board exams in 2013-2014, as well as 600 questions from residency promotion exams and 150 questions from the board exam in 2013-2014 and 2014-2015 at the Tabriz, Shahid Beheshti, Mashhad, and Tehran Universities of Medical Sciences. All questions were at the level I through III by Bloom's taxonomy. Structural principles were evaluated using Millman's checklist. All data were analyzed using SPSS 18 with chi-square tests.

**Results:** The mean percent of more contextualized questions of the questions at Bloom's taxonomy levels II and III in residency pre-board exam questions was 76.6% in 2013-2014 and 86.6% in 2014-2015 among the four universities. In terms of structural principles, the percentage of board exam questions that aligned with Millman's structural principles was 100.0% and 99.3% in 2013-2014 and 2014-2015, respectively. For the residency pre-board exam in 2014-2015, the mean discrimination index was 0.14 (low), and the mean of the difficulty factor was 0.64 (appropriate).

**Conclusion:** Questions at Bloom's taxonomy levels II and III were higher in 2014-2015 in comparison to those in 2013-2014, and the percentage of the correctly-structured questions was high and did not significantly change from 2013-2014 in comparison to that of 2014-2015.

## Introduction

Testing is the most important means of measuring academic achievement. Tests that measure students' academic performance are divided into objective and subjective tests.<sup>1</sup> Multiple-choice questions are the most common form of questions in written exams, grouped by medical topics.<sup>2</sup> Like other test modes, multiple choice has advantages and disadvantages. Familiarity with these can significantly improve these tests. Among the advantages of multiple-choice tests is the fact that questions can be the

same for all students, along with feasibility, high reliability, ease of grading, and objectivity. Another advantage is that multiple-choice question can evaluate a wide range of learners' knowledge in a short period.<sup>3</sup> On the other hand, one significant limitation is the difficulty of designing questions according to clear rules and appropriate taxonomy.<sup>3</sup>

Although multiple choice tests are useful in examining the knowledge level of large groups of test subjects, a lack of familiarity with multiple choice design techniques

\*Corresponding author: Amir Hossein Jafari-Rouhi, Email: jafariroohi@yahoo.com

© 2020 The Author(s). This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, as long as the original authors and source are cited. No permission is required from the authors or the publishers.

significantly reduces the power and performance of this type of test.<sup>4</sup> The more questions are used in the design of the test, the more correct the taxonomy will be, resulting in more useful results to support the purpose of the test, which is to measure student attainment and knowledge retention.<sup>5</sup> One method for the preparation of theoretical questions is MCQs, for which Millman has created a checklist to evaluate question design accuracy.<sup>6</sup>

The taxonomy of an exam question is a classification in which the level of testable knowledge is measured. Its stages are Simple Reminder (Level I), Interpretation of information (Level II), and Problem Solving and Application (Level III). In this research, questions designed in Level I are questions with low taxonomy, and questions designed with Levels II and III are questions with high taxonomy. Questions with a higher taxonomy assess more profound understanding of the topic and thus will be of greater importance in measuring knowledge.<sup>7,8</sup> In Iran, these tests consist of two parts: written and oral, with a four-question written test.

Many studies have been conducted in various fields of medical sciences to examine multiple-choice question: for example, in the research. There was a significant percentage of questions in the four-question Structural Error Exam, and over 90% of the questions in the current study had low cognitive taxonomy.<sup>9-11</sup> Moreover, studies have also shown that only 6.5% of the items in the Nursing School Questionnaire were designed at Level III.<sup>12</sup>

In-country studies also show similar conditions, such that in the studies of Haghshenas and colleagues in Mazandaran,<sup>13</sup> Shakournia and colleagues<sup>14</sup> in Ahvaz a considerable number of questions (54% and 34/8% respectively) had structural problems. Shakournia et al<sup>14</sup> in Ahvaz and Bighlarkhani et al<sup>15</sup> in Hamadan found that most of the questions in the studied medical universities had lower levels of taxonomy: 89.4%, and 68.3%, respectively, and more than 75% of the questions were rated at low cognitive level.

Encyclopedia exams, and promotion of clinical disciplines in medical education residency courses, are conducted annually as a type of certification assessment used to rank and decide the promotion of assistants to higher years or to obtain a degree to serve the community. Since 2006, according to the Secretariat of the Medical and Specialty Education Council, designing and holding exams for promotion of clinical assistantships has been entrusted to type I medical universities to increase the participation of faculty members of medical departments of medical universities of the country, towards the independence of universities, the generalization of the transfer of educational powers. Thus it is necessary to review and evaluate this process (designing questions and conducting university promotion tests).

The purpose of this study was to compare items on the written promotion exams (2013 and 2014) of Emergency Medicine at the Tabriz, Tehran, Shahid Beheshti, and

Mashhad Universities of Medical Sciences, with the encyclopedia exam given in the same years, and compare them with the Emergency Medicine Certificate Exam in the same year. For years, particular attention has been paid to quality improvement management and intra-university examinations.

### **Materials and Methods**

In this cross-sectional descriptive study, the samples consisted of 600 questions from residency promotion exams and 150 questions from the board exam in 2013-2014, as well as 600 questions from residency pre-board exams and 150 questions from the board exam in the year 2014-2015 at Tabriz, Shahid Beheshti, Mashhad, and Tehran Universities of Medical Sciences. Sampling was done by a census of all questions in each year. The questions were evaluated using 12 items in Millman's checklist,<sup>6-16</sup> including stem clearness, negative options for stem, specific options, contrastive options, positive words in stem and options, writing structure of stem, duplicated options, spelling of stem and options, vertical writing of options, positivity of stem and options, and use of the "all of the above" and "none of the above" phrases in options. All questions were found to be at Levels I through III of Bloom's taxonomy and were evaluated independently by two experts in the related fields of medical education and research (including a board member of the pediatric subspecialties holding a master's degree in medical education). Guidelines were sent for each faculty member (experts) to ensure the correct understanding of the taxonomy in order to classify questions based on taxonomic definitions: Level I- ability to recall facts (memories), Level II- ability to interpret information, and Level III- ability to solve a new problem.<sup>7,8</sup>

If two experts disagreed in their determination of the taxonomy level of an item, a third assessor (specialist in the field and experienced test designer) examined the same item to make a final judgment. Respecting Millman's structural principles, the project manager studied the adjusted checklist. In terms of budgeting, the chapters related to each question were determined and matched with reference books by the project manager. The discrimination index and difficulty factor of promotion questions were obtained from the Tabriz University of Medical Sciences, and the results were compared.

### **Results**

#### ***Frequency and taxonomy in the pre-board and national board exam of emergency medicine***

Table 1 shows the frequency and taxonomy in the emergency medicine pre-board exam at the four universities in the years 2013-2014 and 2014-2015 as well as national board exam questions in the same years. The table indicates the frequency and percentage of questions with or without problems (based on Millman's checklist). In 2013, Shahid Beheshti University of Medical Sciences

**Table 1.** Taxonomic distribution of questions in written pre-board exam of emergency medicine at the universities studied 2013-2014 and national board exam in the same year

University	Exam type	Questions structure		Questions taxonomy		Questions taxonomy		
		No problem	With problem	I	II, III	I	II	III
		No. %	No. %	No. %	No. %	No. %	No. %	No. %
Shahid Beheshti	Pre-board,2013	140 (95.2)	7 (4.8)	27 (18.4)	120 (81.6)	27 (18.4)	65 (44.2)	55 (37.4)
	Pre-board,2014	148 (97.4)	4 (2.6)	16 (10.5)	136 (85.5)	16 (10.5)	74 (48.7)	62 (40.8)
Mashhad	Pre-board,2013	148 (98.7)	2 (1.3)	36 (24)	114 (76)	36 (24)	76 (50.7)	38 (25.3)
	Pre-board,2014	148 (98.7)	2 (1.3)	16 (10.7)	134 (89.3)	16 (10.7)	72 (48)	62 (41.3)
Tehran	Pre-board,2013	148 (98.7)	2 (1.3)	42 (28)	108 (72)	42 (28)	50 (33.3)	58 (38.7)
	Pre-board,2014	144 (96)	6 (4)	29 (19.3)	121 (80.7)	29 (19.3)	64 (42.7)	57 (38)
Tabriz	Pre-board,2013	148 (98.7)	2 (1.3)	35 (23.3)	115 (76.7)	35 (23.3)	56 (37.3)	59 (39.3)
	Pre-board,2014	136 (90.7)	14 (9.3)	20 (13.3)	130 (86.7)	20 (13.3)	53 (35.3)	77 (51.3)
National board	2013	152 (100)	0	13 (8.6%)	139 (91.4)	13 (8.6)	57 (37.5)	82 (53.9)
	2014	151 (99.3)	1 (0.7)	11 (7.2)	141 (92.8)	11 (7.2)	97 (63.8)	44 (28.9)

had 120 questions (81.6%) in the pre-board exam that were more contextualized according to Levels I and II than the other universities, while the Tehran University of Medical Sciences, with 108 questions (72.0%) in the pre-board exam, had less than other universities.

Most similarities between pre-board exams in 2013 and the national board exam the same year in terms of difficulty of questions belonged to Shahid Beheshti University of Medical Sciences. In 2014, the Shahid Beheshti University of Medical Sciences had 136 questions (89.5%) in the pre-board exam that were more contextualized questions according to Levels I and II than the other universities, while the Tehran University of Medical Sciences, with 121 questions (80.7%) in the pre-board exam, had less than other universities. The Shahid Beheshti University of Medical Sciences had the most similarities between their pre-board exam in 2014 and the national board exam in the same year in terms of question difficulty.

**“Budgeting” questions in the pre-board and national board exam of emergency medicine**

The number of questions per topic on the national board exam with written pre-board exams at the four universities compared, henceforth referred to as “budgeting” questions.

**Emergency medicine, Shahid Beheshti Medical University**

In 2013-2014, most of the questions on the pre-board exam for Emergency Medicine at Shahid Beheshti Medical University pertained to medicine and surgery topics (31, 21.1%) and trauma (50, 34%), while musculoskeletal and neurological procedures had the least (1 item, 0.7%). In 2014-2015, most questions were devoted to medical and surgical topics (45, 29.6%) and trauma (29, 19.1%) and soft tissue procedures, gastrointestinal, and vital symptoms had the least (1, 0.7%).

In 2013-2014, most of the questions on the pre-board exam for Emergency Medicine at Mashhad Medical University were on medicine and surgery topics (48, 32.0%), and trauma (23, 15.3%), and heart and specific procedures had the least (1, 0.7%). In 2014-2015, most questions were devoted to medical and surgical topics (49, 32.7%) and trauma topics (28 items, 18.7%), and evidence-based medicine and musculoskeletal and neurological procedures had the least (1, 0.7% of the total).

**Emergency medicine, Tehran Medical University**

In 2013-2014, most of the questions on the pre-board exam of Emergency Medicine at the Tehran University of Medical Sciences were on medicine and surgery topics (49, 32.7% of the total) and trauma (22, 14.7% of the total) and evidence-based medicine and anesthesia techniques had the least (1, 0.7% of the total). In 2014-2015, most questions were devoted to medical and surgical topics (51, 34.0%) and trauma (33, 22.0%), and gastrointestinal, respiratory procedures, and musculoskeletal and neurological procedures had the least (1, 0.7% of the total).

**Emergency medicine, Tabriz Medical University**

In 2013, most of the questions on the pre-board exam of Emergency Medicine at Tabriz Medical University were on medical and surgical topics (49, 32.7%) and trauma (22, 14.7%) and neurological and soft tissue procedures and preparedness for disasters had the least (1, 0.7%). In 2014, most items were devoted to medical and surgical topics (31, 20.7%) and trauma (24, 15.8%) and neurological and soft tissue procedures, and American Heart Association (AHA) had the least (1, 0.7%).

**National board exam of emergency medicine**

In 2013, most of the questions on the national board exam

of emergency medicine were from medicine and surgery topics (60, 39.5%) and trauma (24, 15.8%) and neurological and soft tissue procedures and gynecology had the least (1, 0.7%). In 2014, most questions were devoted to medical and surgical topics (50, 32.9%) and trauma (23, 15.1%), and neurological and soft tissue, heart, and gynecology procedures had the least (1, 0.7%).

**Discrimination index and difficulty coefficient of questions in the written pre-board exam at Tabriz University of Medical Sciences**

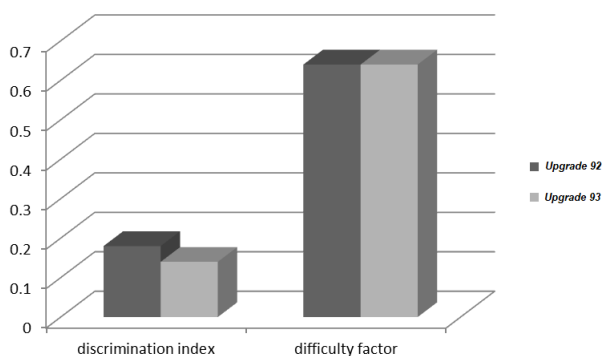
The average discrimination index and difficulty factor of the questions were examined for the written pre-board exam questions from emergency medicine at the Tabriz University of Medical Sciences in 2013-2014 and 2014-2015. In 2013, the discrimination index average was 0.18, and the mean difficulty factor was 0.64. In 2014, the discrimination index average was 0.14, and the mean difficulty factor was 0.64 (Figure 1).

**Response pattern in written pre-board exams at the Tabriz University of Medical Sciences**

In 2013-2014, in pre-board exam questions from Emergency Medicine at the Tabriz University of Medical Sciences, the number of questions that had all four options selected totaled 40. These questions are more reliable than other questions in terms of design because examinees chose all four options. That is, these questions were more difficult for examinees in terms of question design. To continue, the number of questions that had three options selected was 59, and the number of questions with two options selected was 40. In 2014-2015, the numbers were similar: 39, 58, and 39, respectively.

**Discussion**

For this study, the researcher made a qualitative and quantitative comparison of written residency pre-board exams in Emergency Medicine at the Tabriz, Tehran, Mashhad, and Shahid Beheshti Universities of Medical Sciences as well as the national board exam in 2013-2014 and 2014-2015.



**Figure 1.** Comparison of difficulty factors in pre-board exam questions at Tabriz University of Medical Sciences in 2013-2014 and 2014-2015.

Frequency and taxonomy for the pre-board and national board exams of Emergency Medicine showed that in 2013-2014, the average of Level II and Level III questions in the promoting exam questions across all four universities was 76.6% in 2013-2014 and 86.6% in 2014-2015. The statistics show more contextualized questions and an increase in questions at Levels II and III. For the emergency medicine questions of the national board exam in both 2013-2014 and 2014-2015, the Levels II and III averages were 91.4% and 92.8%, respectively. In one study, Mohagheghi et al<sup>17</sup> evaluated written pre-board exam questions and found that 38.7 ±18.9% of questions were designed at Levels II and III in 25 specialized clinical fields in 2007. These figures were 45±19.3 and 56±15.5 percent in 2008 and 2009, respectively, and indicate a growing trend of questions in terms of higher taxonomy levels. Shakournia et al, in a study of 2400 residency exam questions at Jundishapur University of Medical Sciences, found that more than two-thirds of the questions were at Level I and only 28% were at Levels II and III.<sup>18</sup> In a study conducted by Sanagoo et al<sup>19</sup> in the nursing field, 523 questions (fewer than 5%) were at Levels II and III. However, as mentioned, this number has an upward trend.

In the present study, comparing promotion exam questions in emergency medicine at the afore-mentioned universities showed an increase in the number of questions at Levels II and III between the years 2013-2014 and 2014-2015. Questions at Levels II and III increased from 114 (76%) to 134 (89.3%) at Mashhad University of Medical Sciences; from 115 (76.7%) to 130 (86.7%) at Tabriz University; from 108 (72%) to 121 (80.7%) at Tehran University; and from 120 (81.6%) to 136 (89.5%) at Shahid Beheshti University. At 13.3%, Mashhad University of Medical Sciences had the highest increase in designing more contextualized questions. In 2014-2015, the promotion exam questions, in terms of difficulty, were more similar to the national board exam in the same year: the number of questions at either Level II or III was 141 (92.8%). In this respect, the questions designed at Shahid Beheshti and Mashhad Universities of Medical Sciences were most similar to the questions in the national board exam.

In Sayyahmelli and colleagues' study<sup>20</sup> comparing the promotion exam questions at Tabriz University of Medical Sciences in 2000 and 2001 in internal medicine, pediatrics, general surgery and gynecology, a significant improvement in designing questions at more profound levels of learning Levels II and III was noticed, indicating improved skills of faculty members in designing questions. If exam questions only require the memorization of answer, students will be encouraged to memorize; however, if the question requires a need to interpret or solve a problem, students are encouraged to think critically and apply knowledge.

The exam questions were also examined in terms of structural problems of design. In 2013-2014 and 2014-2015, the questions on the national board exam of

emergency medicine were rated at 100.0% and 99.3%, respectively, indicating little or no problems in structure. For the universities involved in this study, values ranged from 90.7% to 98.7% in 2013-2014., also indicating few problems with structure.

In Sayyahmelli and colleagues' study,<sup>20</sup> questions without structural difficulty in pre-board exams in internal medicine, pediatrics, general surgery and gynecology at the Tabriz University of Medical Sciences in 2000 and 2001 were 55.0%-72.7% and 70.2%-72.7% on national board exams in the same years, showing an improvement in the structure of questions based on Millman's checklist. Mohagheghi et al<sup>17</sup> evaluated the national board written exam questions of 25 clinical disciplines in terms of Millman's structural principles from 2007 to 2009 and found that in 2007, 57.5 ±15.1% of questions, in 2008, 63.8 ±15.5 %, and in 2009, 60.6 ±18.9% were structured without few to no problems. Khoshrang et al<sup>21</sup> found that 66.8% of questions on Guilan University residency exam had no structural problems in 2000; this number rose to 75.2% in 2001.

In the current study, the most common problems in the structure of the questions included inconsistency of options and negative stems. Meyari et al<sup>22</sup> found that educational interventions in designing multiple-choice exams can improve the quality of residency exams. In this regard, the Haghshenas et al<sup>13</sup> of Mazandaran University of Medical Sciences found that the most common problems of items were nonvertical alignment of options, inconsistency of options, and not including the central part of the information in the question stem.

Khoshrang et al<sup>21</sup> emphasized the need for more attention to testing principles. Planning to increase the knowledge, skill, and attention of faculty members in this field can help increase this trend and improve the design of multiple-choice questions. In order to improve the current situation, it is recommended that, in addition to suitable training courses, educational groups be organized to help improve these exams through continuous assessment of residency exam questions and feedback.

In this study, pre-board exam budgeting in emergency medicine was examined at Tabriz, Tehran, Mashhad, and Shahid Beheshti Universities of Medical Sciences as well as the national board exam in the same field in 2013-2014 and 2014-2015. Most of the questions on the pre-board exams and the national board exam were related to medicine and surgery. The Tabriz University of Medical Sciences scored the lowest (20.7%) in pre-board tests of Medical Sciences in 2014-2015, and the highest was scored by Tehran University of Medical Sciences (34.0%). For the national board exam, 39.5% were allocated in 2013-2014 and 32.0% in 2014-2015. The next topic to which the most questions were devoted was trauma, ranging from the lowest at 14.7% for the Tehran University of Medical Sciences in 2013-2014 and the highest at 23.3% for the Tabriz University of Medical Sciences in 2013-2014. For

the national board exam, the percentages were 15.8% and 15.1% in 2013-2014 and 2014-2015, respectively. The questions least likely to be included in both pre-board and national board exams were related to gastrointestinal, musculoskeletal, neurological, and evidence-based medical procedures. In the proposed table for budgeting pre-board exam questions of emergency medicine at Tabriz Medical University, 51 (34%) questions for medicine and surgery, and 33 (22%) questions for trauma are recommended. As mentioned, designing pre-board exam questions for the mentioned universities similar to the table has been recommended.

In the present study, the discrimination index and difficulty factor for written pre-board exam questions in emergency medicine at Tabriz University of Medical Sciences in 2013-2014 and 2014-2015 were also studied. The discrimination index average in pre-board exam questions was 0.18 (low), and the mean difficulty factor was 0.64 (appropriate) in 2013-2014. The discrimination index average in promotion exam questions was 0.14 (low), and the mean difficulty factor was 0.64 (appropriate) in 2014-2015. In a study carried out by Pourmirza Kalhori et al<sup>23</sup> at the Kermanshah University of Medical Sciences on pre-board exam questions in 2012, the percentages of questions in terms of difficulty factor are as follows: 9.7% difficult, 59.5% proper, and 30.8% easy; the mean was 64.0%. The average discrimination factor found in this study was 0.23. Kim et al<sup>24</sup> reported in 2012 that questions with higher taxonomy levels have a higher discrimination index and a higher degree of difficulty factor.

This study also examined the response pattern to questions on the pre-board exam of Emergency Medicine at Tabriz University of Medical Sciences in 2013-2014 and 2014-2015. Questions which have all four options chosen by respondents are considered reliable in terms of design; that is, these questions are more difficult for examinees in terms of question design. The numbers for four-option questions were similar in 2013-2014 and 2014-2015 at 40 and 39, respectively. The numbers for three-option questions were 59 and 58 questions in 2013-2014 and 2014-2015, respectively. The numbers for two-option questions were 39 and 39, in 2013-4 and 2014-5, respectively.

Khoshrang et al<sup>21</sup> noted that holding workshops has been effective in helping to design multiple-choice questions, likely due to proper design and consistency of workshop objectives as well as transparent, objective and applied use of questions designed on the residency exam for each department in order to obtain feedback during the workshop. Meyari et al<sup>22</sup> found that holding workshops on teaching proper design of questions accompanied by clear, objective, and applied examples was useful.

Overhauling memory-based questions is a longstanding problem in the medical education system. It can be said that this problem was seen in almost all exams at all educational levels. This situation pushes students to

acquire knowledge that is shallow and easily memorized. One of the reasons for the over-use of such knowledge level questions is that such questions are efficiently designed compared to higher levels of the taxonomy. However, in recent years, a considerable number of questions have been designed at more cognitively complex levels due to the emphasis of the Council of Medical Specialties in the Ministry of Health. Efforts of the learning management system have been effective in encouraging designers to prepare questions.

#### Ethical approval

This article is the result of a master's thesis approved by the Department of Medical Education, which has passed the approval process according to the approvals of Tabriz University of Medical Sciences. This study did not have specific ethical considerations.

#### Competing interests

The authors declare that there is no conflict of interest.

#### Authors' contributions

Data collection was done by FR, AG and AHJ. Data were analyzed by MB, AHJ and RG. The manuscript was written by AHJ and RG and manuscript edition was done by HS and SF. Final confirmation of this article was done by AHJ, HS and SF.

#### Acknowledgment

The study is the result of a research project approved by the Medical Education Development Center at the Tabriz University of Medical Sciences. The researcher would like to thank all the colleagues who helped in the preparation of exam questions. Finally, render thanks to the education deputy and the Medical Education Development Center, Tabriz University of Medical Sciences.

#### References

1. Zolfaghari B, Asadollahi GH. Academic Achievement Tests in Medical Sciences. Isfahan: Isfahan University of Medical Sciences; 2000. [Persian].
2. Burton SJ, Sudweeks RR, Merrill PF, Wood B. How to Prepare Better Multiple-Choice Test Items: Guidelines for University Faculty. Provo, Utah: Birgham Young University Testing Services, the Department of Instructional Science; 1991.
3. Haladyna TM, Downing SM, Rodriguez MC. A review of multiple-choice item-writing guidelines for classroom assessment. *Appl Meas Educ*. 2002;15(3):309-33. doi: 10.1207/s15324818ame1503\_5.
4. Danish KF, Khan RA. Role of effective feed back in Multiple Choice Questions (MCQs) designing for faculty development. *Journal of Rawalpindi Medical College*. 2010;14(2):98-100.
5. Azizi F. Medical Education, Mission, Vision, and Challenges. 1st ed. Tehran: Shahid Beheshti University of Medical Sciences; 2003. p. 659-705. [Persian].
6. Lockyer J, Carraccio C, Chan MK, Hart D, Smee S, Touchie C, et al. Core principles of assessment in competency-based medical education. *Med Teach*. 2017;39(6):609-16. doi: 10.1080/0142159x.2017.1315082.
7. Guilbert JJ. Education Handbook for Health Personnel. 7th ed. Geneva: World Health Organization; 1998. p. 237-54.
8. Buckwalter JA, Schumacher R, Albright JP, Cooper RR. Use of an educational taxonomy for evaluation of cognitive performance. *J Med Educ*. 1981;56(2):115-21. doi: 10.1097/00001888-198102000-00006.
9. McCoubrie P. Improving the fairness of multiple-choice questions: a literature review. *Med Teach*. 2004;26(8):709-12. doi: 10.1080/01421590400013495.
10. Hammond EJ, McIndoe AK, Sansome AJ, Spargo PM. Multiple-choice examinations: adopting an evidence-based approach to exam technique. *Anaesthesia*. 1998;53(11):1105-8. doi: 10.1046/j.1365-2044.1998.00583.x.
11. Tarrant M, Knierim A, Hayes SK, Ware J. The frequency of item writing flaws in multiple-choice questions used in high stakes nursing assessments. *Nurse Educ Today*. 2006;26(8):662-71. doi: 10.1016/j.nedt.2006.07.006.
12. Masters JC, Hulsmeyer BS, Pike ME, Leichy K, Miller MT, Verst AL. Assessment of multiple-choice questions in selected test banks accompanying text books used in nursing education. *J Nurs Educ*. 2001;40(1):25-32.
13. Haghshenas MR, Vahidshahi K, Mahmudi M, Shahbaznejad L, Parvinnejad N, Emadi A. Evaluation of multiple-choice questions in the school of medicine, Mazandaran University of Medical Sciences, the first semester of 2007. *Stride Dev Med Educ*. 2008;5(2):120-7. [Persian].
14. Shakournia A, Khosravi Boroujeni A, Mozaffari A, Elhampour H. An Evaluation of Exam Questions Designed by Faculty Members, Emphasizing on the Multiple-Choice Question Structure, Ahvaz Jundishapur University of Medical Sciences, 2007. *Strides in Development of Medical Education*. 2009;6(2):129-38. [Persian].
15. Bighlarkhani M, Meyari A, Falah M, Zamanian A. Improvement of Design of Multiple Choice Questions in Annual Residency Exams by Giving Feedback. Hamedan: Hamedan University of Medical Sciences; 2009. [Persian].
16. Sayar F, Vatanpour M, Ghasemi M, Shabahangfar MR. Effect of the educational pamphlet on the quality of multiple-choice questions. *J Islam Dent Assoc Iran*. 2016;28(4):118-25. doi: 10.30699/jidai.29.4.118.
17. Mohagheghi MA, Vahidshahi K, Shakeri S, Sabouri M, Razavi SM, Mohammadi M, et al. Evaluation of Some Quality Index of Multiple-Choice Questions in the Board Exams in Medicine from 2005-2007. Ministry of Health; 2013. [Cited 2013 July 20]. Available from: [http://cgme.behdasht.gov.ir/uploads/264\\_975\\_Maghale\\_ShakhesKeifiyat.pdf](http://cgme.behdasht.gov.ir/uploads/264_975_Maghale_ShakhesKeifiyat.pdf). [Persian]
18. Shakournia A, Mozaffari A, Khosravi Boroujeni A. Survey on structural of multiple-choice questions of residency exam in Ahvaz Jundishapur University of Medical Sciences. *Jundishapur Scientific Medical Journal*. 2010;8(4):491-502. [Persian].
19. Sanagoo M, Jouybari L, Ghanbari Gorji M. Quantitative and qualitative analysis of academic achievement tests in Golestan University of Medical Sciences. *Research in Medical Education*. 2010;2(2):24-32. [Persian].
20. Sayyehmelli M, Barzegar M, Bilan N, Aslanabadi S, Khosbaten M, Ghasemzadeh A, et al. Comparison multiple-choice questions quality parameters of pediatric, general surgery, internal medicine and gynecology and obstetrics residency tests between preboard examination of Tabriz University of medical sciences and national

- board examination in 2010 and 2011. *Journal of Medical Education Development*. 2015;8(18):43-53. [Persian].
21. Khoshrang H, Taheri M, Asadi A, Hidarzadeh A. Quality of residents' promotion exams before & after educational intervention in 2010-2011. *Iranian Journal of Medical Education*. 2013;13(7):551-60. [Persian].
  22. Meyari A, Biglarkhani M, Zandi M, Vahedi M, Miresmaeili AF. The effect of education on improvement of multiple-choice questions' designing in annual residency exams of dental school. *Iranian Journal of Medical Education*. 2012;12(1):36-45. [Persian].
  23. Pourmirza Kalhori R, Roshanpour F, Rezaei M, Naderipour A. Academic member's knowledge improvement effect on the results of multiple-choice questions in residency exams analysis (2009). *Journal of Kermanshah University of Medical Sciences*. 2011;15(2):112-8. [Persian].
  24. Kim MK, Patel RA, Uchizono JA, Beck L. Incorporation of Bloom's taxonomy into multiple-choice examination questions for a pharmacotherapeutics course. *Am J Pharm Educ*. 2012;76(6):114. doi: 10.5688/ajpe766114.