ORIGINAL ARTICLE

Reliability and validity of the Adult Learning Inventory among medical students

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Abstract

Objective: To determine the internal consistency and construct validity of the Adult Learning Inventory (AL-i) among first year medical students in a Malaysian medical school.

Methods: Cross sectional study was done on 196 first year medical student in Universiti Sains Malaysia (USM). The Cronbach's alpha reliability analysis, exploratory factor analysis and confirmatory factor analysis were applied to measure internal consistency and construct validity of the AL-i respectively. These analyses were done using Predictive Analytics SoftWare (PASW) version 18 and Analysis of Moment Structure (AMOS) version 19.

Result: A total of 196 medical students responded to this study. Exploratory factor analysis showed that two potential constructs would be extracted from the inventory. The confirmatory factor analysis showed the two factor model with six items had a good fit with the latent constructs (X^2 (df) = 25.63 (8), p = 0.048, RMR = 0.045, GFI = 0.974, AGFI = 0.933, NFI = 0.974, RFI = 0.951, IFI = 0.987, TLI = 0.975, CFI = 0.987, RMSEA = 0.07). Each domain of the final model of the AL-i has three items. The Cronbach's alpha value of the AL-i was 0.72. The Cronbach's alpha values of andragogy and pedagogy domains were 0.87 and 0.86 respectively. Composite Reliability and Average Variance Extracted values were more than 0.6 and 0.5 respectively indicating good construct reliability and adequate convergent validity.

Conclusion: This study suggested that the two factor model with 6 items of the AL-i has a good fit and shown good psychometric values. It is a valid and reliability measurement to determine types of leaner among first year medical students.

Keyword
Validity, Reliability, Adult Learning, Undergraduate, Medical student, Pedagogy, Andragogy, Adult Learning Inventory, Confirmatory factor analysis

Introduction

The variation between individuals is almost never-ending because each one of us has very unique characters that make our ways of learning are different from others. In general learning is referred to an active and lifelong process of acquiring information through various medium where the information are transformed and translated into meaningful ideas that lead to formation of knowledge, skills, behaviour and attitude (1-3). The core

characteristics of how person learn that remain stable for life can be referred as learning traits. They are thus a good and visible predictor of learning patterns and styles. It is worth noting that part of an effective educator involves understanding how learners learn best (4).

In general, learners can be grouped into two types which are adult learner (andragogic learner) and child learner (pedagogic learner) (4-7). The word andragogy was derived from the Greek word *aner* which means man not boy and *agogus* which means leading. While the term pedagogy was originated from Greek word *paid* which means child. That is why andragogy and pedagogy are commonly referred as the art and science of teaching adults and children respectively (6, 7). It is worth to mention that part of an effective learning involves understanding of how we learn best (6, 8).

Adult learners are always known to be as independent learner and self-directed leaner (6, 8). They decide what important to learn and act as a resource for learning whenever they are needed by other learners (8). Their learning are driven and affected by the need to know something or to do something where they validate any information given to them before accepting it. When they learn they relate their belief and experience upon their new learning experience where they tend to immediately make use the learning experience to their jobs (6, 8). They tend to take active role in planning, monitoring and evaluating their learning (8). In contrast, pedagogic learners are known to be as dependent learner and more teacher-directed where they rely on others to decide what is important to be learnt (6 -8). Their learning is affected by desire to meet course requirement and tend to be rot learners where they accept all information given to them at face value without validating it (7, 8). They have very limited knowledge and experience to relate upon their learning where they expect their learning to be useful in long-term future; that is why they have little ability to serve as resource learning to other learners (5-8). It should be noted that understanding of nature of learners will be advantages for educators to enhance learning experience of the learners (9-11). One of instruments that can be used to identify types of learners is the Adult Learning Inventory (AL-i) (8).

Validity is defined as to what extent the measurement measures what it should measure, whereas reliability is generally defined as consistency or reproducibility of measurement over time or occasions(12-15). Both validity and reliability are important qualities that an inventory must be tested for in order to ensure it measures what it is supposed to measure and the measurement obtained is reproducible over time and occasion if similar measurements are being measured. The Reliability analysis of Cronbach's alpha and factor analysis are commonly used by researchers to determine the internal consistency and construct validity of an inventory (13-14). From that notion, similar analyses were applied to determine the internal consistency and construct of the AL-i.

This study described the reliability and validity of the AL-i, which was developed based on the andragogy and pedagogy theories (6, 7) to assess nature of learners with the hope that it can be used as a valid and reliable instrument among medical students. It is hoped that this study may provide some validity evidence in the use of the AL-i to identify nature of learners thus will help medical educators to understand better about their students' nature of learning.

Methodology

The Adult Learning Inventory (AL-i)

The inventory was developed based on the principles of pedagogy and andragogy that were proposed by learning theory researchers [6, 7]. The items of AL-i were framed literature review and discussion with the experts in medical education. The items were designed based on its compatibility and suitability with medical professional qualities,

local culture and values. Items conveying characteristics of the andragogic and pedagogic learner most clearly were selected. About six items were selected for each group of learner. The items were undergone a process of scrutiny and evaluation as a result of it the language of the items was modified to make it simple and suitable to express the concept implied. Each item of the AL-i was rated using 5-likert scores (1=least like you, 2=in between scores of 1 and 3, 3= 50% like you, 4=in between scores of 3 and 5, 5=most like you) to indicate how close the statement described the respondents' behaviour.

Expert evaluation of the items

In order to establish the content validity of the AL-i, the items were subjected to experts' evaluation. The experts were drawn from the field of Medical Education. Necessary modifications were made with the feedback given by the experts.

Preliminary try-out

The items were administered to a sample of 100 first year medical students and 20 medical teachers to check their applicability and face validity during separate face-to-face sessions. The students and medical teachers were encouraged to express their doubts freely. Necessary modifications were made with the experience gained through this preliminary try-out. The selected 12 items according to the learner groups are shown in table 2.

Validation study

Purposive sampling method was applied. Approximately 196 new first year medical students were selected as respondents. Proper instructions were given before the administration of the questionnaire. The applicants were asked to respond to all the statements and no time limit was imposed. During the time of administration the investigator gave proper assistance and directions whenever necessary.

Study subjects

Population of this present study was 196 new first year medical students at the School of Medical Sciences, Universiti Sains Malaysia. All of them were selected as study subjects.

Collection of data

The investigator obtained permission and clearance from the School of Medical Sciences and Human Ethical Committee of Universiti Sains Malaysia. Informed consent was obtained from the respondents and they were requested to fill in the questionnaire. Completion of the questionnaire was voluntary and the respondents were informed that not returning the questionnaire would not affect the students' progress in the course. Data was collected by guided self-administered questionnaire. The questionnaires were collected on the same day.

Reliability analysis

Reliability analysis was done to determine the reliability of the questionnaire. Internal consistency of the items was measured by using Cronbach's alpha coefficient. For an estimation of reliability, statistical reliability of individual items was done. Items with corrected-item total correlation value of more than 0.3 were selected and items with corrected-item total correlation value of less than 0.3 were deleted. The Cronbach's alpha value of deleted item could determine which item highly contributed to the reliability of the AL-i. If the Cronbach's alpha value for those items-deleted decreased, it would indicate that the items highly contributed to alpha value. In contrast, if the Cronbach's alpha value for those items-deleted increased, it would indicate that the items poorly contributed to alpha value. The items of AL-i were considered to represent measure of good internal consistency if the total alpha value was more than 0.6 (15).

Exploratory Factor Analysis

Collected data was analysed using Predictive Analytics SoftWare (PASW) version 18. Factor Analysis was done to determine construct validity of the AL-i. Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity was applied to measure the sampling adequacy and appropriateness of the factors extracted (16). The sample and factors extracted was considered as adequate and appropriate if i) KMO value was more than 0.5 and ii) Bartlett's test was significant (p-value less than 0.05). Principal Component Analysis (PCA) method was applied in extraction of components. Components with Eigen values of over 1 were retained. With the assumption that all items were uncorrelated with each other, Varimax rotation was applied in order to optimize the loading factor of each item on the extracted components. Items with loading factor of more than plus or minus 0.3 were considered as an acceptable loading factor (16, 17, 18). Once constructs of the AL-i were finalised, reliability analysis for each construct was done.

Confirmatory Factor Analysis

The analysis was done using Analysis of Moment Structure (AMOS) software version 19. The measurement model fit with the data was checked with model chi-square goodness-of-fit, and approximate fit indexes (19). Insignificant model chi-square goodness-of-fit (set at 0.05) signifies model fit. For approximate fit indexes, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed fit index (NFI), relative fit index (RFI), incremental fit index (IFI), Tucker-Lewis fit index (TFI) and comparative fit index (CFI) of above 0.9 would indicate model fit (18; 19). For another approximate fit index, root mean square error of approximation (RMSEA), a value less than 0.08 Root Mean Squared Residual (RMR) value less than 0.05 would signify reasonable model fit (20). Significance of standardized regression weight (standardized loading factor) estimates signifies that the indicator variables are significant and representative of their latent variable. Significance of estimates of correlations indicates significant two-way correlation between specified variables. Modification indices (M.I) suggested correlations between variables and the respective reductions in chi-square values should these correlations added to the model. Though reduction in chi-square values would improve model fit, following the suggestions in M.I. should be based on literature review or theoretical basis (18).

Based on the final model, Composite Reliability (CR) and Average Variance Extracted (AVE) were calculated manually by computing formulas given by Fornell and Larckers (1981) using the Microsoft Excell 2007 (refer to table 3 for the formulas).

Result

Table 1: Profile of participants.

Variable		(n = 196)
Gender, n (%)	Male	68 (34.7)
	Female	128 (65.3)
Qualification, n (%)	Matriculation	174 (88.8)
	High School Certificate (HSC)	13 (6.6)
	A-Level	9 (4.6)
Race, n (%)	Malay	105 (53.6)
	Chinese	61 (31.1)
	Indian	22 (11.2)
	Others	8 (3.6)
Origin, n (%)	Urban	99 (50.5)
	Rural	88 (44.9)
	Missing data	9 (4.6)
Parent income, n (%)	RM 1 – RM 500	8 (4.1)
	RM 501 – RM 1000	41 (20.9)
	RM 1001 – RM 2000	30 (15.3)
	RM 2001 – RM 3000	25 (12.8)
	RM 3001 – RM 4000	29 (14.8)
	RM 4001 – RM 5000	8 (4.1)
	RM 5001 – RM 7500	30 (15.3)
	RM 7501 – RM 10000	6 (3.1)
	More than RM 10000	6 (3.1)
	Missing data	13 (6.6)
CGPA result, mean ± SD (minimum, maximum)		3.97 ± 0.05 (3.88, 4.00)

A total of 196 (100%) medical students participated in study. Table 1 shows the demographic profile of the respondents. In

general the demographic profile represents the Malaysian population. Majority of the respondents were female (65.3%), Malays (53.6%) and came from the matriculation (88.8%) stream. It seems that most of the respondents originated from urban areas (50.5%) and various economic strata.

Exploratory Factor Analysis & Reliability Analysis

The sample was adequate as indicated by i) a KMO value of 0.798 and ii) Bartlett's test of sphericity being significant (p-value < 0.001). Table 2 showed the initial factor analysis where 2 components were extracted using principal component analysis (PCA with rotation of Varimax). It seems that Q9 were loaded into different group while Q3 and Q8 were loaded on both groups. Total variance explained by these two components was 55.88%. The Cronbach's alpha for Andragogy and Pedagogy domains were 0.57 and 0.77 respectively with overall Cronbach's alpha value of 0.70.

Confirmatory Factor Analysis & Reliability Analysis

Model 1: Two-factor model with 12 items was analysed by the AMOS revealed a poor fit with the latent constructs (X^2 (df) = 282.97 (53), p < 0.001, RMR (root mean square residual) = 0.155, GFI (goodness of fit index) = 0.806, AGFI (adjusted goodness of fit index) = 0.714, NFI (Normed fit index) = 0.764, RFI (relative fit index) = 0.706, IFI (incremental fit index) = 0.799, TLI (Tucker-Lewis fix index) = 0.747, CFI (comparative fix index)= 0.797, RMSEA (root mean square error of approximation) = 0.150), indicating needs for further modification based on the Modification indices (M.I).

Model 2: Four items (i.e. Q5, Q6, Q8, Q9) were removed based on the M.I. Two-factor model with 8 items (Andragogy represented by Q1, Q2, Q3 & Q4 and Pedagogy represented by Q7, Q10, Q11 & Q12) was analysed and showed a poor fit with the latent constructs (X^2 (df) = 55.60 (19), p < 0.001, RMR = 0.102, GFI = 0.936, AGFI = 0.878, NFI = 0.930, RFI = 0.897, IFI = 0.953, TLI = 0.930, CFI = 0.952, RMSEA = 0.100), indicating further modification was necessary based on the M.I to improve the model fitness.

Model 3: Based on the M.I another two items (i.e. Q1, Q7) were removed from the model 2. Two-factor model with 6 items (Andragogy represented by Q2, Q3 & Q4 and Pedagogy represented by Q10, Q11 & Q12) was analysed and found a good fit with the latent constructs (X^2 (df) = 25.63 (8), p = 0.048, RMR (root mean square residual) = 0.045, GFI (goodness of fit index) = 0.974, AGFI (adjusted goodness of fit index) = 0.933, NFI (normed fit index) = 0.974, RFI (relative fit index) = 0.951, IFI (incremental fit index) = 0.987, TLI (Tucker-Lewis fix index) = 0.975, CFI (comparative fix index)= 0.987, RMSEA (root mean square error of approximation) = 0.07). This final model was shown in the figure 1. Standardized factor loadings showed that all the items in the model 3 well loaded on each latent construct and very poor correlation was noted between the two constructs (r=0.07, p = 0.401) as shown in the figure 1 indicating they were independent of each other.

Reliability analysis (table 3) showed that the total Cronbach's alpha value of the model 3 of the AL-i was 0.72 which indicated a high level of internal consistency (12-15). All the items had corrected-item total correlation of more than 0.3 and highly contributed to the inventory reliability. The Cronbach's alpha values of the andragogy and pedagogy domains were 0.87 and 0.86 respectively. Those domains show high levels of internal consistency (15, 17). Composite Reliability (CR) and Average Variance Extracted (AVE) was more than 0.6 and 0.5 respectively indicating good construct reliability and adequate convergent validity (21). These findings suggested that the 6 items of the AL-i was reliable and had a high level of internal consistency.

Discussion

The demographic profile of the respondents was almost parallel with that of the Malaysian student population in terms of gender and ethic group. Even more, the distribution also can be considered to represent those from rural areas and lower social strata. These facts were considered as evidence of a good level of representativeness of study samples to the Malaysian student population.

The confirmatory factor analysis showed that the final model with 6 items had a good fit as all the goodness of fit indices support the model fit. The six items were also well loaded into the two predetermined domains (figure 1) as all the items had standardized loading factors of more than 0.3 (18). On top of that the two constructs showed they were independent of each other which is in keeping with the theory of andragogy and pegagogy (4-8). These findings concurred that the AL-i has a good construct. It provides evidence to suggest that the inventory measures what it should measure and it is a valid tool to be utilized in identifying types of learner among medical students.

The reliability analysis suggested that the final model items of AL-i exhibited a measure of high internal consistency as their Cronbach's alpha were more than 0.7 as shown in table 3; it reflected the high internal reliability of the inventory (17). The two domains had also shown a measure of good internal consistency as the Cronbach's alpha, Composite Reliability and EVA values were more than 0.7, 0.6 and 0.5 respectively; it was another evidence to support good construct reliability and adequate convergent validity of the inventory (17, 21). These findings provided evidence to support that the AL-i is a reliable instrument that could be used in the future to identify types of learner among medical students.

The reliability and confirmatory factor analyses have provided evidence of validity and reliability of the AL-i in determination of learner types among medical students of Universiti Sains Malaysia. However, a limitation of this study is that it is only confined to one institution. Therefore it is recommended that a multi-centre validation study should be conducted in the future to determine the validity and reliability of the AL-i across institutions.

Conclusion

The AL-i has shown good psychometric values. It is a valid and reliability tool to determine adult leaner status among medical students. It is a promising psychometric instrument that can be used to determine types of learner among students in future.

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Table 2: The exploratory factor analysis and reliability analysis of the 12 items AL-i.

No	Item	[a]Component 1	[a]Component 2	[b]Corrected Item-Total Correlation	[b]Cronbach's Alpha if Item Deleted	[c]Domain	[b]Cronbach's Alpha
Q1	Most of the time, I decide what is important to be learned.	**0.788**	0.037	0.496	0.675	**Andragogy (adult learner)**	**0.57**
Q2	I need to validate the information based on my beliefs and experiences.	**0.836**	0.038	0.512	0.674		
Q3	I expect what I'm learning to be immediately useful.	**0.323**	0.225	0.302	0.806		
Q4	I have much experience to relate upon my learning.	**0.795**	0.021	0.506	0.670		
Q5	I like to participate and involve in a discussion.	**0.706**	-0.093	0.339	0.687		
Q6	I have abilities to serve as a knowledgeable resource to teachers or fellow classmates.	**0.733**	0.148	0.521	0.670		
Q7	Most of the time, I rely on others to decide what is important to be learned.	0.364	**0.583**	0.468	0.669	**Pedagogy (child learner)**	**0.77**
Q8	I accept all the information being presented at face value.	**0.496**	**0.472**	0.525	0.668		
Q9	I expect what I'm learning to be useful in my long-term future.	**0.609**	0.054	0.342	0.689		
Q10	I don't like to participate and involve in a discussion.	-0.058	**0.826**	0.356	0.682		
Q11	I have little or no experience to relate upon my learning.	-0.044	**0.870**	0.362	0.682		
Q12	I have little or no ability to serve as a knowledgeable resource to teachers and fellow classmates.	-0.002	**0.878**	0.426	0.674		

[a] Factor Analysis; Exploratory Factor Analysis with varimax rotation, total variance explained was 55.88%, Kaiser-Meyer-Olkin (KMO) measure was 0.785 and Bartlett's test of sphericity $p < 0.001$

[b] Reliability analysis; Cronbach's Alpha Coefficient, overall Cronbach's alpha = 0.703

[c] Domains were predetermined based on adult learning principles.

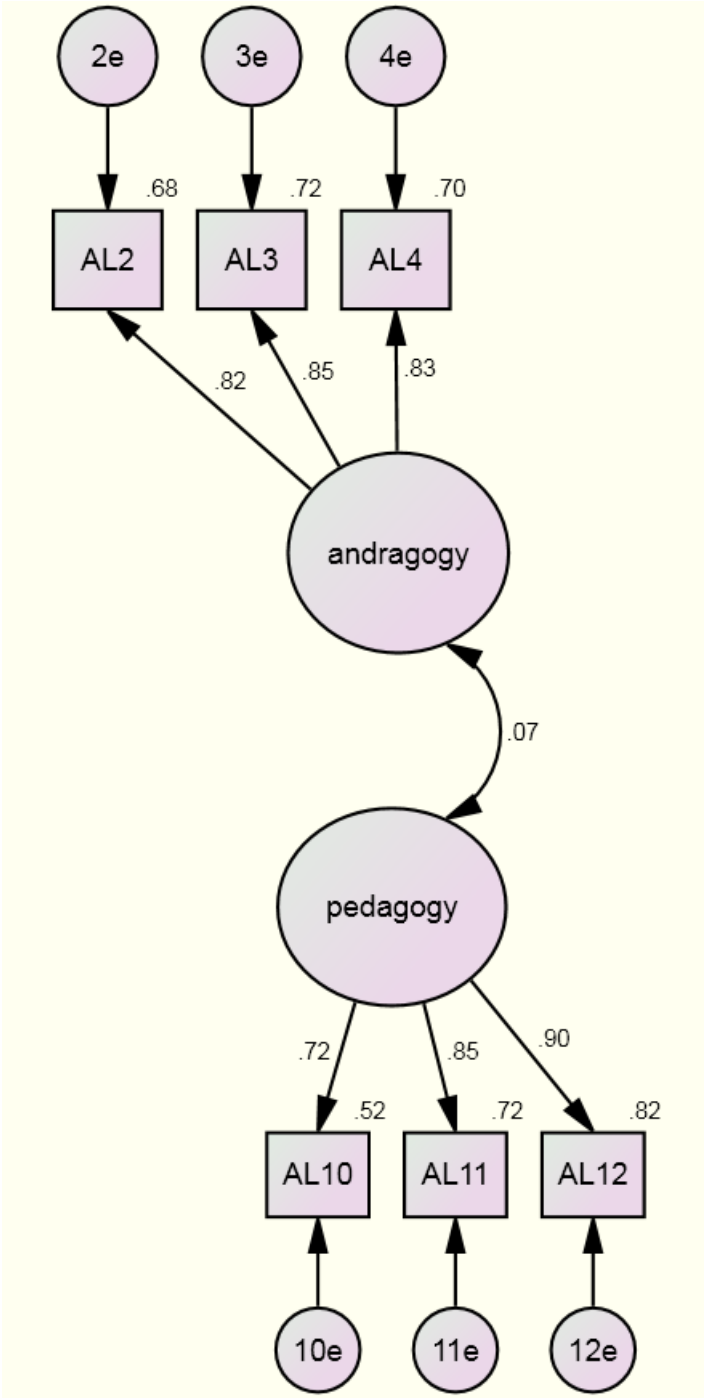

Figure 1: Standardized factor loading of the final model of the AL-i in first year medical students

Table 3: The reliability analysis of the 6 items of the AL-i based on the final model.

No	Item	[a]Corrected Item-Total Correlation	[a]Cronbach's Alpha if Item Deleted	[b]Domain	[a]Cronbach's Alpha	[c]AVE	[d]CR
Q2	I need to validate the information based on my beliefs and experiences.	0.749	0.828	**Andragogy (adult learner)**	**0.87**	**0.69**	**0.87**
Q3	I expect what I'm learning to be immediately useful.	0.764	0.809				
Q4	I have much experience to relate upon my learning.	0.757	0.813				
Q10	I don't like to participate and involve in a discussion.	0.671	0.868	**Pedagogy (child learner)**	**0.86**	**0.68**	**0.87**
Q11	I have little or no experience to relate upon my learning.	0.759	0.786				
Q12	I have little or no ability to serve as a knowledgeable resource to teachers and fellow classmates.	0.786	0.759				

[a]Reliability analysis; Cronbach's Alpha Coefficient, overall Cronbach's alpha = 0.72
[b]Domains were predetermined based on adult learning principles.
[c]AVE (Average Variance Extracted) was calculated manually based on formula given by Fornell & David (1981) (21) λ = standardized factor loading, n = number of item

$$VE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$$

[d]CR (Composite Reliability) was calculated based on formula given by Fornell & David (1981) (21)

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} \delta_i)}$$ λ = standardized factor loading, δ = error variance

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