ORIGINAL ARTICLE

Psychometric Properties of the Learning Approach Inventory: A Confirmatory Factor Analysis

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Abstract

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

Methods: Cross sectional study was done on 196 first year medical students in Universiti Sains Malaysia (USM). The items of the LA-i were framed based on characteristics of three learning approaches. The Cronbach's alpha reliability analysis, exploratory factor analysis and confirmatory factor analysis were applied to measure internal consistency and construct validity. These analyses were done using Predictive Analytics SoftWare (PASW) version 18 and Analysis of Moment Structure (AMOS) version 19. The Composite Reliability (CR) and Average Variance Extracted (AVE) were calculated manually to measure construct reliability and convergent validity.

Result: A total of 196 medical students responded to this study. Exploratory factor analysis showed that three potential constructs were extracted from the inventory. The confirmatory factor analysis showed the three factor model with nine items had a good fit with the latent constructs (X^2 (df) = 26.07 (20), p = 0.163, RMR = 0.04, GFI = 0.969, AGFI = 0.93, NFI = 0.967, RFI = 0.941, IFI = 0.992, TLI = 0.985, CFI = 0.992, RMSEA = 0.04). Each domain of the final model of the LA-i has three items. The Cronbach's alpha value of the AL-i was 0.86. The Cronbach's alpha values of surface, strategic and deep approach domains were 0.62, 0.73 and 0.88 respectively. Most of learning approach domains had 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 three factor model with 9-items of the LA-i has a good fit and shown good psychometric values. It is a valid and reliability measurement to determine learning approaches among first year medical students.

Keyword: Validity, Reliability, learning approaches, strategic approach, deep approach, surface approach, Learning Approach Inventory, confirmatory factor analysis

Introduction

The variation between students is almost never-ending because each one of them has very unique characters that are strongly influenced by genetic makeup (1). Similar phenomenon happens on students approach to learning where they tend to adopt certain ways of learning that best fit with their belief, ability and capacity. Commonly, 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 (2-4). It is noteworthy that understanding of student learning approaches will help educators to be better and efficient teachers as well as it help students to be better learners if they are aware about their own learning approach (5, 6).

Students have different levels of motivation, different attitudes towards teaching and learning, difference levels of maturity, different levels of response to specific educational and classroom environments, and different levels of reception to specific instructional design (7). Although each of students is unique, but there are common behaviours being displayed which can be clustered together to form meaningful concepts. From that notion, Marton and Saljo (8) have proposed three different approaches to learning which are surface approach, strategic approach and deep approach.

Students who adopt surface approach commonly learn through memorizing facts from the books they read and from lectures they attended (5-9). Their learning driven by extrinsic motivation where they learn due to fear of failure, they want to pass examination and get job. Their intention is just to pass and getting thing done with minimal efforts. Most of the time they accept all the information obtained from books and lecturers unquestioning. Studies have revealed that surface approach to learning has consistently been found to negatively correlate with academic performance and achievement (10-12).

Deep learners usually learn through understanding on subjects where their intention is to seek own meaning on the subjects to enhance understanding and mastery (5-9). They love to validate information given to them prior to accepting it through relating to previous knowledge and searching for evidence. Their learning is driven by intrinsic motivation where they want to master the subjects so that they can use it for good as well as to teach and share with others. They always monitoring, updating and evaluating their understanding through self-directed and life-long learning. It is worth noting that, studies have reported that high academic achievement and performance can be predicted from students who adopt deep approach to learning either alone or in combination with strategic approach (10, 11, 13).

Students who adopt strategic approach to learning commonly learn through systematic or smart study where they are bound to the syllabus of course and their intention is to attain the highest marks as possible (5-9). They are usually competing with other learners to get top rank in the course and are reluctant to share information with others. They stick to time and plan as well as monitor their study progress to ensure every course objectives have been read and understood. Students who adopt strategic approach in combination with deep approach tend to attain high academic success (10, 11, 13).

Reliability is generally defined as consistency or reproducibility of measurement over time or occasions whereas validity is defined as to what extent the measurement measures what it should measure (14-17). An inventory must be tested for both qualities in order to ensure it measures what it is supposed to measure and the measurement obtained is reproducible over time and occasion if similar attributes 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 of an inventory (18, 19); therefore, similar analyses were applied in this study.

This study investigated the reliability and validity evidence of the Learning Approach Inventory (LA-i), which was developed to measure student approaches to learning, among medical students. It is hoped that this study will provide ample evidence to ensure that this inventory can be used as a valid and reliable instrument to identify learning approaches of students.

Methodology

The Learning Approach Inventory (LA-i)

The inventory was developed based on the learning approach dimensions that have been proposed by Marton and Saljo (8) which are surface approach, strategic approach and deep approach. The items of LA-i were derived from literature review and discussion with the experts in medical education. The items were designed based on its compatibility and suitability with local culture and values. Items conveying characteristics of the learning approach dimensions most clearly were selected. About four items were selected for each of dimensions. The items were undergone a process of scrutiny and evaluation, as a result of that the language of the items was modified to make it simple and suitable to express the concept implied. Each item of the LA-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 LA-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 of previous batch 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 learning approach groups were shown in table 2.

Validation study

Purposive sampling method was applied. Approximately all 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 removed. The Cronbach's alpha value of deleted item could determine which item highly contributed to reliability of the LA-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 LA-i were considered to represent measure of good internal consistency if the total alpha value was more than 0.6 (11, 14, 17).

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 (18-20).

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 (21). 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 (20, 21). 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 (22). 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 (20).

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 Excel 2007 (refer to table 3 for the formulas).

Results

A total of 196 (100%) medical students responded to this study which was considered as excellent response rate.

Table 1 shows the profile of the respondents. 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 social strata.

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)

Exploratory Factor Analysis & Reliability Analysis

The sample was adequate and appropriate as indicated by i) a KMO value of 0.861 and ii) Bartlett's test of sphericity being significant (p-value < 0.001). Table 2 showed the exploratory factor analysis results where three components were extracted without forced extraction using principal component analysis (PCA) with rotation of Varimax. The analysis showed that all the items were well loaded on the three components with factor loadings more than 0.3. These findings indicate that the LA-i has a good construct. The total variance explained by these three components was 69.98% which was acceptable. Reliability analysis shows that the total Cronbach's alpha value of the LA-i was 0.867 which indicated a high level of internal consistency (14-17). The Cronbach's alpha values of the surface, strategic and deep approach domains were 0.69, 0.81 and 0.89 respectively as shown in table 2. Those domains show good to very good level of internal consistency (17, 19). Table 2 also shows that all the items has corrected-item total correlation of more than 0.3 and highly contributed to the inventory reliability as the Cronbach's alpha value decreased after deleting the items.

Confirmatory Factor Analysis & Reliability Analysis

Model 1: Three-factor model with 12 items (i.e. surface approach represented by Q1, Q2, Q3, and Q4; strategic approach represented by Q5, Q6, Q7 and Q8; deep approach represented by Q9, Q10, Q11 and Q12) was analysed by the AMOS revealed a poor fit with the latent constructs (X^2 (df) = 285.92 (51), p < 0.001, RMR (root mean square residual) = 0.121, GFI (goodness of fit index) = 0.788, AGFI (adjusted goodness of fit index) = 0.676, NFI (Normed fit index) = 0.768, RFI (relative fit index) = 0.7, IFI (incremental fit index) = 0.801, TLI (Tucker-Lewis fix index) = 0.740, CFI (comparative fix index)= 0.799, RMSEA (root mean square error of approximation) = 0.156), indicating needs for further modification based on the Modification indices (M.I).

Model 2: Based on the M.I recommendation, three items (i.e. Q4, Q6 and Q12) were removed from the initial model. Three-factor model with 9 items was analysed and found a good fit with the latent constructs (X^2 (df) = 26.08 (20), p = 0.163, RMR (root mean square residual) = 0.04, GFI (goodness of fit index) = 0.969, AGFI (adjusted goodness of fit index) = 0.93, NFI (normed fit index) = 0.967, RFI (relative fit index) = 0.941, IFI (incremental fit index) = 0.992, TLI (Tucker-Lewis fix index) = 0.985, CFI (comparative fix index)= 0.992, RMSEA (root mean square error of approximation) = 0.04). Since all the goodness of fit indices showed the fitness of this model, therefore it is considered as the final model for the LA-i (figure 1). Standardized factor loadings showed that all the items in the this

model well loaded on each latent construct (figure 1). There are good correlations between the three learning approach domains indicating they were not exclusively independent of each other (the r value ranged from 0.58 to 0.77) (figure 1).

Reliability analysis (table 3) showed that the total Cronbach's alpha value of the final model was 0.86 which indicates a high level of internal consistency (14-17). 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 deep, strategic and surface learning approach domains were 0.62, 0.73 and 0.88 respectively. Those domains showed high levels of internal consistency (17, 19). The Composite Reliability (CR) values for the three learning approach domain were more than 0.6 indicated that they had good construct reliability (23). The Average Variance Extracted (AVE) values of strategic and deep approach domains were more than 0.5 indicating adequate convergent validity however the surface approach domain failed to demostrate adequate convergent validity as its AVE value was less than 0.5 (23). In overall, findings suggested that the 9-items LA-i had a high level of internal consistency and had valid constructs that measuring the surface, strategic and deep learning approaches.

Discussion

The confirmatory factor analysis showed the final model with 9 items had a good fit of constructs as all the goodness of fit indices support the model fit. The nine items were well loaded into the three hypothetical domains (i.e. surface, strategic and deep learning approaches that were proposed by Marton & Saljo) as all the items had loading factors of more than 0.3 (17, 19); this finding showed that the LA-i has valid constructs. Furthermore, the domains were not exclusively independent from each other which are in keeping with the proposed principles of student approaches to learning (8, 9); this fact showed that there are certain degree of relationships between the three constructs which is logical and understandable because all of the constructs measuring student learning approaches that result of inter-relationships between motives and strategies of students (8, 9). This study provides realistic evidence to support the validity of the inventory where it measures what it should measure. Therefore, it is a valid tool to be utilized to identify student approaches to learning.

The reliability analysis suggested that the LA-i demonstrated a measure of high internal consistency as its overall Cronbach's alpha value was more than 0.7 for both model either the 12-items or 9-items LA-i; this indicated that in general the LA-i has a good level of internal reliability (14-17, 19). The newest version seem to be as reliable as the original 12-items version; this indicated that removing certain items were not affected the reliability of this inventory. The three domains had shown a measure of good internal consistency as their Cronbach's alpha values ranged from 0.62 to 0.88; this further prove that the internal consistency of each construct was not deteriorated as a result of item removal. They had also shown a good construct reliability and adequate convergent validity as the Composite Reliability and EVA values were more than 0.6 and 0.5 respectively (23); this was another important finding to show its construct reliability. These findings provide substantial amount of evidence to concur that the 9-items LA-i is a reliable instrument that could be used to identify students' approaches to learning.

The analyses have consistently provided satisfactory evidence to support the validity and reliability of the 9-items LA-i to measure student learning approaches. One of the advantages of this newest version of the LA-i is it has minimum number of item therefore easier to be administered and answered. This will result in good response rate from respondents. However, the biggest limitation of this study was related to study population where it was conducted in an institution which may not represent the student population in other institutions. Therefore it is

recommended that a multi-centre validation study should be conducted in the future to determine the validity and reliability of the LA-i across institutions. Apart from that, this study has provided useful evidence to support usage of this inventory for future studies in this area.

Conclusion

This study suggested that the three factor model with 9-items of the LA-i has a good fit and shown good psychometric values. It is a valid and reliability measurement to determine learning approaches among first year medical students.

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Table 2: The exploratory factor analysis and reliability analysis of LA-i according to its domains.

No	Item	[a]Component			[b]Corrected Item-Total Correlation	[b]Cronbach's Alpha if Item Deleted	[c]Domain	[b]Cronbach's Alpha
		1	2	3				
Q1	I'm motivated to learn by a concern to complete the course.			**0.334**	0.618	0.853	**Surface approach**	**0.69**
Q2	I'm motivated to learn by a fear of failure.			**0.405**	0.517	0.859		
Q3	Most of the time, I'm learning through acquiring information, mechanical memorization without understanding it, and reproducing it on demand in a test.			**0.888**	0.465	0.864		
Q4	My learning focus is on the task and material, not on the meanings and purpose.			**0.742**	0.389	0.870		
Q5	I'm motivated to learn by a need to achieve high marks.		**0.832**		0.614	0.853	**Strategic approach**	**0.81**
Q6	I'm motivated to learn by a need to compete with others.		**0.893**		0.519	0.860		
Q7	My learning focus is depending on what is required by the course.		**0.680**		0.680	0.849		
Q8	Most of the time, I'm learning through understanding and memorizing of the subject matter based on assessment requirement.		**0.442**		0.624	0.853		
Q9	I'm motivated to learn by an interest in the subject matter	**0.830**			0.618	0.854	**Deep approach**	**0.89**
Q10	I'm motivated to learn by a need to make sense of things and to interpret knowledge.	**0.887**			0.641	0.853		
Q11	My learning intention is to reach an understanding of the subject or material.	**0.826**			0.622	0.854		
Q12	During learning, I always make use of analogies and attempt to give the material personal meaning, and sometimes make use of memorization when the need arises.	**0.815**			0.464	0.862		

[a] Factor Analysis; Exploratory Factor Analysis with varimax rotation, total variance explained was 69.96%, Kaiser-Meyer-Olkin (KMO) measure was 0.861 and Bartlett's test of sphericity $p < 0.001$

[b] Reliability analysis; Cronbach's Alpha Coefficient, overall Cronbach's alpha = 0.867

[c] Domains were predetermined based on learning approach characteristics.

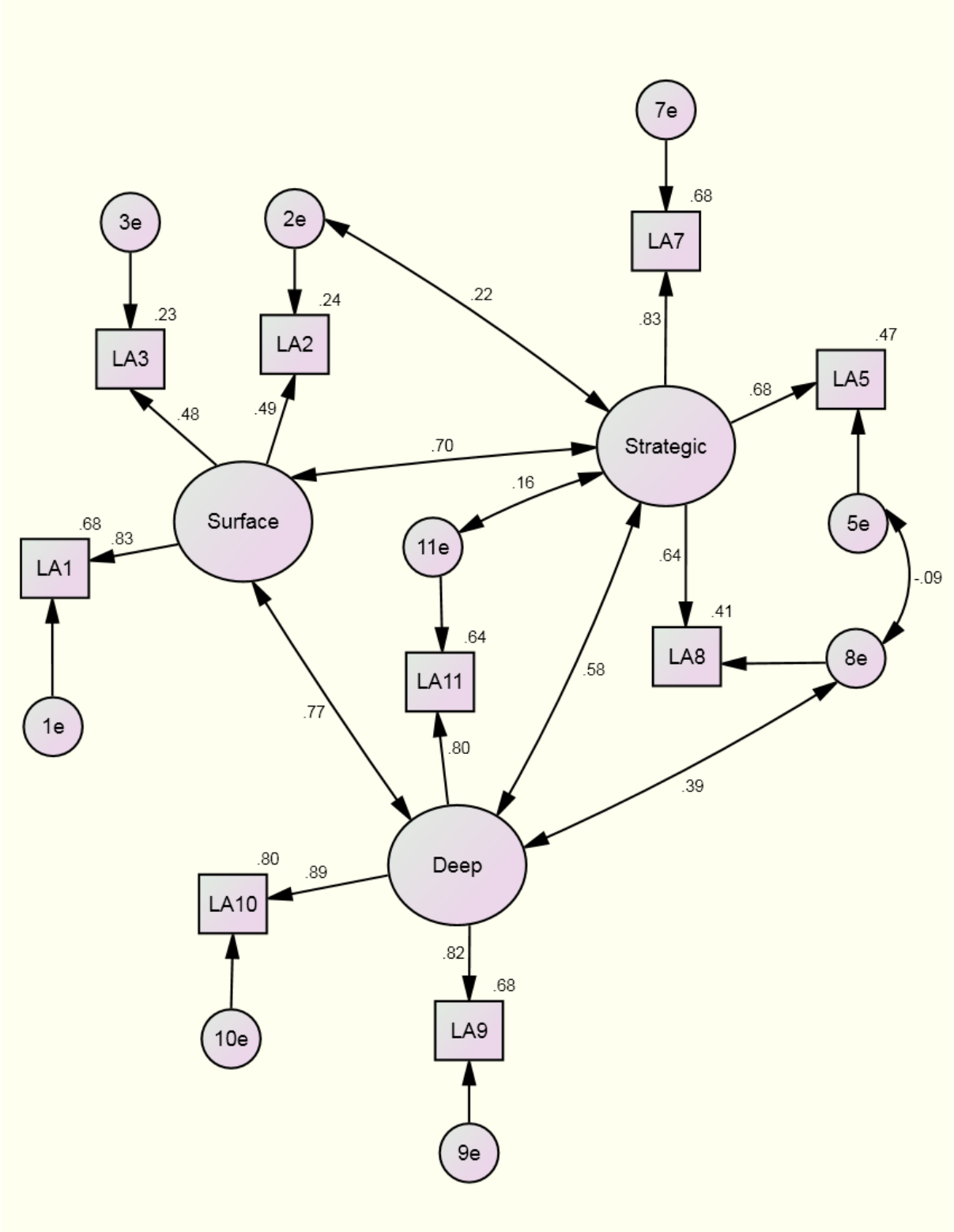

Figure 1: Standardized factor loading of the final model of the LA-i in first year medical students

Table 3: The reliability analysis of the 9 items of the LA-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
Q1	I'm motivated to learn by a concern to complete the course.	0.48	0.49	**Surface approach**	0.62	0.39	0.64
Q2	I'm motivated to learn by a fear of failure.	0.43	0.53				
Q3	Most of the time, I'm learning through acquiring information, mechanical memorization without understanding it, and reproducing it on demand in a test.	0.41	0.57				
Q5	I'm motivated to learn by a need to achieve high marks.	0.53	0.68	**Strategic approach**	0.73	0.52	0.76
Q7	My learning focus is depending on what is required by the course.	0.67	0.52				
Q8	Most of the time, I'm learning through understanding and memorizing of the subject matter based on assessment requirement.	0.48	0.73				
Q9	I'm motivated to learn by an interest in the subject matter	0.76	0.83	**Deep approach**	0.88	0.70	0.88
Q10	I'm motivated to learn by a need to make sense of things and to interpret knowledge.	0.79	0.81				
Q11	My learning intention is to reach an understanding of the subject or material.	0.74	0.85				

[a]Reliability analysis; Cronbach's Alpha Coefficient, overall Cronbach's alpha = 0.86

[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) (23) 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) (23)

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} \delta_i)}$$

λ = standardized factor loading, δ = error variance

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