Education in Medicine Journal ISSN 2180-1932

ORIGINAL ARTICLE
Volume 4 Issue 2 2012
DOI:10.5959/eimj.v4i2.33
www.eduimed.com

Confirmatory factor analysis (CFA) of USM Emotional Quotient Inventory (USMEQ-i) among medical degree program applicants in Universiti Sains Malaysia (USM)

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ARTICLE INFO

Received	: 17/05/2012
Accepted	: 30/07/2012
Published	: 01/12/2012

KEYWORD

USMEQ-i
Emotional intelligence
Mixed-model approach
Faking index
Confirmatory factor analysis

ABSTRACT

Introduction: Emotional intelligence (EI) is deemed an important aspect of being good medical doctors. Universiti Sains Malaysia (USM) Emotional Quotient Inventory (USMEQ-i) is an EI inventory in Malay language developed primarily as medical student selection tool in USM. Although it was already validated by exploratory factor analysis (EFA), EFA is considered insufficient evidence of construct validity, thus confirmatory factor analysis (CFA) was conducted. **Objectives**: To determine measurement model validity and construct validity of USMEQ-i among medical degree program applicants in USM by CFA. **Methods**: USMEQ-i data file for medical degree program applicants in USM for year 2010/2011 and 2011/2012 academic sessions were obtained from Medical Education Department in USM. A random sample of 512 cases was drawn from the data file. Of the sample, only 453 cases were valid study sample after preliminary data screening and assumption checking. CFA was conducted on the sample using maximum likelihood (ML) estimation with bootstrapping technique due to violation of multivariate normality assumption. USMEQ-i measurement model was proposed as a second-order EI factor with seven first-order factors of EI and a Faking Index (FI) factor, with correlation between second-order EI factor and FI factor. **Results**: The proposed model could not be fit into the study sample data. EI factors and FI factor had to be analyzed separately due to non-positive definite problem. After modifications to the model, CFA of EI factors were suggestive of two-factor model instead of the proposed seven-factor model. Consciousness, Maturity and Control (CoMaCt). CFA of FI factor maintained one-factor model and also valid in term of construct. **Conclusion**: The modified USMEQ-i, which consisted of separate EI and FI models, was proven to have valid measurement models and reliable constructs. It is considered to be suitable for use among applicants to medical degree program in USM. However, its use as medical student selection tool may require further research, especially how predictive USMEQ-i scores with real performance of medical students, generalizability of the inventory and its stability over time.

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Introduction

Being a medical doctor is not only about diagnosing and treating medical illnesses, but also about caring and being able to work as a team [1]. Among the 10 golden rules of good medical practice (Malaysian Medical Council, 2001) are to practice with kindness, ethics and honesty, having good communication with patients and relatives and maintaining good relationship with colleagues. These soft skills are deemed important parts of patient care [1]. In addition, having good attitude and coping ability are also important qualities required in new members of medical professionals so called house officers, as inability to cope with workloads would cause intense pressure to these house officers [2].

Public Relations Office, Ministry of Health Malaysia in year 2007 [cited by 1, p18] reported that 42.6% of the complaints received were related to communication problems, with the majority the complaints were directed towards medical doctors (26.8%). The image of house officers and medical professionals were further eroded with a sensational newspaper report entitled "Saravanan catches two doctors not doing their jobs" [3], suggestive that doctors were lazy and having poor attitudes.

As the quality of medical graduates is questionable, it can be reflected back to the quality of medical education itself. What if the selection of right persons to be house officers were done even before they enroll into medical schools? Apart from selecting medical students based on academics merits, selecting the students based on their emotional quality can be viewed as a crucial step to producing responsible medical doctors.

Emotional intelligence in medicine

Emotional intelligence (EI) is defined by Mayer and Salovey [4, p5] as "the ability to perceive emotions, to access and generate emotions so as to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth." EI is useful to predict the outcomes of social relationships, workplace performance, and also mental and physical well beings in a positive way [5]. EI is also related to greater satisfaction with life, higher self-esteem, lower depression rating, as well as fewer negative somatization symptoms [6].

Empathy is an ability to understand the perspectives and emotions of others as well as to communicate the understanding [7], as such many authors linked empathy to being good medical doctors and its importance to medical students [8-10]. EI and empathy was found to be positively correlated [11], while empathy itself, which is related to EI, was found to have positive influence on patient's satisfaction and compliance [12].

In a study by Wagner et al. [13], patients were found to be more satisfied with physicians who scored high mark on "happiness", a subscale of EI measurement. Weng et al. [14] found that one of the scales of EI (Use of Emotion, on external assessment) in the study was found to be positively correlated with patient's trust. Austin, Evans, Goldwater and Potter [11] found a positive correlation between EI among medical students and communication skills. Similar findings were also found in other studies [15, 16].

EI was found to be positively correlated to coping ability and affective organizational commitment in a study among healthcare workers [17]. In a study among human service workers (physicians, nurses, teachers, probation officers and managers), Oginska-Bulik [18] found that EI is negatively correlated with general perceived stress at work and depressive symptoms. Putting EI in medical students' perspective, medical training is regarded as a highly stressful period by most of them [19], as such these qualities are deemed important for them to make through the turbulent years.

A systematic review on factors associated with success in medical school is suggestive of the positive impact of normal personality factors, especially conscientiousness on medical school progression [20]. Another systematic review on the relationship between EI and medical training concluded that higher EI is positively associated with compassionate and empathic patient care, higher score on medical knowledge, effective coping under organizational pressures and better organizational commitment [21].

USM Emotional Quotient Inventory

Realizing the importance of EI, an inventory to measure EI among medical degree program applicants in Malaysia, namely Universiti Sains Malaysia (USM) Emotional Quotient Inventory (USMEQ-i) was developed [22]. Primarily developed as an EI instrument for medical student selection in USM, the inventory was structured in Malay language, taking into account its compatibility to medical profession and local values in Malaysia [22]. It consists of EI component and faking component. The EI component of the inventory was based on mixed-model approach of EI [22], while the faking component development was guided by article by [23]. There were seven factors conceptualized in EI scale of USMEQ-i: Emotional Control, Maturity, Conscientiousness, Awareness, Commitment, Fortitude, and Expression. Faking scale was represented by one factor namely Faking Index (FI), which was meant to measure tendency of respondents to overrate themselves [22].

More than 100 items were captured from literature and discussion with experts at the initial stage of the inventory development. On further evaluation, only 43 items representing EI and seven items representing faking were selected, with necessary improvements made to the wordings of the items [22]. Face validity of these 50 items was investigated by administering the items to 100 first year medical students and 30 medical lecturers. Four items representing EI were removed and improvements were made on the remaining 46 items (39 EI items, seven faking items). Exploratory factor analysis (EFA) to establish the validity and reliability of these 46 items USMEQ-i was conducted by [22] on a sample of 462 applicants of medical degree program in USM for year 2009/2010 academic session, after which on analysis 39 items representing the seven factors of EI remained in the inventory with factor loadings of more than 0.3 each. All seven items selected for faking scale also remained in FI. This process resulted in 46 items inventory. The Cronbach's alpha for each factor ranges from 0.603 to 0.899, while the overall Cronbach's alpha coefficient was 0.960.

EFA-validated USMEQ-i was also tested for its stability among medical students in a study by Yusoff [24], in which the inventory was administered four times at two month intervals to a group of 196 first year medical students. It was found that the intraclass correlations ranged between 0.62 to 0.83 for the seven factors of EI scores, FI score and total EI score.

However, EFA is only explorative in nature and construct validation by EFA alone is insufficient and should be interpreted with caution [25]. Confirmatory factor analysis (CFA) can provide confirmative evidence measurement model validity and construct validity, as such it is an indispensable analysis for construct validation in social and behavioral sciences [25], and as such the next stage of validation of USMEQ-i was CFA. The objectives of this study were to determine measurement model validity and construct validity of USMEQ-i among medical degree program applicants in USM by CFA.

Method

Study population and design

A cross-sectional, validation study was conducted to achieve our objectives. We aimed to generalize this study finding to applicants of medical degree program in Malaysian universities. Population available to us was of the applicants in USM. Our sampling frame was the USMEQ-i data file containing responses collected from applicants in year 2010/2011 and 2011/2012 academic sessions.

It was determined that a minimum of 460 subjects were required for 46 USMEQ-i items following Bentler and Chow [26] suggestion of a minimum ratio of cases to item of 10:1. We decided to sample 512 subjects after including 10 percent dropout.

Measurement tool

USM Emotional Quotient Inventory, or in short USMEQ-i was the measurement tool of concern in this study. The inventory was investigated for its measurement model validity and construct validity. USMEQ-i responses by item were taken as outcomes for analysis.

The responses for an item in the inventory were on Likert scale of 0 to 4: 0 - tidak sama seperti saya (not like me); 1 - sedikit sama seperti saya (a bit like me); 2 - hampir sama seperti saya (quite like me); 3 - sama seperti saya (a lot like me); 4 - sangat sama seperti saya (totally like me). Thirty nine EI related items are grouped into seven factors which were Pengawalan Emosi (Emotional Control), Kematangan Emosi (Emotional Maturity), Kehematan Emosis (Emotional Conscientiousness), Kepekaan Emosi (Emotional Awareness), Komitmen Emosi (Emotional Commitment), Keanjalan Emosi (Emotional Fortitude) and Ekspresi Emosi (Emotional Expression). Seven faking related items were clustered under a single FI factor. Table 1 gives an overview of the factors. Detailed descriptions of each factor can be referred in Appendix 1.

Data and sampling process

The sampling frame were two USMEQ-i PASW data files in .sav format for applicants to medical degree program in USM for year 2010/2011 and 2011/2012 academic sessions respectively. The files contained USMEQ-i responses of applicants of medical degree program in USM for year 2010/2011 and 2011/2012 academic sessions collected when they came for interview in the university by USM's Student Selection Committee. Consents were obtained from each applicant during the data collection. The files were obtained with permission from Medical Education Department, School of Medical Sciences, USM. The data file for year 2011/2012 also included applicants to USM-KLE (USM and Karnataka Lingayat Education) conjoint international medical degree program. The use of the data files for this study was approved by Human Research Ethics Committee, Universiti Sains Malaysia on August 2, 2011 (Approval letter: USMKK/PPP/JEPeM [239.4.(2.8)]).

The data files were merged into one single PASW data file, which in total consisted of 960 cases. The files were merged together as the year of application was not considered an important factor for the purpose of the analysis. The data obtained were also anonymous and contained only a number of demographic particulars of the respondents. Identification card number of each respondent was also available for the purpose of identifying the cases in data file only, not for tracing back the respondents. As far as the analysis was concerned, only USMEQ-i responses for each item were required.

There was a duplicate case noted, which was removed from the file, leaving the data file with 959 cases. Next, 512 cases were selected from the file by simple random sampling, of which the selected cases were saved into another PASW data file. The sampling process relied on PASW built-in random selection function. The file consisting of these 512 cases was referred as preliminary study sample data file.

Data management and statistical analyses

Data management and statistical analyses were done using PASW Statistics version 18 (PASW) and SPSS Amos version 19 (Amos). During preliminary data screening, cases with 50 percent missing values were deleted and treated as non-respondents. For cases with less than 50 percent missing values, the missing values were imputed with a value of 2 based on inventory developer recommendation. Demographic characteristics of respondents were described in term of frequencies and percentages for categorical variables (gender, race, year of application and program applied). For numerical variable (age), it was described in term of mean and standard deviation or median and inter-quartile range (IQR) after a check on normality.

Table 1. Number of item by factor and the questions under each factor

Factor	Number of items	Items under factor
I. Control	9	Q4, Q7, Q10, Q11, Q12, Q25, Q32, Q38, Q44
II. Maturity	8	Q14, Q23, Q30, Q33, Q34, Q37, Q42, Q43
III. Conscientiousness	5	Q5, Q9, Q17, Q20, Q26
IV. Awareness	5	Q22, Q28, Q29, Q40, Q41
V. Commitment	4	Q15, Q16, Q36, Q45
VI. Fortitude	4	Q1, Q3, Q31, Q46
VII. Expression	4	Q2, Q8, Q19, Q35
H. Faking Index	7	FQ6, FQ13, FQ18, FQ21, FQ24, FQ27, FQ39

Abbreviations: Q, Question number. FQ, Faking question number.

Multivariate normality assessment was done on three levels; univariate, bivariate and multivariate level. At univariate level, it was done visually by means of histogram with normality curve, box-and-whisker plot and Q-Q plot. Statistically, Kolmogorov-Smirnov and Shapiro-Wilk tests of normality were used to help with evaluation of normality. Bivariate normality assessment was done by checking linearity and homoscedasticity of residuals [27]. The assessment was done to a number of selected pairs of items only as it was impossible to examine all bivariate correlations between 46 items. Each possible pair of the items underwent simple linear regressions, from which standardized residuals and standardized predicted values were obtained. Standardized residuals versus standardized predicted values scatter plots were constructed for the pairs.

Multivariate normality assessment was done by examining chi-square versus Mahalanobis distance plot [28] and Mardia's normalized estimate of multivariate kurtosis (in Amos). A Critical Ratio (C.R.) of more than 5.0 is suggestive of violation of multivariate normality assumption (Bentler, 2005 cited by 28, p104). Identification of multivariate outliers by Mahalanobis distance was also done in Amos.

Evaluation of positive definiteness was done by subjecting variance-covariance matrix of USMEQ-i items to principal component analysis. All eigenvalues should be more than zero for a data matrix to be positive definite [25].

For multivariate collinearity assessment, squared multiple correlations (SMC), tolerances and variance inflations factors (VIF) for the items were obtained by running multiple linear regression analysis in PASW with a dummy variable (ID was used) as dependent variable and the 46 items as independent variable [27]. Tolerance and VIF for each item were given in the output, while SMC for a particular item was calculated by subtracting tolerance from 1. A value of more than 0.90 for SMC, a value of tolerance of less than 0.10 or a value of VIF of more than 10 for any particular variable is suggestive of multivariate collinearity [27].
Scaling of latent variables was done by marker indicators approach. Items with the largest unit of discrimination were chosen as marker indicators. All marker indicators' factor loading were fixed to 1.0.

Measurement model validity by confirmatory factor analysis

Measurement model validity was assessed by looking into fit, parameter estimates and construct validity [25, 30] of proposed and revised measurement models. The analysis was done in Amos software. ML estimation method was the main estimation method in Amos, and its use depended on multivariate normality assumption checks results.

Modifications to the model were done based on standardized residuals, modification indices, factor loadings given theoretical considerations.

Items with factor loadings of less than 0.50 were removed first based on recommendation by Hair Jr., Black, Babin and Anderson [30]. The removal or of the remaining items or modifications to the models were based on balanced approach between assessment of standardized residuals, modification indices and factor loadings, guided by theoretical considerations. The items having standardized residuals with absolute values of more than 4.0 were considered for removal, while those with residuals of between 2.5 to 4.0 were given more attention [30]. Items with standardized residuals of more than 2.58 (absolute value) were considered problematic [25] in this study. Items with relatively low factor loadings in comparison to other items of respective factors were also considered problematic. A correlation of more than 0.85 between any factors was considered as multicollinearity, thus considered having problematic discriminant validity [25].

Only a number of model fit indices were selected based on recommendation by Brown [25]. The selected fit indices were chi-square goodness-of-fit, Tucker- Lewis Fit Index (TFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR). Insignificant model chi-square goodness-of-fit was taken as indicative of model fit, with significance level set at 0.05. For TFI and CFI, a cut-off point of 0.95 and above was taken to indicate model fit [25, 31]. For RMSEA a cut-off value of 0.06 and less was acceptable, with upper limit of 90 percent confidence intervals (CI) also below the cut-off value and Clfit of more than 0.05 [25]. For SRMR a cut-off point of 0.08 and less was used to indicate model fit [25].

In addition, for model to model comparison, Aikaike Information Criterion (AIC) and Expected Cross-Validation Index (ECVI) were used. Smaller values of AIC and ECVI indicate better model fit. AIC and ECVI were used in this study as the indices are good for comparing non-nested models in place of more commonly used chi-square value [25, 31].

Evidence of construct validity are divided into two; convergent and discriminant validity. Convergent validity of the measurement models was checked with construct reliability (CR) and average variance extracted (AVE). Calculation of CR and AVE were done using the formulas given by Fornell and Larcker [32] and Hair Jr., Black, Babin and Anderson [30]. A value of 0.7 or more for CR [30], and 0.5 or more for AVE are recommended [30, 32]. Additionally, to obtain more accurate estimate of the CRs and their respective CIs, Raykov's procedure using bootstrapping technique was used [33, 34].

Discriminant validity was checked by comparing AVEs of factors with their respective shared variances (SV). In case of two factors, when their AVEs are greater their respective SV, discriminant validity for the factors is satisfied [32]. SV is given as the square of correlation between two factors.

Result

Data screening and assumption checks

Of the 512 cases in preliminary study sample data file, 54 cases were dropped from the data file due to empty responses for all USMEQ-i variables. These cases were considered as non-respondents. Another case was dropped due to having 19 out of 46 items (41.3%) on USMEQ-i with empty response from Q21 to Q39. Even though the percentage of missing values was less than 50 percent, the case was removed due to the non-responding to 19 questions consecutively, which might be indicative of non-responding intention of the case. In total, there were 55 (10.7%) non-respondents out of 512 sample cases, leaving only 457 respondents. The sample data file was further screened for missing values. There were 12 cases with one missing value on USMEQ-i responses, and 2 cases with two missing values on USMEQ-i responses. The missing values were imputed with a value of 2. The data file before imputation and the data file after imputation were compared in term of median (interquartile range) for each USMEQ-i item and there was no noticeable difference between the data file, suggesting that the imputation procedure did not affect the data markedly.

On principal component analysis of the items, all resulting eigenvalues were more than zero, with the smallest eigenvalue of 0.092. Thus, the data matrix was positive definite and suitable for confirmatory factor analysis.

As for multivariate collinearity assessment, upon inspection of squared multiple correlations (SMC), tolerances and variance inflation factors (VIF) for the items, none of the values for any of the items were suggestive of multivariate collinearity.

On univariate checks of normality, visually by histograms and box-and-whisker plots, and statistically by Kolmogorov-Smirnov and Shapiro-Wilk tests of normality, collectively the items were suspiciously not normally distributed on univariate level.

At bivariate level, eight items were randomly selected, forming 28 bivariate correlations, which were manageable number for manual scrutiny. On examination of the 28 scatter plots of standardized residuals versus their respective standardized predicted values, none of the plots met linearity and homoscedasticity assumptions. Thus, on bivariate level the items did not form bivariate normal distributions.

On assessment of Chi-square versus Mahalanobis distance plot, the points did not form a straight line, especially at lower and higher values of Mahalanobis distance, thus multivariate normality assumption for the items was unlikely to be met. Multivariate kurtosis was 633.90 with critical ratio (C.R.) of 101.96. The C.R. was more than the recommended 5.0, thus the items were clearly not following multivariate normal distribution.

On assessment of multivariate outliers by Mahalanobis distance, 64 cases were considered as outliers and marked for further scrutiny. The 64 outliers were inspected for peculiar pattern of

Table 2. Demographic characteristics of respondents and non-respondents.

Demographic characteristics		Respondents (n = 453)		Non-respondents (n = 59)		Non-responding rate (%) by subcategory
		Median (IQR)	n (%)	Median (IQR)	n (%)	
Age (years)		19 (0.5)[a]	-	19 (0)[a]	-	-
Gender	Male	-	164 (36.2)	-	11 (18.6)	6.3
	Female		289 (63.8)		27 (45.8)	8.5
	Unknown		0 (0)		21 (35.6)	100
Race	Malay	-	249 (55.0)	-	4 (6.8)	1.6
	Chinese		155 (34.2)		2 (3.4)	1.3
	Indian		37 (8.2)		0 (0)	0.0
	Others		11 (2.4)		0 (0)	0.0
	Unknown		1 (0.2)		53 (89.8)	98.1
Year of Application	2010	-	171 (37.7)	-	1 (1.7)	0.6
	2011		282 (62.3)		58 (98.3)	17.1
Programme applied	USM	-	382 (84.3)	-	58 (98.3)	13.2
	USM-KLE		71 (15.7)		1 (1.7)	1.4

[a]Age was not normally distributed as assessed by histogram, box-and-whisker plot and tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk). Abbreviations: IQR, Interquartile range; n, number; USM, Universiti Sains Malaysia medical degree program; USM-KLE, Universiti Sains Malaysia and Karnataka Lingayat Education conjoint international medical degree program.

responding to the items. The cases were checked for repetitive responses, too many similar responses and unusual pattern of responding. Five cases were noted for peculiar pattern of responding, of which one of the cases was retained as the responses might be valid, while the rest were dropped and considered as non-respondents. In total there were 453 (88.5%) valid cases out of 512 cases initially sampled, while 59 (11.5%) cases were non-respondents. Table 2 gives demographic characteristics of respondents and non-respondents.

The effect of removing the four outliers was checked again with Mardia's normalized estimate of multivariate kurtosis. There was not much improvement in term of multivariate normality with multivariate kurtosis of 619.42 with critical ratio (C.R.) of 99.20. Thus it was decided that the study sample consisting of 453 cases was also not multivariate normal.

Bootstrapping

From the multivariate normality checks, clearly the items were not multivariate normal. As the multivariate normality assumption was not met, bootstrapping technique was used as it does not rely on assumption of multivariate normality [29]. The recommended sample size for bootstrapping is more than 200 as suggested in a simulation study by Nevitt and Hancock [35]. In this study the study sample size was 453, which was more than the cited sample size. The number of bootstrap samples for this study was set at 250 samples as having bootstrap samples beyond this size does not give added quality in bootstrapped standard error estimates [35]. As bootstrapping technique was used in this study, scaling of latent variables was done by marker indicator approach as suggested by Arbuckle [36].

Measurement models descriptions

USMEQ-i full measurement model

USMEQ-i full measurement model (FMM) is presented in Figure 1. There were 46 items representing eight factors. Seven factors of EI, namely Control, Maturity, Conscientiousness, Awareness, Commitment, Fortitude and Expression (first-order factors) were represented by one second-order EI (second-order EI) factor. FI factor was allowed to correlate with second-order EI factor.

However, the model had non-positive definite covariance matrix of FI with second-order EI factor, thus the solution for this model was inadmissible. The cause of non-positive definite was inspected on correlation matrix of the items. FI items were found correlated to most items from other factors with correlations (r) of more than 0.3. In reference to the exploratory factor analysis (EFA) study of USMEQ-i (Yusoff et. al., 2011a), the EI factors were analyzed separately from FI factor. The correlation between second-order EI factor and FI was not analyzed due to the limitation of EFA. On theoretical level, it might be possible that second-order EI factor should not be allowed to correlate with FI as the purpose of faking was distinct from EI as it was meant to gauge the tendency to overrate [22]. As such FMM model, in which correlation was allowed between FI and second-order EI factor was abandoned and EI factors and FI factor were analyzed separately and treated as different inventories.

Furthermore, also on inspection of the correlation matrix, items for Commitment, Fortitude and Expression factors were found insufficiently correlated with other items within the same factors, while at the same time had several correlations with other items in other factors at r more than 0.3, indicative of their non-specificity. Of note, Fortitude and Expression factors had low internal consistency in the EFA study, with Cronbach's alpha of 0.656 and 0.603 respectively [22]. However, Commitment factor had good internal consistency of 0.773 in the EFA study. These three factors were put on high priority list due for deletion.

USMEQ-i emotional intelligence only measurement model

USMEQ-i emotional intelligence only measurement model (EIMM) is presented in Figure 2. In total, there were 39 items representing the seven factors of EI, which were allowed to be correlated to each other, forming 21 factor correlations.

The model had no problem with non-positive definiteness and inadmissibility of solution. However, the model had poor model fit (Table 3 and Table 4). Improvements were made, starting from EIMM model, six items (Q45, Q3, Q2, Q31, Q23 and Q28) with factor loadings of less than 0.5 were removed. Next, Fortitude and Expression factors were removed altogether as the presence of these two factors resulted in inadmissible solution and inspecificity of the factors, which also meant removal of Q35, Q19 and Q8 from Fortitude factor, and Q46 and Q1 from Expression factor. Q29 and Q30 were removed due to relatively low factor loadings and high standardized residuals. Conscientiousness, Maturity and Control factors were combined due to correlations of more than 0.85 between the factors into a combined ConMatCtr factor. Next, Q9 was removed due to low factor loading. Commitment factor was found to be highly correlated with ConMatCtr factor at r = 0.861, thus it was combined with ConMatCtr and named as CoMaCtCm factor. Q15, Q10 and Q14 were also removed due to high standardized residuals and relatively low factor loadings. Subsequently, another item Q4 was removed due to low factor loading of 0.507. Next, five more items, Q25, Q11, Q43,

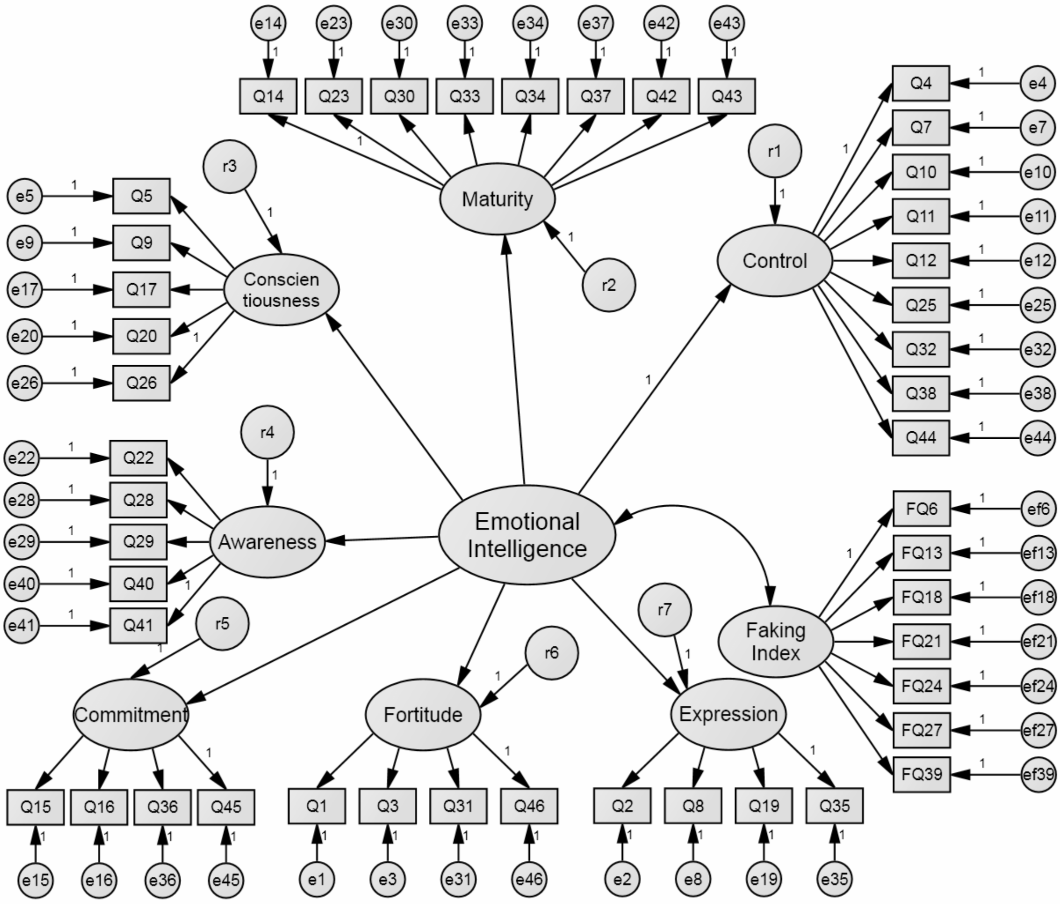

Figure 1. USMEQ-i full measurement model (FMM).

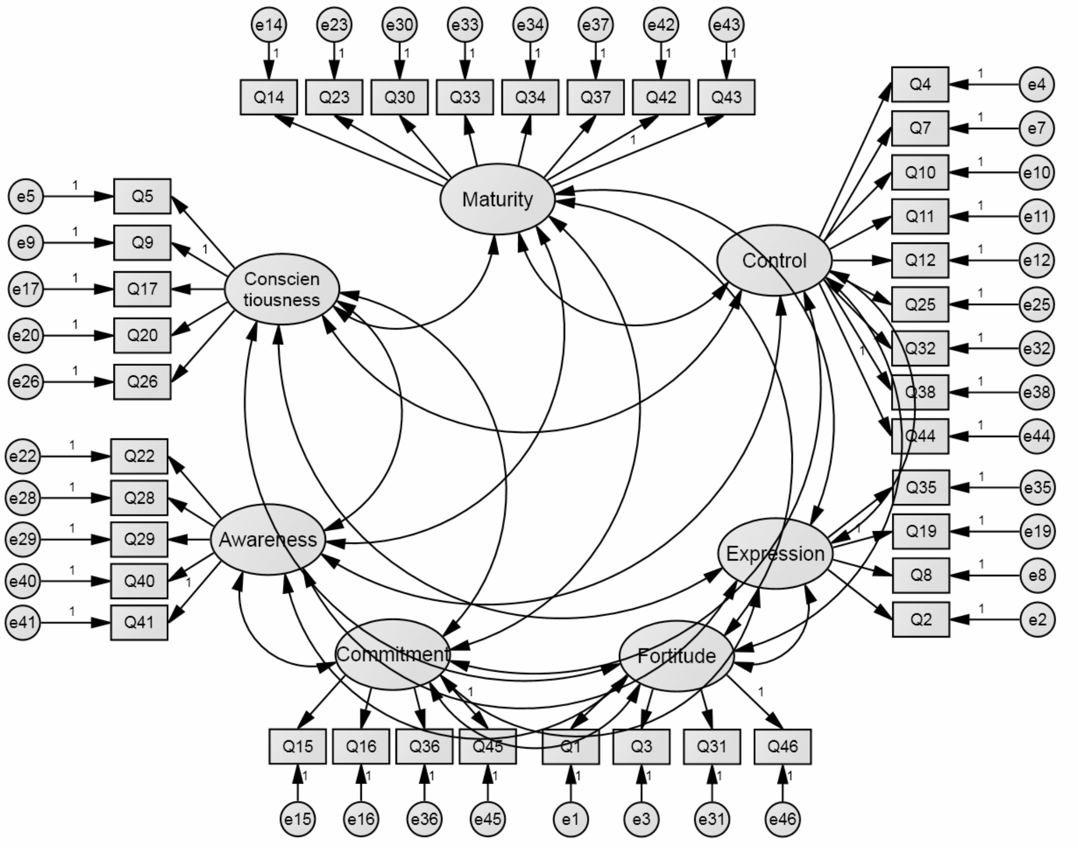

Figure 2. USMEQ-i emotional intelligence only measurement model (EIMM).

Q36 and Q44 had to be removed due to standardized residual problems. Up to this stage, in total there were 23 items removed, two factors dropped and four non-discriminative factors combined. On construct validity assessment of this intermediary model, AVE for CoMaCtCm was low at 0.421 in comparison to AVE of Awareness at 0.567, and lower than its SV at 0.453. To improve the AVE of CoMaCtCm factor, Q16 was dropped due to low factor loading of 0.541. CoMaCtCm was renamed as CoMaCt as the last remaining item from Commitment factor, Q16 was no longer part of the combined factor. Next, Q37 was also dropped due to relatively low factor loading, while maintaining good model fit. Lastly, Q5 was removed as it had low factor loading, and its removal resulted in best improvement in AVE (0.446) while keeping low SV (0.441). This model is referred as USMEQ-i emotional intelligence only measurement model revision (EIMM-R), presented in Figure 3. In total, there were 13 items remaining after the modification with two factors. The two factors of EI, namely CoMaCt factor and Awareness factor were allowed to be correlated to each other, forming one factor correlation. The model fit indices are presented in Table 3 and Table 4. EIMM-R was accepted as final measurement model as it had good model fit, significant estimates, and acceptable construct validity.

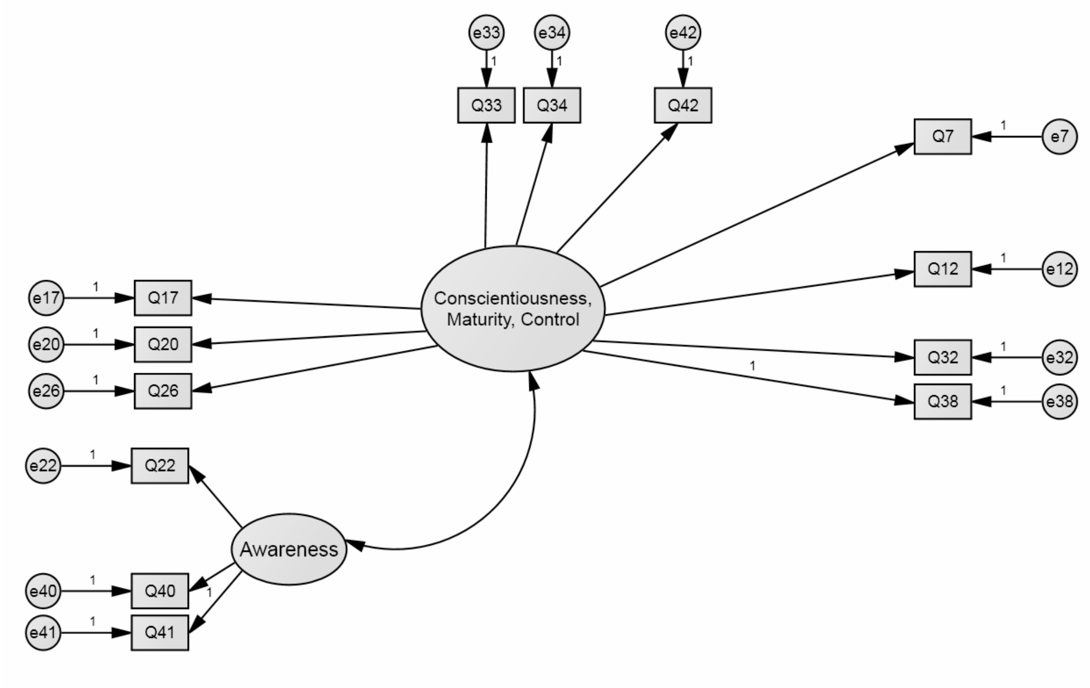

Figure 3. USMEQ-i emotional intelligence only measurement model revision (EIMM-R).

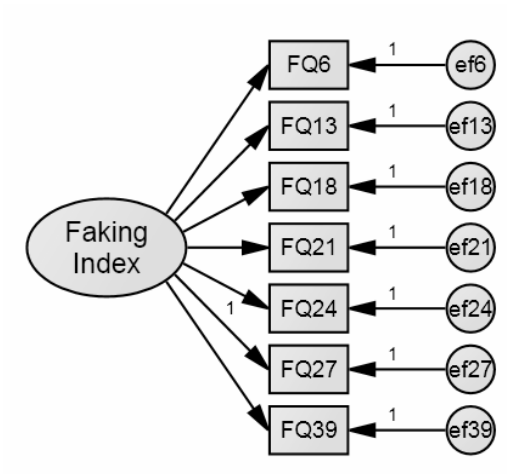

Figure 4. USMEQ-i Faking Index only measurement model (FIMM).

USMEQ-i Faking Index only measurement model

USMEQ-i Faking Index only measurement model (FIMM) is presented in Figure 4. In total there were seven items for FI factor. The model had no problem with non-positive definiteness and inadmissibility of solution.

The model did not fit well with fit indices presented in Table 3 and 4. Modification to the model was required to obtain good fit. FQ24 was first removed due to low factor loadings. Next, FQ6 was removed as its removal resulted in good model fit despite its relatively high factor loading of 0.660. Lastly, to obtain better construct reliability and AVE, FQ21 was removed as its factor loading was only 0.544. This modified model had good model fit (Table 3 and 4), construct reliability of 0.786 with an AVE of 0.481, which was very close to the recommended value of 0.5. The model was taken as final and acceptable. FIMM model and named as USMEQ-i Faking Index only measurement model revision (FIMM-R) as presented in Figure 5. In total there were 4 items remaining for FI factor.

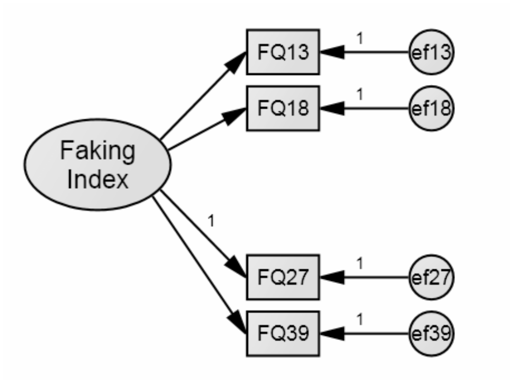

Figure 5. USMEQ-i Faking Index only measurement model (FIMM-R).

presented for every estimate. Factor loadings (Table 5 and Table 6) for EIMM-R and FIMM-R models are presented in respective tables. For EIMM-R model, the correlation between Awareness and CoMatCt factors was 0.664 [95% CI: 0.571, 0.730], p-value = 0.007.

Construct validity

Construct validity in form of convergent and discriminant validity is presented for good-fitting models only, which are EIMM-R and FIMM-R.

The evidence of convergent validity is presented in Table 7 in form of CR and AVE. CR estimation with 95 percent CI using bootstrapping technique following Raykov procedure is written as CR(R). The evidence for assessment of discriminant validity is presented in Table 8 in form of AVE and SV.

Table 3. Chi-square goodness-of-fit, AIC, ECVI, TLI and CFI.

Models	Chi-square (df), p-value	AIC	ECVI	TLI	CFI
FMM	Solution was not admissible				
EIMM	1559.055 (681), <0.001	1757.055	3.887	0.858	0.870
EIMM-R	117.608 (64), <0.001	171.608	0.905	0.972	0.977
FIMM	47.889 (14), <0.001	75.889	0.168	0.946	0.964
FIMM-R	0.266 (2), 0.876	16.266	0.036	1.011	1.000

Table 4. RMSEA, SRMR and Bollen-Stine bootstrap.

Models	RMSEA (90% CI), Clfit p-value	SRMR	Bollen-Stine bootstrap
FMM	Solution was not admissible		
EIMM	0.053 (0.050, 0.057), 0.054	0.050	0.004
EIMM-R	0.043 (0.031, 0.055), 0.819	0.036	0.076
FIMM	0.073 (0.051, 0.096), 0.043	0.038	0.004
FIMM-R	0.000 (0.000, 0.046), 0.957	0.004	0.884

Summary of results for model fit, parameter estimates and construct validity

Model fit

The fit indices are presented in Table 3 and Table 4 by model. As bootstrapping technique was used, Bollen-Stine p-value was given priority to assess model fit [37], with p-value of 0.05 and more was considered to indicate model fit.

Parameter estimates

Parameter estimates for the models were obtained using bootstrapping technique. Bias-corrected 95 percent CIs and p-values are

Table 5. Factor loadings for model EIMM-R.

Factors	Items	Loadings (95% CI)	p-value
Awareness	Q41	0.727 (0.649, 0.792)	0.011
	Q22	0.737 (0.671, 0.793)	0.008
	Q40	0.792 (0.718, 0.839)	0.012
Conscientiousness, Maturity and Control combined (CoMaCt)	Q12	0.594 (0.509, 0.655)	0.019
	Q7	0.607 (0.521, 0.649)	0.027
	Q20	0.615 (0.541, 0.669)	0.010
	Q34	0.627 (0.552, 0.678)	0.020
	Q38	0.656 (0.588, 0.718)	0.006
	Q42	0.664 (0.560, 0.730)	0.013
	Q17	0.677 (0.603, 0.730)	0.013
	Q32	0.709 (0.647, 0.775)	0.005
	Q26	0.714 (0.650, 0.768)	0.009
	Q33	0.788 (0.745, 0.831)	0.010

Table 6. Factor loadings for model FIMM-R.

Factor	Items	Loadings (95% CI)	p-value
Faking index	FQ18	0.619 (0.541, 0.702)	0.007
	FQ13	0.683 (0.593, 0.753)	0.011
	FQ27	0.709 (0.628, 0.776)	0.013
	FQ39	0.755 (0.695, 0.817)	0.004

Discussion

Mixed-model approach of emotional intelligence

In this study USMEQ-i EI only scale, which was based mixed-model approach of EI, was found to consist of two distinct factors only: Emotional Awareness factor and Emotional Conscientiousness, Maturity and Control combined (ComaCt) factor, which was inconsistent with the originally conceived seven factor model. This two-factor model of USMEQ-i EI only scale is consistent with Goleman's Emotional Competence framework [38]. In the framework, he divided Emotional Competence into two competencies: Personal Competence and Social Competence.

Table 7. CR and AVE of EIMM-R and FIMM-R.

Models	Factors	Number of items	CR	CR(R) (95% CI)	AVE
EIMM-R	Awareness	3	0.796	0.796 (0.762, 0.828)	0.566
	CoMaCt	10	0.889	0.889 (0.876, 0.903)	0.446
FIMM-R	Faking index	4	0.786	0.780 (0.736, 0.812)	0.481

Table 8. AVE and SV of EIMM-R.

Factors	AVE	SV by factor	
		Awareness	CoMaCt
Awareness	0.566	-	0.441
CoMaCt	0.446	0.441	-

Emotional Competence Inventory (ECI) [39], which is a mixed-model approach EI inventory, was constructed on Goleman's framework. The second version of ECI namely ECI-2 reported four second-order factors. Boyatzis [40] reported the need to differentiate the factors on personal and social level as reflected in development of Emotional and Social Competency Inventory (ESCI) in place of ECI, which is more in sync with Goleman's conception.

Other inventories which were based on mixed-model approach are EQ-i, Self-Report Emotional Intelligence Test (SREIT) and Multidimensional Emotional Intelligence Assessment (MEIA). CFA of the inventories found one-factor model for EQ-i [41] and SREIT [42], and three-factor model for MEIA [43].

In short, USMEQ-i has closer resemblance to ESCI and the two-factor model of USMEQ-i is backed by Goleman's framework of EI.

Faking index

USMEQ-i also has a number of integrated items meant to measure response distortion among the respondents, namely FI. Instead of using the index to adjust EI scores for USMEQ-i like EQ-i's Positive Impression, it is meant to categorize the tendency to overrate oneself [6]. Other commonly used inventories to measure faking are Marlowe-Crowne Social Desirability Scale (MCSDS) and Balanced Inventory of Desirable Responding (BIDR).

In this study, FI scale was found to be unidimensional. The finding is consistent with CFA of MCSDS short forms which were found to be unidimensional [44, 45]. On the other hand, BIDR and its revised form namely Paulthus Deception Scales (PDS), of which are two-factor model inventories fit poorly in studies by Leite and Beretvas [45] and Lanyon and Carle [46]. Modified unidimensional models of BIDR and PDS also did not fit well in study by Lanyon and Carle [46].

Relationship of emotional intelligence with faking

In present study, although FMM was initially conceptualized with correlation between EI and FI scales, this relationship could not be proven. Attempting to do so resulted in the correlation between second-order EI factor and FI factor at r = 1.009, which was out-of-bound relationship which was unexpected during the planning for FMM model. FMM model was conceptualize as such because, the factors, including FI were in same inventory and some amount of correlations are expectable among factors in psychological measurements [47]. In contrast, correlation between faking and EI were found to range from low to moderate level of correlation in studies by Sjöberg [48] ($r = 0.144$, p-value not significant at 0.05 level), Mesmer-Magnus, Viswesvaran, Deshpande and Joseph [49] ($r = 0.44$, p-value < 0.01) and Day and Caroll [23] (faking accounting for 30 percent of EI score). Going back to EFA of USMEQ-i [22], EFA for EI items and FI items were done separately using the same study sample, which explained why such high correlation was not detected in EFA. Additionally, a proper assessment of correlation between second-order EI factor and FI factor was not possible under EFA. Thus, it was decided that not correlating EI with FI and analyzing the two concepts separately was possibly a better solution following the way EFA was conducted, and also more consistent with theory and purpose of FI to gauge EI, although CFA allows analysis of a more complicated model like FMM.

Number of dropped items

In obtaining EIMM-R model from EIMM model, 26 out of 39 items (66.7%) were dropped, three factors were eliminated and three factors were combined. This might look like overdoing the CFA to obtain a good model based on statistical basis. However, it can be attributed to the EFA of USMEQ-i. Judging from EFA study, there were at least two factors that could be removed due to low Cronbach's alpha, namely Fortitude and Expression factors. In addition, Commitment factor was also non-specific on careful inspection of correlation matrix. As such, at least 12 items from the deleted three factors were suitable for removal from the start, leaving only 27 out of 39 items worth of analysis. Thus, only 51.9 percent of the items were dropped (14 out 27 items) instead of 66.7 percent. In contrast, Hair Jr., Black, Babin and Anderson [30] suggested that if more than 20 percent of measured variables are dropped (in the context of CFA), a new data should be collected.

In EFA study also, items with factor loadings of more than 0.3 were retained [22] and carried over to present CFA study. This decision was disadvantageous as shown in this study, quite a number of items had to be dropped on CFA. Despite that, it is possible that lowering the cut-off of 0.5 to 0.3 for EFA items is indeed worthwhile as there were three items that were retained in EIMM-R model which had factor loadings lower than 0.5 in EFA study (factor loading: Q12 = 0.492, Q33 = 0.485, Q26 = 0.389) [22], while majority of items with factor loadings lower than 0.5 in EFA study were dropped. Furthermore, in EFA study of USMEQ-i, the sample size was large enough (n= 469) to support retaining items with factor loadings of 0.3 and more, as for a sample size of above 350, a factor loading of 0.3 is considered significant in EFA context, although factor loading of more than 0.5 is more practical [30].

However, it was possible that the removal of 51.9 percent of items from EIMM model in transition to EIMM-R model was due to carrying over items with low factor loadings from EFA study, and that of Hair Jr., Black, Babin and Anderson [30] argument of collecting a new data when 20 percent of items are dropped might be inapplicable in this study given that low loading items (of factor loading between 0.3 to 0.5) were allowed into CFA study.

As for FIMM model, three out of seven items (42.9 percent) were dropped in transition between FIMM to FIMM-R model. The factor loadings of the items ranged between 0.647 to 0.750 in the EFA study [22], all of which more than 0.5. However, FQ24 and FQ21 had low factor loadings in this CFA study (0.513 and 0.544 respectively), so the items had to be removed to obtain better AVE. Furthermore, in EFA several other considerations such as standardized residuals and modification indices were not accounted in contrast to CFA. On this basis, it could be argued that EFA might have missed the variables that were not well estimated by the model, which were only detected on CFA.

Limitations

There are two important limitations of present study. Firstly, USMEQ-i's EI and FI models in this study were intended to be generalizable to population of medical degree program applicants in Malaysian universities. However, up to date, both EFA and CFA studies of USMEQ-i were conducted only among applicants of USM medical degree program. As such, the external validity of the models to applicants in other universities is still questionable. Until the models are tested on applicants in several other universities in Malaysia, the validity is still limited to USM applicants of USM only.

Secondly, convergent validity evidence of EI measure is commonly established in relation to other available EI assessments, while evidence of discriminant validity is by proving that the measure is different from personality assessment [50]. In other words, USMEQ-i's EI scale should correlate well with established EI inventories based on mixed-model approach of EI such as EQ-i and ECI, while at the same time proven to have poor correlation with established Big Five personality scales such as Big-Five Inventory (BFI) and NEO Five-Factor Inventory (NEO-FFI). However, this study was focused on proving construct validity based on CFA alone and no other auxiliary EI measures were distributed to the applicants during data collection. Furthermore, although a Malay language personality inventory based on Big Five framework, namely USM Personality Inventory (USMaP-i) [51], was distributed together with USMEQ-i to the applicants, as of date the inventory is still in its infancy and not yet CFA validated, thus unsuitable for use as a comparison or criterion inventory to establish discriminant validity. While proving convergent and discriminant validity in comparison with other inventories are common, "there are many more ways of establishing it [i.e. construct validity]" [52, p261).

Conclusion

In conclusion, in this study the proposed USMEQ-i full measurement model, consisting of second order EI factor and FI factor did not fit the data and had to be analyzed separately. On analysis of USMEQ-i EI only measurement model, the seven-factor EI model did not fit the data. Instead, the data was more supportive of measurement model with two factors of EI: Awareness factor and Conscientiousness, Maturity and Control combined factor. The model had good model fit and acceptable construct validity. For USMEQ-i FI only measurement model, the one-factor faking model fit the data with acceptable construct validity. The inventory is considered suitable for use among applicants to medical degree program in USM.

For future research, it is recommended to test the models among applicants in other universities, as well as testing its validity among medical students population. This CFA-validated USMEQ-i is also not yet tested for stability over time, thus CFA of USMEQ-i testing longitudinal measurement invariance is recommended. A predictive validity study to find the relationship between USMEQ-i scores and medical students' performance is also recommended.

Acknowledgement

We were especially grateful to the School of Medical Sciences, Universiti Sains Malaysia for allowing us to conduct this study. We were also truly grateful to Department of Medical Education for allowing us to use the data of applicants. We also would like to thank the applicants for providing us the much needed data for the purpose of USMEQ-i validation.

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Appendix 1: Detailed descriptions of each factor in USMEQ-i inventory. Adapted from Yusoff, Rahim and Esa [6] with permission

Factors	Descriptions
I. Control	Emotional control is referred to the ability of self-control from disruptive emotions and impulsive feelings. People with this ability are skillful at handling their impulsive and disruptive emotions. They stay composed, positive and unflappable and they look so calm and cool even under great pressure. They think clearly and stay focused under pressure. They bounce back from setbacks and change misfortune into fortune. They have very strong inner self and internal control. They are the people who thrive under pressure.
II. Maturity	Emotional maturity is referred to the ability to facilitate and guide emotional tendencies to achieve and reach intended goals. People with this competence are outcome-oriented, with a high drive to achieve their objectives and standards. They set challenging goals, pursue it beyond what is required or expected of them and take calculated risks. They search for information to minimize uncertainty and find ways to do better as well as learn how to improve their performance. They operate from hope of success rather than fear of failure. They see setbacks as due to controllable circumstances rather than a personal flaw.
III. Conscientiousness	Emotional conscientiousness is referred to the ability of taking responsibility and maintaining integrity for personal performance. People with this competence take a tough, principled stand even if they are unpopular. They act ethically, built trust, meet commitment and keep promises. They are accountable, organized and careful in their work for meeting objectives. They know their values and principles, intentions and feelings, and act in a way that is reliably consistent with them.
IV. Awareness	Emotional awareness is referred to the ability of knowing and understanding one's own and other persons' internal states, preferences, resources and intuitions as well as their effects. People with this competence recognize which emotions they are feeling and why it happens. They realize the connections between their feelings and what they think, say and do as well as potential effects to others that may result from it. They have a guiding awareness of values and goals.
V. Commitment	Emotional commitment is referred to the ability of aligning and working with others in a group or organization towards common goals. People with this competence are ready to make sacrifices to meet a larger organizational goal. They find a sense of purpose in the larger mission and use the group's core values in making decisions and clarifying choices. They actively seek out opportunities to fulfill the group's mission.
VI. Fortitude	Emotional fortitude is referred to the ability of negotiating and resolving disagreements as well as sending convincing messages. People with this competence handle difficult people and tense situations with diplomacy and tact. They spot potential conflict, bring disagreement into the open, and help to resolve it. They encourage debate, open discussion and win-win solutions. They admit their own mistakes and confront unethical actions in others. They are effective in give-and-take, registering emotional cues in attuning their message.
VII. Expression	Emotional expression is referred to the ability of conveying and adjusting one's emotions, thoughts and behaviors to changing situations and conditions. People with this competence know how to react towards self and others' feelings effectively. They fine-tune their presentation to appeal to the listener. They express their emotions effectively through non-verbal communications such as appropriate voice tone, body language and facial expression. They are skilled at winning people over. They use complex strategies like indirect influence to build consensus and support.
H. Faking Index	Faking index measures the tendency of respondents to overrate themselves. High scores do not indicate cheating, but rather the tendency of over rating themselves based on what they wish to be in the future. Therefore if they score high on this scale, it is recommended to repeat the test and respond to statements that describe themselves as they are generally now, not as they wish to be in the future.