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Psychometric properties of the Persian version of the Anesthetic Trainee Theatre Educational Environment Measure (ATEEM)

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Abstract

Background: The quality improvement of medical education programs and the ongoing reform of the curriculum should be done in the light of clinical training fields and identifying the strengths and improving the weaknesses. Therefore, this study was conducted to evaluate the validity and reliability of ATEEM (Anesthetic Trainee Theatre Educational Environment Measure) questionnaire for assessing learning environment of anesthesiology residents in educational centers affiliated to 3 main medical schools in Tehran, Iran.

Methods: This study was conducted on first to fourth year anesthesiology residents using a questionnaire. Validity (face, content, construct) and reliability of ATEEM questionnaire was investigated. Construct validity was measured by confirmatory factor analysis, stability of reliability by test-retest, and internal consistency by Cronbach's alpha.

Results: A total of 156 questionnaires out of 190 were fully answered, returned by residents of anesthesiology, and analysis were performed (82% response rate; 44.5% male (n=69); 55.5% female (n=86)). The age range of respondents was 26 to 48 years. The mean total ATEEM score was 114.03 out of 160. Face and content validity of the questionnaire was approved. Content validity ratio (CVR) and content validity index (CVI) were 0.63 and 0.88, respectively. Fitness indices in confirmatory factor analysis were greater than 0.9, and RMSEA (root mean square error of approximation) index was less than 0.08 (0.07). This indicator measures the acceptability of fitness and it is an appropriate measurement model. The average reliability coefficient was 0.73 and the overall Cronbach's alpha coefficient was 0.959.

Conclusion: The results of this study showed that the Persian version of the ATEEM questionnaire, with appropriate psychometric properties, can be used to evaluate the anesthetic trainee theatre learning environment used in hospitals.

Keywords: Validity, Reliability, Learning environment, Anesthesiology residents, ATEEM questionnaire

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Introduction

Based on adult learning theory, education is to create an environment favorable to learning, knowledge transfer, and sharing experiences (1). Education both conveys information and shares the experiences and establishes an environment favorable to learning. Educational programs (curriculum) is the most influential factor in the learning

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↑What is "already known" in this topic:
The clinical learning climate is believed to influence learners' behavior and predict medical students' satisfaction and success. One way to evaluate the quality of training programs is to evaluate the learning climate. Thus, understanding these educational environments and subenvironments is fundamental to managing curriculum development and change.

→What this article adds:
In order to improve the learning experience, learning outcomes, and performances, the learning climate needs to be monitored. One approach to study the clinical learning climate is using valid and reliable instruments to measure this concept.

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environment, and learning environment is the most effective factor in determining behavior of different parts in education (2). In 1998, the World Federation of Medical Education (WFME) emphasized the role of the learning environment as one of the purposes of the evaluation of medical education programs (3). Evaluation of the learning environment is the key to providing high quality medical education; however, such an evaluation requires valid and reliable tools (4). Measuring practice is an essential component of scientific research in the natural, social, and health sciences (5). Quantitative measures in learning environment require tools or questionnaires. Such a tool should be selected based on the quality of measurement process. Quality or psychometric properties are usually considered under 2 main headings: reliability and validity. A valid and reliable instrument measures the learning environment of an institution meaningfully. As a result, an appropriate measurement tool will improve the learning environment (6).

Many tools have been developed to measure learning environment.

DREEM (Dundee Ready Educational Environment Measure), a measurement tool to assess learning environment in University of Dundee, was used to measure the perceived educational environment by medical students, nurses, dentists, etc. (7). PHEEM (Postgraduate Hospital Educational Environment Measure) questionnaire is used to study postgraduate medical education environment (8). ACLEEM (Ambulatory Care Learning Education Environment Measure) is designed to assess the educational environments of ambulatory care (9). STEEM (Surgical Theatre Educational Environment Measure) and OREEM (Operating Room Educational Environment Measure) are measurement tools used to understand the learning environment by surgeons in surgery rooms, and ATEEM (Anesthetic Trainee Theatre Educational Environment Measure) is a tool to measure learning environment in anesthesia (10). Patel & Dauphinee found that clinical learning environment is not the same in different disciplines (11), so specific tools are requires to measure learning environment.

Anesthesiology is one of the important fields in medicine. Much of the anesthetic curriculum is taught in the operating room, for which limited educational environment research has been done. According to Roff & McAleer (1997), by identifying the elements of the climate of operating room and using a validated theatre educational environment assessment tools and finding how these factors are perceived by trainees, we can have the basis for modifying them to increase our learning experiences (12). The aim of this study was to obtain a valid and reliable tool to identify the educational environment of anesthesiology residents in operating rooms. This study could help to identify the strengths and weakness of anesthesiology educational environment and assist the authorities to improve the quality of education. Also, conditions for a successful learning will be prepared by designation and implementation of required interactions and proceedings.

Methods

Type of study

This cross sectional study was conducted in 2014. The studied population consisted of 225 under training anesthesiology residents in educational centers affiliated to Tehran, Iran, and Shahid Beheshti Universities of Medical Sciences. All anesthesiology training residents of both genders were included in this study. Inclusion criterion was presence in the operating room for at least 1 month. Exclusion criteria were incomplete questionnaires and residents' unwillingness to participate in the study. Finally, 190 residents participated in the study and their comments about educational environment of the operation room were collected using ATEEM questionnaire.

ATEEM questionnaire

ATEEM has 2 sections: the first section is demographic information which includes age, sex, marital status, and academic year. The second section consists of 40 items in 5 domains. There was a scale of 0-4, with the maximum score of 160 and the minimum score of 0. Each item was rated on a 5-point Likert scale (4 = strongly agree, 3 = agree, 2 = unsure, 1 = disagree, 0 = strongly disagree). The maximum score of each domain is calculated by number of questions multiplied by the maximum score of items: autonomy (8 × 4 = 32 max), perceptions of atmosphere (10 × 4 = 40 max), workload/supervision/support (7 × 4 = 28 max), perception of teachers and teaching (5 × 4 = 20 max), learning opportunities and orientation to learning (10 × 4 = 40 max). The 2 negative items (items 14 and 18) were reversed for scoring.

The following guide was used to interpret the ATEEM's overall score. The division was based on the opinions of an expert statistician and an expert in medical education. The overall scores were classified into 5 groups: very undesirable (0 to 31.99), undesirable (32 to 63.99), moderate desirable (64 to 95.99), desirable (96 to 127.99), and very desirable (128 to 160). Undesirable environment is an environment where the negative aspects of the educational environment are more than the positive. In desirable environment, positive aspects are more than the negative, and a semi-desirable environment needs to be moderated.

Validity and reliability

Permission was obtained from the developer of the original questionnaire to translate it into Persian, which was done by a qualified translator. Then, the 2 translations were integrated into a single copy. The Persian version was reviewed and updated by an expert panel (the supervisor and advisor professors).

The Persian version was evaluated for quality of translation, which included resolution of translation and applying common language and conceptual equivalence. Then, errors in understanding the meanings of sentences were modified. The Persian questionnaire was translated into English by the translator who was unaware of the original questionnaire transcript. Retranslated questionnaire was adapted to original transcript and gaps were modified, and eventually the retranslated questionnaire was emailed to the original developer to evaluate the conformity process,

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and she confirmed the validity of the final version.

Face validity of the questionnaire was evaluated through appearance, rational introduction, appropriate sequence, and legibility of questions.

To achieve content validity, the questionnaire was presented to 15 professors of anesthesiology and medical education by email and in person. To determine content validity, content validity index (CVI) and content validity ratio (CVR) were applied.

To determine content validity ratio, 15 anesthesiology and medical education experts were asked to check each item based on a 3-degree scale (essential, useful but not essential, not necessary).

Numeric value of CVR is determined according to Lawshe table. Thus, If CVR is higher than 0.49 (based on evaluations of 15 experts), then, the item is acceptable (13).

Sometimes it is necessary to assign weights to calculated CVRs for different items. Based on Lawshe suggestion, to calculate the mean value of the judgment assigned to each component of the tools, the following conversions in the validity of the questionnaire are done:

E: Indicates “essential” and replaced by 2.

U: Indicates “useful but not essential” and replaced by 1.

N: Indicates “not necessary” replaced by number 0.

Just those components whose CVR value and their average are compatible with the minimum agreed values remain in the questionnaire.

Determining the criteria for acceptance or rejection of questions:

1. The question is unconditionally accepted if its CVR value is equal or greater than 0.49. This number is acquired according to 15 experts and Lawshe table.

2. The question is accepted if its CVR is between 0 and 0.49 and if the numerical mean of the judgments is equal or greater than 1.5.

3.The question is rejected if its CVR value is less than 0 and the numerical mean of the judgments is less than 1.5, which showed that less than half of respondents have selected "the Essential" option (14).

Content validity index (CVI) indicates the comprehensiveness of judgments related to the validity or functionality of the final instrument. The higher the final content validity, the more the CVI tends to be 0.99. The opposite case is also true. To apply CVI using Waltz & Bausell method, 3 criteria of relevance, simplicity, and clarity of each question were studied on a 4-point scale. CVI for each item is obtained by dividing the number of experts who agree to grade 3 and 4 to the total number of experts (15). CVI mean of the 3 domains is calculated to determine each question's CVI. Grade 0.79 and greater is a criterion for acceptance of questions. Grades between 0.7 and 0.79 indicate that the question should be modified and grades less than 0.7 indicate that the question is rejected. In this study, opinions of 7 anesthesiology and medical education experts were used to determine the relevance, clarity, and simplicity of each question.

Consistency reliability was conducted using test-retest method. The important point in this method is the interval between the 2 tests. The interval between the 2 tests should be long enough so that respondents could not remember the test items but also it should be short enough so that changes in the measured phenomenon do not occur. Questionnaires were distributed and completed among 30 anesthesiology residents in 2 stages with time interval of 10 days. Then, achieved grades in this stage were compared by intraclass correlation coefficient (ICC) index. A review was done on those questions whose correlation coefficient was 0.

Statistical analysis

Data were analyzed by SPSS V.22. Following the standardization, questionnaires were distributed among anesthesiology resident trainees in affiliated hospitals of Iran, Tehran, and Shahid Beheshti Medical Siences Universities. To determine the reliability of the questionnaire, 2 methods were used: internal consistency and stability. Consistency reliability was conducted using test-retest method. Cronbach alpha (alpha ratio) was used to determine internal consistency. Cronbach's alpha indicates the proportion of a group of items which measures a structure.

Construct validity of confirmatory factor analysis was conducted using LISREL V.8.8. Also, discriptive statistics were presented as frequency distribution tables, mean, and standard deviation. Independent sample t test was used to compare means in 2 independent samples and one-way ANOVA was used for more than 2 states, such as academic year. A p-value less than 0.05 was considered as statistically significant.

Results

A total of 156 questionnaires out of 190 were fully answered, returned, and analyzed (response rate: 82%; 69 males (44.5%); 86 females (55.5%)). The average age of participants was 33.66±4.96 years (age range: 26-48 years).

Anesthesiology residents affiliated to university hospitals were as follow: 80 residents (51.6%) from Tehran University of Medical Sciences, 38 (24.5%) from Shahid Beheshti University of Medical Sciences, and 37 (23.9%) from Iran University of Medical Sciences.

The number of people involved in this survey were 51 (34%) first-year residents, 39 (26%) second-year residents, 25 (16.7%) third-year residents, 35 (23.3%) fourth-year residents. Mean±SD of residents' scores in domains were as follow: autonomy: 24.87±4.51; perceptions of atmosphere: 28.28±6.25; workload/supervision/support: 18.23±5.13; perception of teachers and teaching: 14.94±3.98; learning opportunities and orientation to learning: 27.69±7.05 (Table 1).

The mean±SD total ATEEM score for anesthesiology residents was 114.03±23.59 out of 160, which was in a desirable range (48-157).

The mean±SD score for all domains was 113.59±25.12 in female residents and 114.85±21.78 for male residents. However, according to independent t test, there was no significant difference between male and female groups in the mean scores (p=0.742) (Table 2).

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Table 1. Descriptive statistics for each domain of educational environment (n= 156)

Score percentage	Minimum	Maximum	Mean± standard deviation	Domain
77.71%	10	32	24.87±4.51	Autonomy
70.7%	7	40	28.28±6.25	Perceptions of atmosphere
65.1%	3	28	18.23±5.13	Workload/supervision/support
74.7%	1	20	14.94±3.98	Perception of teachers and teaching
69.22%	10	40	27.69±7.05	Learning opportunities and orientation to learning
71.26%	48	157	114.03±23.59	Total score

Table 2. Comparison of the mean and standard deviation for each domain of educational environments in terms of gender (n= 156)

Domain	Gender		p
	Male	Female	
Autonomy	24.76±4.68	25.03±4.38	0.715
Perceptions of atmosphere	28.68±5.57	28.1±6.67	0.566
Workload/supervision/support	18.43±4.65	18.12±5.51	0.713
Perception of teachers and teaching	15.33±3.91	14.6±4.05	0.260
Learning opportunities and orientation to learning	27.63±6.48	27.72±7.54	0.942
Total score	114.85±21.78	113.59±25.12	0.742

Mean±SD score of all domains was 112.29±23.33 in single residents and 115.62±23.38 in married residents. However, according to independent t test, there was no significant difference between the single and married groups in the mean scores of the domains (p= 0.397).

A significant difference (p= 0.032) was found between academic year and the field of perception of teachers and teaching in the mean scores of the fields and year using ANOVA test, but no significant difference was detected in other domains (Table 3).

Average content validity ratio (CVR) and the overall average content validity index (CVI) were calculated to be 0.63 and 0.88, respectively. Questions 14, 17, and 38 were corrected and accepted. To perform test-retest reliability method, the intraclass correlation coefficient (ICC) was used and the correlation coefficient of questions was between minimum of 0.37 and maximum of 0.92, and its average was calculated to be 0.73.

In the next level, construct validity was assessed using confirmatory factor analysis, which provided an answer to the following question: Did the predicted relations have harmony with the existing relation in real data among the variable items? Therefore, this method was the best technique to estimate the construct validity of the questionnaire (16).

In confirmatory factor analysis, chi-square statistic is very important, as it measures the difference between observed and estimated matrices. Meaninglessness of this statistic shows the fitness of data with the model. Nonetheless, since the chi-square value is dependent on sample size and obtaining a non-significant chi-square test samples with high volume is impossible, to reduce the sensitivity, ratio of chi-square to degree of freedom is used. The numeric value less than 3 for this statistic approves the fitness of data with the model.

Fitness indexes were reported to be higher than 0.9 and RMSEA index was less than 0.08 (0.07). This indicates acceptable fit indexes, fitness, and proper model of measurement (Table 4). The alpha coefficient of the whole questionnaire was 0.959, indicating the reliability of the questionnaire (Table 5).

Table 3. Comparison of mean and standard deviation for each domain of educational environments in terms of academic year (n= 156)

Domain	Academic year				p
	Year 1	Year 2	Year 3	Year 4	
Autonomy	24.84±4.17	25.12±5.31	25.52±4.11	24.94±4.24	0.938
Perceptions of atmosphere	29.15±5.64	29.23±6.25	27.28±4.58	28.2±7.01	0.528
Workload/supervision/support	19.11±4.81	17.58±5.91	17.84±3.89	18.6±4.97	0.492
Perception of teachers and teaching	16.35±3.24	14.53±4.58	14.32±2.89	14.17±4.46	0.032
Learning opportunities and orientation to learning	29.21±7.07	27.28±7.19	26.24±6.2	27.31±7.61	0.312
Total score	118.68±21.01	113.76±26.87	111.2±19.6	113.22±24.61	0.525

Table 4. Fit indexes values confirmatory factor analysis pattern

Fitness indexes	Witnessed values
Chi - square x^2	1432.84
Degree of freedom (df)	730
P-value	0.001
Ratio of chi-square to degree of freedom x^2/df	1.96
Goodness of fit index (GFI)	0.98
Normalized fitness index (NFI)	0.98
Comparative fit index (CFI)	1
Incremental fit index (IFI)	1.02
Relative fitness index (RFI)	0.98
Standardized root mean square residual (Standardized RMR)	0.064
Root mean square error of approximation (RMSEA)	0.079

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Table 5. Cronbach's alpha comparison of educational environment

Domain	Number of questions	Cronbach's alpha
Autonomy	8	0.833
Perceptions of atmosphere	10	0.841
Workload/Supervision/Support	7	0.824
Perception of teachers and teaching	5	0.902
Learning opportunities and orientation to learning	10	0.913
Total score	40	0.959

Discussion

More anesthetic curriculums are taught in the operating room environment. On the other hand, very little research has been done on the anesthetic trainee educational environment. This study aimed to provide a valid and reliable tool to identify the educational environment of anesthesiology residents in the operating room. This study was performed in Iran for the first time. The results of this study showed a good reliability and validity of the Persian version of this questionnaire.

ATEEM questionnaire examines the learning environment of operating rooms in 5 domains: autonomy, perceptions of atmosphere, workload/supervision/support, perception of teachers and teaching, learning opportunities and orientation to learning.

In the domain of autonomy, the highest average score belonged to sense of responsibility and accountability and the lower average score to appropriate teaching times not affecting vigilance. It seems that the type and nature of anesthesiology bring about high sense of responsibility and accountability toward the patient. Due to the high sensitivity in the type of activity performed in ICU and operation room, special care and vital support of critical patients and administration of patients during anesthesia, it is essential for learners of this major to have high self-confidence, responsibility and accountability, and provide the best service to patient at the earliest time possible. Responsibility is also shaped by medical oath, legal issues, morals, and respect to patients.

In workload/supervision/support domain, availability of professors to provide guidance and appropriate workload had the highest and lowest average scores, respectively. Also, the importance of anesthesiology in educational and clinical centers, constant presence of anesthesiology residents in these centers, patients need for anesthesiology specialty, and constant education needs, on-call schedules, and responsibility to provide care to patients have led to a heavy workload. Moreover, high workload, little opportunity for adequate and up-to-date study, and inappropriate communication with the medical team led to dissatisfaction of anesthesiology residents in this study.

In the studies of Holt and Roff, the highest scoring domain was perceptions of atmosphere and the lowest scoring domain was learning opportunities and orientation to learning. In a study by Kanashiro et al, the surgical resident perception of educational environment in the operating room was conducted using the OREEM instrument at the University of Calgary, Canada. The highest score belonged to atmosphere domain, which indicates an educational environment without racism or sexual discrimination in Calgary's operation theatres. However, the lowest score belonged to workload, supervision, and support (17), which is similar to the findings of the present study. In his article, Kaneshiro referred to Cassar's research, which was applied on basic surgical trainees in Scotland by STEEM tools. In that study, teaching and training domain obtained the richest point unlike the learning opportunities domain. Holt and Roff also found learning opportunities domain to be at the bottom of the list (17, 12). These findings illustrate the elements and factors that affect education environment in operation rooms.

By comparing the present study and the main article of ATEEM (Holt and Roff), average total score of ATEEM (maximum score 160) for this article was estimated to be 114.03± 23.59, which is close to the main article (117 of 160), and both h evaluated as desired educational environments. In Kanashiro study, the average total score was 147.2 of 200 (73.6%) (17), which was close to Holt and Roff's study. In Cassar research with STEEM tools, this score was reported to be 148.7 (74.4%) of 200.

The average total score for all domains in this research for female residents was estimated to be 113.59±25.12 and 114.85±21.78 for male residents. Regarding t test, there was no significant difference in comparison of mean scores of domains between male and female ($p= 0.742$) residents. The original article did not mention this comparison but there was a significant difference in the perception of the educational environment in Kanashiro research that was less favorable in women. In learning opportunities domain, this difference showed women are less fortunate to learn and experience new things in the operation room compared to men, but the reasons were not clarified. There was no difference in the Cassar research.

The comparison of the average scores of domains in terms of academic year, using ANOVA test, revealed a significant difference ($p= 0.032$) between academic year and domain of perception of teachers and teaching. However, no significant differences were detected in other areas. The highest average score in the domain of perception of teachers and teaching belonged to first-year anesthesiology residents and the lowest to the fourth-year residents. Frequent first-year residents' presence in operation room and teachers' interaction, support, and supervision on them may have caused this difference compared to the fourth-year residents. In Kanashiro research, no difference was found between junior residents and senior residents in educational environment perception; however, the workload/supervision/support scores of the Junior residents were lower than senior residents, and the difference was statistically meaningful ($p<0.05$). Junior residents agreed that they are too busy doing other work to go to the operating room and while they are in operation rooms, there is nobody to cover the ward and so they are paged during operation. The nursing staff dislike it when junior resi-

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dents operate because the operation takes a longer time. Anesthetists prefer a preceptor to operate him/herself to reduce anesthetic time (17). No difference was detected in Cassar research.

In terms of internal consistency of the questionnaire, Cronbach's alpha in this study was 0.959, which showed a desirable reliability of the questionnaire. Cronbach's alpha in domains was estimated between 0.82 (workload/supervision/support) and 0.91 (learning opportunities and orientation to learning). Cronbach's alpha in Kanashiro and Cassar study was 0.86 and 0.87, respectively.

According to the results of this study, learning environment of operating rooms in teaching hospitals of Tehran, Iran, and Shahid Beheshti Universities of Medical Sciences are desirable according to opinion of anesthesiology residents.

Suggestions

This questionnaire was used in Iran for the first time to evaluate the operating room environment for anesthesiologists, which is one of the strengths of this study.

This study was conducted on Type 1 universities in Tehran. It is suggested that the study is done multicentrally (among multiple universities with anesthesiology residents) to increase its strength and generalize the results to all other anesthesiology residents over the country. In addition, the results of this study can be useful to education programmers at the level of Ministry of Health and at the nationwide level.

Limitations of the study

The weaknesses of this study were small sample size due to the low access to senior residents. There was no guide to interpret the ATEEM's overall score that was done in this study, which can be used in subsequent studies. The paucity of literature on using ATEEM questionnaires was another limitation of this study.

Conclusion

Using ATEEM tool enables educational trainers and professors to recognize their weaknesses in educational environment in operation rooms and take action to correct them. Information gathered from ATEEM is highly valuable in educational planning and qualitative assessment of the learning environment. By improving education environment weaknesses, there would be a balance between real and desired environment, which may result in improvement in quality of education. This tool is a valuable complement to judge the quality of learning and teaching activities and understanding educational objectives. Thus, it contributes to finding educational environment weaknesses and its strengths are usable in peer environments that are weak (12).

Generally, the ATEEM questionnaire has suitable psychometrics to measure educational environment for anesthesiology residents. Reliability, validity, and general structure of questions have been confirmed. Therefore, this questionnaire can be used as a perfect tool to assess educational environment for anesthesiology residents in operation room.

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Conflict of Interests

The authors declare that they have no competing interests.

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