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A Confirmatory Factor Analysis of USM Personality Inventory (USMaP-i) among Medical Degree Program Applicants in Universiti Sains Malaysia

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ABSTRACT

Introduction: USMaP-i is an English, 66-item self-administered inventory, consisting of personality (60 items, 5 factors) and faking (one factor) components, which was mainly developed to measure personality traits among Malaysian students based on local cultures and values. The personality component was based on the Big Five dimensions as suggested by numerous personality researchers. Previous exploratory studies showed promising validity, reliability and stability of USMaP-i. **Objective:** To provide further validity evidence of USMaP-i for use among medical degree program applicants by confirmatory factor analysis (CFA). **Methods:** Data were collected as a part of screening of medical degree program applicants for year 2010–2013 intakes in Universiti Sains Malaysia (USM), of which 657 cases were suitable for analyses following a data screening measures. CFA was performed by bootstrap maximum likelihood estimation due to non-normality of items at multivariate level. **Results:** Although the revised five-factor model of personality showed good model fit (X2(df) = 144.36(55), *P*-value < 0.001; CFI = .944, TLI = .921; RMSEA = .050; SRMR = .032, Bollen-Stine bootstrap *P*-value = 0.004), the reliability of the factors is very poor (composite reliabilities (CR) = .483 to .650). In contrast, the unidimensional faking component exhibited good model fit (X2(df) = 14.15(5), *P*-value = 0.015; CFI = .984, TLI = .968; RMSEA = .053; SRMR = .011, Bollen-Stine bootstrap *P*-value = 0.068) and factor reliability (CR = 0.731). **Conclusion:** The personality component should be revised and revalidated due to poor reliability, despite showing good model fit. In contrast, the faking component showed good model fit and reliability. Further validation studies are recommended before its use among medical degree program applicants.

Keywords: *Confirmatory factor analysis; Personality; Reliability; USMaP-i;Validity*

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Introduction

Medicine is a highly demanding course that may physically and psychologically burden medical students; most of the time leads to stress, anxiety, burnout and depression (1–5). For that reasons, medical students require certain personality traits to enable them to effectively cope with such pressure in the unfavourable education environment (6).

So far, most of medical schools selected their prospective medical students by looking at the cognitive ability, particularly previous academic achievement. Unfortunately, the academic achievement

alone does not predict that a person will become a good doctor in the future (7–9). There is an approach that emphasises on demonstrating operationalised capabilities across a number of domains as supported by knowledge, skills and attitudes. The attitudes include personal qualities and attributes (10). Knights suggested that potential students should be assessed not only on their cognitive attributes, but also on non-cognitive skills such as emotional intelligence and personality that may be predictive of their future professional behaviours (11).

A five-factor model of personality traits provides a theoretical basis to understand the predictive abilities and effects of personality traits in medical admission practice and training (9, 12). Even so, the ability of inventories measuring personality traits to predict important outcomes such as job performance have been debated by traditional psychologists, as a result of inconclusive findings in early analysis and worries that most personality inventories are over-rated (13). However, recent research findings have demonstrated that personality traits are valid predictors of various job-related outcomes (14–16). Moreover, research have shown that personality measures do not have an adverse impact on employees, and thus be able to improve equality and tolerability in personnel decisions (13). Therefore, personality test scores need to be combined with other methods of assessment to that effect (9).

Given the importance of assessing personality, a group of researchers from Universiti Sains Malaysia (USM) developed an instrument to measure personality traits among Malaysian students based on local cultures and values, known as USM Personality Inventory (USMaP-i). The personality domains of the USMaP-i were developed based on the Big Five dimensions as proposed by personality researchers (17). The items of this inventory originated from the International Personality Item Pool (IPIP) website.

This study was aimed to provide further validity evidence of USMaP-i for use among medical degree program applicants. The provision of the evidence is important given its intended use as a screening tool during student selection process.

Materials and Methods

Participants

Data for this study were collected as a part of screening measures for medical degree program applicants for year 2010 to 2013 intakes in Universiti Sains Malaysia (USM). Following a data cleaning process, data from 657 applicants were suitable for use in subsequent analyses. The demographic characteristics of the applicants are displayed in Table 1.

Table 1: Demographic characteristics of medical degree program applicants (n = 657)

Demographic characteristics		n (%)
Age (years)		19.20 (0.73)[a]
Gender	Male	262 (39.9)
	Female	395 (60.1)
Race	Malay	342 (52.1)
	Chinese	226 (34.4)
	Indian	64 (9.7)
	Others	25 (3.9)
Year intake	2010/2011	160 (24.4)

(*continued on next page*)

Table 1: (*continued*)

Demographic characteristics		n (%)
	2011/2012	273 (41.6)
	2012/2013	224 (34.1)
Program applied	USM	589 (69.7)
	USM-KLE	68 (10.4)

[a]Mean (SD)

Measurement Tool

USMaP-i is a 66-item self-administered inventory, which consists of personality and faking components (17, 18). The 60-item personality component consists of five factors: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism. The unidimensional faking component or Faking Index consists of six items that is intended to measure the tendency of respondents to over rate themselves. Each item is rated on a 5-point Likert scale: 0 = very inaccurate, 1 = moderately inaccurate, 2 = neither inaccurate nor accurate, 3 = moderately accurate, and 4 = very accurate. In an exploratory study of USMaP-i, five factors representing the personality domains were extracted with Cronbach's alpha values that ranged from 0.63–0.8318. A follow-up study of the applicants during first year of study showed stability of USMaP-i, in which the intraclass correlation coefficients (ICCs) ranged from 0.64 to 0.78 (19).

Data Management and Statistical Analysis

IBM SPSS Statistics version 20 and SPSS Amos version 19 were used for data entry and statistical analysis.

Assumption checks

Assessment on multivariate normality of the items was done by chi-square versus Mahalanobis distance plot in SPSS (20, 21) and Mardia's normalised estimate of multivariate kurtosis in Amos. The points in the plot should form a straight line (20) and the critical ratio of the multivariate kurtosis should be 5.00 or less (22) to indicate multivariate normality.

The items were also checked for multivariate outliers in Amos by Mahalanobis distances. In Amos output, the first 100 observations farthest from the centroid as indicated by the Mahalanobis distances are listed. The identification of outliers were done to identify outlying responses and as another screening point to ensure the validity of the responses.

A Structural Equation Modeling (SEM) software application like Amos requires positive definite data matrix for most estimation methods to obtain the inverse of the matrix in multivariate statistics (23, 24). Thus, evaluation of the matrix was done according to Brown (24) by subjecting the variance-covariance matrix of the items to principal component analysis. Eigenvalues for all items should be more than zero for the matrix to be positive definite.

Collinearity diagnostics by Squared Multiple Correlations (SMC) and Variance Inflation Factors (VIF) were obtained by running a multiple linear regression analysis (the items as independent variables, a dummy variable as dependent variable). SMC of greater than 0.9 and VIF of more than 10 suggest multivariate collinearity between items (23). Items with collinearity problems were marked for deletion.

Confirmatory factor analysis

A confirmatory factor analysis (CFA) was performed to evaluate the validity of five-factor model of personality and one-

factor model of Faking Index of USMaP-i, specifically through assessment of model fit indices and factor loadings. In the analysis, marker indicator approach was used to set the scale of the latent variable as recommended in Brown (24).

The model fit was checked with chi-square goodness-of-fit and other selected fit indices (24). Insignificant (*P*-value > 0.05) model chi-square goodness-of-fit signifies model fit. However, because chi-square goodness-of-fit is known to be sensitive to sample size, other indices were considered to assess the fit. Standardized Root Mean Square (SRMR) value of 0.08 or less (24, 25), Comparative Fit Index (CFI) and Tucker-Lewis Fit Index (TLI) values of 0.90 or more (23, 26, 27), and Root Mean Square Error of Approximation (RMSEA) value of 0.08 and less are indicative of model fit (28). It is suggested to use at least three different fit indices to decide on model fit (28). Standardised factor loading of more than 0.5 on the respective factors and their significance (*P*-value < 0.05) indicate good relationship between the items and the factors, hence provide additional evidence of validity of the model (28).

Model revisions were done based on three criteria: standardised residuals and factor loadings, while also taking into account the theoretical considerations. Removal of items with factor loadings of less than 0.50 is suggested (28). Removal of the remaining items was considered based on standardised residuals. Absolute value for standardised residuals of more than 2.58 indicates that the model over or underestimated the relationship between two indicators (24). The commonly used modification indices were not considered in this study as Brown (24) suggests giving more focus on the standardised residuals.

Multicollinearity problem between factors exists when the correlation between any two factors is more than 0.85, affecting the discrimination between the factors (24). In this study, highly correlated items across factors (cross-loading items), were considered for removal to maintain the number of theoretical factors, despite recommendation (24) to combine the factors in this situation.

Additionally, in the model revisions, no correlated errors were specified given the decision of the researchers not to include them without any theoretical justification for their inclusion.

Next, composite reliability coefficients of the factors were determined, following the method as suggested by Raykov (29, 30) as demonstrated by Fan (31) to obtain the values with the respective confidence intervals in Amos. A latent reliability variable (RV) was created for each factor. Next additional paths were created from the items to the respective RVs, in which the regression weights were all set to 1. The square of correlation values between the factors and their RV are the reliability coefficients for that factors. A value of 0.7 or more for the coefficient is recommended (28).

Ethics Approval

The study was approved by Human Ethics Committee of Universiti Sains Malaysia (approval reference: USMKK/PPP/JEPeM[257.4.(1.3)]). Confidentiality and privacy of responses were ensured and the respondents were identified by identification number only.

Results

Preliminary Screening of Data

The data was screened to identify missing values. There were 29 and 3 cases have one and two missing values on USMaP-i responses respectively (0.08% of data points). The missing values were imputed with a value of "2" ("neither inaccurate nor accurate"), which is the middle value of the response option, based on prior knowledge

imputation method (32) as decided by the researcher following a discussion with the inventory developer. The method was also chosen due to the simplicity of the method and the small percentage of missing values.

Assumption Checks

Based on chi-square versus Mahalanobis distance plots for both personality and faking items, the points did not form a straight line, showing violation of multivariate normality assumption. Next, based on Mardia's normalised estimate of multivariate kurtosis, the critical ratio was 62.97 and 40.86 for the personality and faking items. The values exceeded the recommended value of 5.0, indicative of violation of multivariate normality assumption.

The first 100 multivariate outliers were manually checked for validity of their responses. As none of them was noted to have unusual response pattern (repetitive pattern of responses for example "343434…" or "333333…"), thus, they were kept in the data set for the subsequent analysis. In total there were 657 cases for the CFA. The data matrix was confirmed as positively definite and suitable for CFA since all the eigenvalues were more than zero. There was no multivariate collinearity problem observed among the variables as all SMC and VIF values were blow the cutoff values.

Bootstrap for Non-normality

In normality assumption assessment, it was found that responses did not follow multivariate normally distribution. As Maximum likelihood (ML) is the main estimation method used in Amos that is dependent on multivariate normality assumption, ML estimation method with bootstrapping was applied. The bootstrapping allows more accurate estimation of standard errors (25) as reflected in *P*-values and confidence intervals. Bootstrap samples were determined at 250 samples following a recommendation (33). The 95% bias-corrected confidence interval was specified.

Description of the Measurement Models

The CFA of USMaP-i involved assessment of validity of five-factor model of personality and one-factor model of Faking Index of USMaP-i separately. Model specifications and revisions for each model are described accordingly. The model fit indices, factor loadings, factor correlations and composite reliability coefficients are reported in the respective subheadings.

Five-factor Model of Personality

The factors in the five-factor model of personality are Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. Each of the factors consisted of 12 items. This measurement model is referred as FF-A. The model did not fit based on fit indices assessment (Table 2).

Model revision of FF-A started with assessment of the factor loadings for all items in their respective construct. There are 30 items with factor loadings less than 0.5 were removed from the model, leaving 30 items for further assessment. Next, five items were removed due to the standardised residuals more than 2.58. Lastly, 12 items were discarded as they were identified to cause multicollinearity problems between the five factors ($r > 0.85$). The remaining 13 items formed the revised five-factor model of personality (FF-B) (Figure 1; Tables 2 and 3) with an acceptable model fit. All factor correlations for the model were less than 0.85 (Table 4), indicative of discrimination between the factors. Assessment of composite reliability coefficients showed that the values ranged from 0.483 to 0.650, indicating the poor reliability of the factors (Table 3).

Table 2: Model fit summary for all models

Model	Chi-square (df), *P*-value	AIC	ECVI	CFI	TLI	SRMR	RMSEA (90% CI), Clfit *P*-value	Bollen-Stine bootstrap *P*-value
FF-A	4727.39 (1700), <0.001	4987.39	7.603	0.717	0.705	0.050	0.052 (0.500,0.540), 0.025	0.004
FF-B	144.36 (55), <0.001	216.36	0.330	0.944	0.921	0.032	0.050 (0.400,0.600), 0.499	**0.004**
FI-A	17.83(9), 0.037	41.83	0.064	0.986	0.977	0.012	0.039 0.010,0.070), 0.732	0.147
FI-B	14.15 (5), 0.015	34.15	0.052	0.984	0.968	0.011	0.053 (0.021,0.086), 0.389	0.068

Abbreviations: FF-A, five-factor model of personality (original); FF-B, five-factor model of personality (revised); FI-A, one-factor model of Faking Index (original); FI-B, one-factor model of Faking Index (revised); TLI, Tucker-Lewis Fit index; CFI, comparative fit index; RMSEA, root mean square error of approximation; Cfit, close fit; SRMR standardised root mean square residual. The revised models are highlighted in bold.

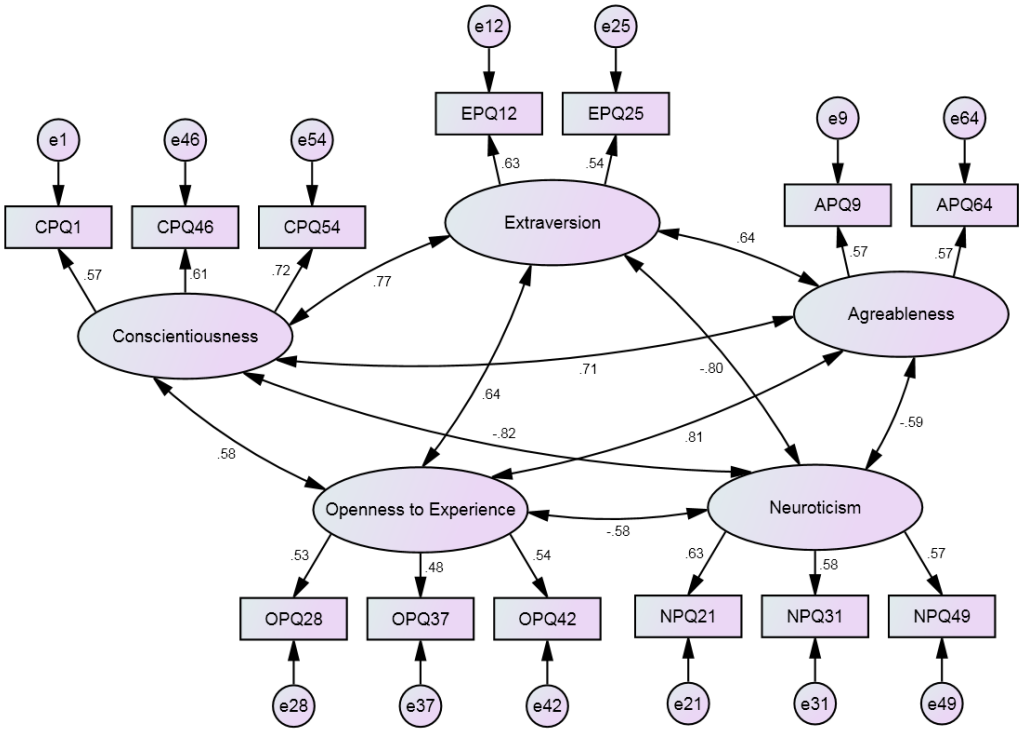

Figure 1: FF-B, five-factor model of personality (revised)

Table 3: Factor loadings and reliabilities for the revised models

Model	Factor	Item	Loading (95% CI)	*P*-value	CR (95% CI)[a]
FF-B, five-factor model of personality (revised)	Openness to experience	OPQ28 See beauty in things that others might not notice	0.53 (0.43, 0.64)	0.007	0.518 (0.432, 0.584)
		OPQ37 Have difficulty imagining things*	0.48 (0.38, 0.57)	0.007	
		OPQ42 Love to read challenging material	0.54 (0.44, 0.67)	0.008	
	Conscientiousness	CPQ1 Often make last-minute plans*	0.57 (0.48, 0.63)	0.018	0.650 (0.578, 0.691)
		CPQ46 Get tasks done right away	0.61 (0.53, 0.69)	0.007	
		CPQ54 Waste my time*	0.72 (0.66, 0.78)	0.012	
	Extraversion	EPQ12 Wait for others to lead the way*	0.63 (0.54, 0.74)	0.004	0.511 (0.401, 0.585)
		EPQ25 Avoid crowds*	0.54 (0.44, 0.62)	0.015	
	Agreeableness	APQ9 Believe that others have good intentions	0.57 (0.44, 0.67)	0.008	0.483 (0.334, 0.593)
		APQ64 Love to help others	0.57 (0.43, 0.69)	0.008	
	Neuroticism	NPQ21 Panic easily	0.63 (0.55, 0.70)	0.017	0.623 (0.566, 0.674)
		NPQ31 Get angry easily	0.58 (0.47, 0.66)	0.018	
		NPQ49 Can't make up my mind	0.57 (0.51, 0.66)	0.006	
FI-B, one-factor model of Faking Index (revised)	Faking Index	FPQ13 Am always confident in doing daily work	0.61 (0.50, 0.69)	0.008	0.731 (0.669, 0.771)
		FPQ20 Am always proactive in completing tasks	0.64 (0.56, 0.72)	0.008	
		FPQ30 Am always do self-reflection on what I did to improve myself	0.58 (0.45, 0.68)	0.011	
		FPQ45 Am always investigating problems arise thoroughly in order to solve it appropriately	0.61 (0.53, 0.72)	0.005	
		FPQ65 Always be honest to myself	0.52 (0.40, 0.63)	0.011	

[a]Composite reliability

*Negative statement (reversed scoring)

Table 4: Correlation between factors for FF-B, five-factor model of personality (revised)

Factor		Correlation (95% CI)	*P*-value
Openness to experience	Conscientiousness	0.58 (0.46,0.70)	0.011
	Extraversion	0.64 (0.51,0.77)	0.004
	Agreeableness	0.81 (0.67,0.96)	0.011
	Neuroticism	–0.58 (–0.70,–0.41)	0.009
Conscientiousness	Extraversion	0.77 (0.63,0.87)	0.014
	Agreeableness	0.71 (0.59,0.82)	0.016
	Neuroticism	–0.82 (–0.93,–0.73)	0.007
Extraversion	Agreeableness	0.64 (0.48,0.79)	0.007
	Neuroticism	–0.81 (–0.92,–0.67)	0.007
Agreeableness	Neuroticism	–0.59 (–0.73,–0.46)	0.011

One-factor Model of Faking Index

The one-factor model of Faking Index with 6 items is referred as FI-A. This model fit well based on the fit indices. However, the model was revised to exclude item FPQ53 from the model due to low factor loading of 0.383. The model with 5 items (FI-B) (Figure 2; Table 2 and 3) showed good model fit, and reduction in AIC and ECVI values. The factor was also shown to be reliable (composite reliability = 0.731).

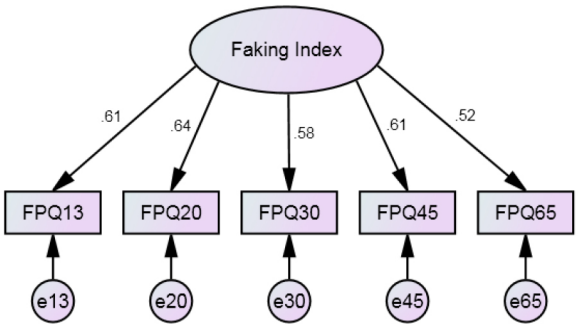

Figure 2 : FI-B, one-factor model of Faking Index (revised)

Discussion

The revised five-factor model of personality component (FF-B) that consists of 13 items for the theoretically defined five factors has good model fit. Previous studies have reported similar findings on the five-factor personality traits (34–36). In addition, this finding provides further evidence to support the finding of a previous study that was done by Yusoff (37) on the psychometric properties of USMaP-i in the medical student population. Thus, in this study, the question of the validity of the theoretical five-factor of personality might not arise. However, in this study the reliability of the factors is very poor. This could be attributed to a small number of items per factor despite having good factor loadings. Moreover, given the findings, the use of the current version of USMaP-i as one of the tools for medical student selection cannot be recommended. The USMaP-i personality items should be revised so as to include more representative items for each of the personality factors of personality. The

revised personality component of USMaP-i should again undergo detailed assessment of validity and reliability.

The revised unidimensional Faking Index model (FI-B) has very good validity as evidenced by the fit indices, good factor loadings and good reliability. The Faking Index items in USMaP-i were adapted from Faking Index items in Universiti Sains Malaysia Emotional Quotient Inventory (USMEQ-i) (18). In a study validation study (38), the unidimensional Faking Index model of USMEQ-i also showed good model fit and reliability, which is consistent with results in the present study.

Conclusion

In conclusion, the five-factor model of personality in USMaP-i should be revised and revalidated by as it exhibited poor validity and reliability. In addition, the stability of USMaP-i among the applicants to medical degree program is not yet tested, thus it is recommended to perform CFA for longitudinal measurement invariance of USMaP-i in this sample. As USMaP-i is a tool specifically developed for used in selection of medical students, a study to determine the predictive ability of the inventory is also recommended to find the relationship between USMaP-i scores at admission to the program and their performance throughout and at the end of the program.

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