Validation of Kolb's Structural Model of Experiential Learning Using Honey and Mumford's Learning Style Questionnaire

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Learning Style Questionnaire (LSQ) was developed according to Kolb's experiential learning model which classified learning into a four-stage cycle. The LSQ was translated into Chinese and applied to a convenient sample of students from a university and a nursing school. Seven hundred and twenty students (women 55.1%) completed the survey. Men had a more theorist style than women (P=0.001). Medical students had a more theorist style than other students. Cronbach's coefficient alphas of the four learning styles are 0.65, 0.62, 0.67 and 0.67, respectively. Theorist was positively related to the reflector (r = 0.44) and pragmatist (r = 0.50). The activist was negatively related to the reflector (-0.20). Item factor analysis did not reproduce the four-stage structure. Indirect factoring using the miniscales approach produced 17 miniscales, which were corresponded to the characteristics compositions of each learning style. Miniscales of the theorist and the pragmatist were grouped into one factor, and miniscales of the activist and the reflector formed the other factors in a four-factor solution. In a two-factor solution, miniscales of the activist and the theorist were separated into different factors. In Sum of scales factoring, the theorist, the pragmatist, and the reflector scales were grouped in factor 1 and the activist scale was in factor 2. Our data suggested a two-style learning model, the active and the conservative, with three facets in the conservative construct. Cultural factors may modify a person's learning style, but most of the learning style characterisations are cross-cultural.

Key words: learning styles, medical education, psychometric test, educational measurement.

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INTRODUCTION

The way students approach their learning is more important than content knowledge in educational outcome. Previous studies have revealed that different learning approaches affect academic outcome [1-3], clinical performance [4] and instructional preferences [5]. Newble and Entwistle developed a

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model of the teaching-learning process to explain the complex interactions within the educational process [6]. Teaching characteristics, student characteristics and departmental characteristics are three major factors affecting learning outcome. Knowing and matching students' learning preference to the design of curriculum and teacher's teaching and learning characteristics may produce better learning [6, 7]. Moreover, pairing students of opposite learning style (Abstract conceptualization vs. Concrete experience) can enhance clinical collaboration skills in solving medical problems [8]. Nevertheless, understanding how students acquire their knowledge may have great implications in medical educations.

One mainstream of evaluation of learning styles originated from cognitive psychology and psychometrics and viewed learning style as a cognitive style or personality trait [9]. Kolb's structural model of experiential learning is the most well-known in medical educational research [10]. Kolb has proposed a four-stage cycle, in which all stages are equally important and mutually supportive. An effective learner needs all four stages of abilities: concrete experience (feeling), reflective observation (watching), abstract conceptualization (thinking), and active experimentation (doing). However, learner may have individual preference for their learning ability.

Based on the four-stage model, Kolb has developed the Learning Style Inventory (LSI) to assess learners' learning preferences [10]. Unfortunately, other researchers have questioned the validity and reliability of the ipsative and normative versions of the LSI [11, 12]. Dissatisfied with the content and results of the LSI, Honey and Mumford modified Kolb's terminology and developed the Learning Style Questionnaire (LSQ) [13]. The LSQ emphasizes observable behaviors rather than the psychological basis for that behavior and comprises four subsets of 20 statements with each subset measures one of the Activist, Reflector, Theorist, and Pragmatist learning style. Although LSQ shares the same theoretical basis with Kolb's LSI, researchers found that the LSQ has better psychometric properties than the LSI [14].

That LSQ has not been extensively studied as Kolb's LSI may limit its application in educational research. Initial validation and application of LSQ has been mostly within management development and training. In two studies on small samples of British and Indian managers, researchers did not reproduce the hypothesized two orthogonal bipolar factor structure [14, 15]. Other researchers have revealed similar factor structure consisted of Activist-Reflector and Theorist-Pragmatist pairing which is different from the hypothesized Activist-Theorist and Reflector-Pragmatist pairing [16]. In a study of 284 psychology undergraduates, Cockerton et al. identified a four-factor oblimin solution from the LSQ [17]. However, the result is not consistent with the hypothesized structure and the use of the LSQ as a satisfactory measure to Kolb's learning styles is questionable. Since understanding learners' learning style may have great implications on education, the search for a valid and reliable measurement is worthwhile. Owing to the high acceptability and application of Kolb's learning style model in medical education, further researches focused on clarifying the dimensions and validity of the LSQ with different and large samples are required.

In this study, we developed a Chinese version of LSQ (C-LSQ) and verified the Kolb's four-stage model of experiential learning as well as psychometric properties of C-LSQ in Taiwanese university students. We also compared our results with results from pertinent literature.

METHODS

Instrument

A Chinese-English bilingual medical staff

translated the Honey and Mumford's LSQ into Mandarin Chinese with cultural adaptation. The C-LSQ was back translated to English by another bilingual medical staff and revised until the back translation revealed no discrepancy with the original English version. The translated questionnaire was assessed for readability by five experienced medical educators and pre-tested in a group of twelve family medicine residents. Modification of the wording of C-LSQ was performed until satisfactory. The C-LSQ contains four subsets of 20 items measuring the Activist, Reflector, Theorist, and Pragmatist learning styles and scores by "agree" or "disagree" as the original version.

Sample and procedure

The C-LSQ was administered in four groups of university students: nursing students from a nursing school; psychology students, liberal arts students, medical students, and paramedical students from one university. Group data collection sessions were arranged at the end of ordinary lectures at the convenience of the students and teachers who assisted in data collection. Oral consent was obtained from all recruited students and teachers who participated in the data collection process. On average, students took about ten minutes to complete the C-LSQ.

Statistical analyses

Questionnaire responses were coded and analyzed using SPSS/PC version 11. First, we examined each item of the LSQ for response distribution. Internal reliability of the C-LSQ was examined by the Cronbach's alpha coefficients of the four scales. Then, we administrated item factor analysis to the whole C-LSQ to see whether a four-factor structure can be reproduced. Since the response format of the C-LSQ provides dichotomous data rather than interval or continuous data, the skewness of item distribution can be great. Factor analysis with "miniscales" approach can reduce this problem [18,19]. By grouping items into "miniscales" or "parcels", we can reduce problems inherent in factoring items. Gorsuch advocated the assignment of "miniscales" on an empirical base [20]. This procedure required grouping of items based on the results of first order factor analysis and extracting higher order factors from primary factors. In this study, factors obtained from the primary factoring procedure were equivalent to "minscales", which entered second order factor analysis. Associations of the four learning style scales were examined by Pearson's correlation. We also examined the orthogonal bipolar hypothesis by factoring with sum scores of the four learning style scales and compared our results with the results of previous studies. In addition, we compared the learning styles between men and women and among different academic groups using ANOVA.

RESULTS

A total of 720 students completed the C-LSQ with slightly more female students. Students who did not turn in the questionnaire were not counted. Based on the general norms from 3500 people in Honey's study, most of our students (62.9%) are strong and very strong reflectors, about half of the students (53.3%) are strong and very strong activists, 35% are strong and very strong theorists, and 29.4% are strong and very strong pragmatists (Table 1). Obviously, some students have more than one dominant learning style.

Gender difference was found only in the Theorist style where men have a higher mean score than women (mean ± S.D. = 12.5±3.3 and 11.7±3.3, respectively; P=0.001). Comparing students from different academic background revealed difference only in the Theorist scale (F = 5.38, d.f. = 4, P =

Table 1. Descriptive statistics of the study sample

			No.	%
Gender			323	44.9
Man			397	55.1
Woman				
College/department				
Nursing			179	24.9
Psychology			92	12.8
Art or Literature			89	12.4
Medicine			252	35.0
Other Para-medicine			108	15.0
	Mean	S.D.	Skewness	Kurtosis
Learning styles				
Activist	10.84	3.22	.14	-.15
Reflector	15.18	2.69	-.06	.43
Theorist	12.02	3.35	-.23	-.40
Pragmatist	12.56	3.19	-.31	-.30

Table 2. Pearson correlations of the four learning styles

	Activist	Reflector	Theorist
Reflector	-0.20**		
Theorist	-0.07*	0.44**	
Pragmatist	0.16**	0.27**	0.50**

*P < 0.05; ** P < 0.01

0.0001). Post hoc examination with Scheffé's test demonstrated medical students have a high mean Theorist score (12.7±3.4) than students of nursing (11.6±3.2), psychology (11.3±3.2), and liberal arts (11.5±3.3). Since there were more female students in nursing, psychology, and liberal arts and more male students in medicine, a confounding effect may exist. In the bi-variate analysis, high Theorist score was still presented in medical students after controlling the gender effect (F=376, d.f.=4, P=0.005).

Psychometric properties of the C-LSQ

Internal consistency reliability of the C-LSQ

Internal consistency analysis of the C-LSQ revealed Cronbach's alpha of 0.65 for activist, 0.62 for reflector, and 0.67 for theorist and pragmatist scale. Two items in the activist and the pragmatist scale, and one item in the reflector and theorist scale have an item-total correlation of less than 0.1. Removal of these items can slightly improve the alpha coefficient of the scales.

Correlations between the four learning style scales

Table 2 presented the Pearson correlation of the four learning style scales. Theorist was modest and positive related to the Reflector (r = 0.44) and Pragmatist (r = 0.50). Activist was weakly and negative related to the Reflector (-0.20). This result did not support the hypothetical orthogonal bipolar structure of the LSQ.

Item factor analysis

Measures of sampling adequacy, Kaiser-Meyer-Olkin (KMO) value (0.77) and Bartlett's test of sphericity (X_{3160}^2 = 10451.43; p = 0.0001), indicated that the data were appropriate for factor analysis. However, when we limited the number of factors to four in order to reproduce the four-scale structure of the LSQ, items from each of the scales spread into different factors and failed to reproduce the four hypothetical scales.

Indirect factor analysis and cross cultural comparison of the LSQ

Miniscales and sum score factoring of the C-LSQ were conducted for construct validation and cross cultural comparison with results from Western

studies.

Factor analysis with miniscales approach

Miniscales were obtained by using principal axis factoring and oblimin rotation on the four learning style scales separately. Number of factors (miniscales) was determined by applying the eigenvalue > 1 criterion, parallel analysis and interpretability of factors. There were a total of 17 miniscales. The Activist scale produced four miniscales: "Impulse" (included 3 items), "Open to new challenge" (8 items), "Enjoy present moment" (4 items), and "Like novel experience" (5 items). The Reflector scale produced 5 miniscales: "Conclusion and decision" (3 items), "Thoughtful and careful" (5 items), "Listening" (3 items), "Caution" (5 items), and "Stand back and watch" (4 items). The Theorist scale produced 4 miniscales: "Perfectionism" (8 items), "Theoretical" (3 items), "Rational and objective" (6 items), and "Logical and detached" (3 items). The Pragmatist scale produced 4 miniscales: "Direct and straight" (7 items), "Practical approach" (4 items), "Realistic value" (6 items), and "Emotional insensitive" (3 items). The score for each miniscale was constructed by summing the rating of items in that miniscale.

Principal axis factoring with oblimin rotation was used in the second order factor analysis. Sampling adequacy for the 17 miniscales revealed a KMO value of 0.77 and a significant Bartlett's test of sphericity (X_{136}^2 = 1975.66; p = 0.0001), which indicated factor analysis is appropriated. In the determination of factor numbers, parallel analysis suggested a 4-factor solution, the eigenvalue >1 criterion suggested a 5-factor solution, and the scree test suggested two major factors underlying the 17 miniscales. Since the eigenvalue criterion tended to overestimate the factor number, we conducted factor analysis with the 4-factor and 2-factor solutions. In the 4-factor solution, most of the miniscales from the theorist and pragmatist learning style grouped into one factor with the exception of the "Perfectionism". Miniscales of Activist learning style grouped into three factors and miniscales of the Reflector learning style dispersed in all four factors (Table 3). Table 4 presented the 2-factor solution of the miniscales factor analysis. All miniscales of the theorist and most of the miniscales of the pragmatist and the reflector learning styles grouped into the first factor. The second factor contained all miniscales of Activist and 2 reflector and 1 pragmatist miniscales. This result is different from the result from Cockerton where Activist and Reflector item sets loaded in one factor with different direction and Theorist and Pragmatist item sets loaded on another factor.

Sum score factor analysis of the four learning style scales

The KMO value was 0.56 and the Bartlett's test of sphericity was significant (X_6^2 = 410.52; P = 0.0001). The KMO in fact indicated poor sampling adequacy for sum score factor analysis. Principal axis factoring with oblimin rotation obtained a two-factor solution with interfactor correlation of -0.085. Theorist, Pragmatist, and Reflector scales were grouped in factor 1 and the Activist scale was in factor 2. Theorist and Reflector scales have negative loadings in factor 2, which indicated an opposite direction with Activist scale (Table 5).

DISCUSSION

Using a Chinese version of LSQ, we failed to verify Kolb's four learning styles from item factor analysis. Since Honey and Mumford and subsequent researchers have not reported the result of the item factor analysis of the LSQ, cross-cultural comparison was not possible.

Table 3. Four-factor solution of miniscales factor analysis for the Learning Style Questionnaire

		Factor 1	Factor 2	Factor 3	Factor 4
Rational (T)		**.646**			-.116
Direct (P)		**.580**			-.104
Practical (P)		**.445**	-.187	-.135	.246
Insensitive (P)		**.395**	.121		
Theoretical (T)		**.395**	.116		
Logical (T)		**.372**	-.262		.131
Realistic (P)		**.355**			
Cautious (R)		**.352**	-.293		.109
Enjoy present (A)			**.631**		.168
Impulsive (A)		.220	**.573**		-.160
Perfection (T)		.369	**-.520**		.122
Thoughtful (R)		.118	**-.495**		.105
Listening (R)		.113	.165	**.811**	
Like novel (A)		.195	.362	**-.363**	
Stand back (R)					**.569**
Challenge (A)			.299	-.292	**.475**
Conclusion (R)			-.261		**.416**
Correlation	Factor 2	-.073			
	Factor 3	-.107	-.185		
	Factor 4	.233	-.199	-.064	

Principal axis factoring and oblimin rotation with Kaiser normalization.
Factor loadings of less than 0.10 were not shown in the table
A: activist; R: reflector; T: theorist; P: pragmatist

Table 4. Two-factor solution of miniscales factor analysis for the Learning Style Questionnaire

	Factor 1	Factor 2
Practical (P)	**.622**	
Perfection (T)	**.619**	-.326
Logical (T)	**.513**	-.112
Rational (T)	**.504**	.175
Cautious (R)	**.502**	-.123
Direct (P)	**.443**	.249
Realistic (P)	**.405**	
Conclusion (R)	**.353**	-.283
Theoretical (T)	**.336**	.217
Stand back (R)	**.197**	
Impulsive (A)	-.132	**.568**
Like novel (A)		**.536**
Enjoy present (A)	-.166	**.501**
Thoughtful (R)	.369	**-.424**
Challenge (A)	.207	**.329**
Insensitive (P)	.270	**.297**
Listening (R)		**-.150**

Interfactor correlation: -0.018
Principal axis factoring and oblimin rotation with Kaiser normalization.
Factor loadings of less than 0.10 were not shown in the table
A: activist; R: reflector; T: theorist; P: pragmatist

Table 5. Sum score factoring of the four learning style scales

Scales	Factor 1	Factor 2
Theorist	**.790**	-.113
Pragmatist	**.694**	.311
Reflector	**.467**	-.377
Activist		**.512**

Interfactor correlation: -0.085
Principal axis factoring and oblimin rotation with Kaiser normalization
Factor loadings of less than 0.10 were not shown in the table

Because dichotomy response scale of the LSQ is inappropriate for item factor analysis, our second attempt was indirect factoring with miniscales approach. Comparing to Cockerton's random assignment approach, Gorsuch's method of forming miniscales has two advantages. First, the formation of miniscales is based on correlations in empirical data. Second, the miniscales are more meaningful than random item groups and can reveal the underlying constructs within each of the four learning style scales. In the LSQ, learning styles are described by statements referring to a context-related behavior, attitude, or intention. For example, Honey described "Activist" as "Those who involve

themselves fully in new experiences... They are open-minded, not skeptical, enthusiasm in new things… They tend to act first and consider the consequences later… They tend to thrive on the challenge of new experiences but bored with long term consolidation…" [13]. In the Activist scale four miniscales were identified which included "Impulse", "Open to new challenge", "Enjoy present moment", and "Like novel experience" These four miniscales are corresponded to Honey's description of the Activist's characters. Miniscales of the other three scales also corresponded respectively to Honey's learning style descriptions. The reproduction of the characteristic compositions of the learning styles in our data demonstrated construct validity within each of the four scales of the LSQ.

Factoring of the miniscales identified a 4-factor solution; however, miniscales of the four learning styles could not clearly separate from each other. Most of the miniscales of the Pragmatist and Theorist styles grouped into one factor. This result associated with high correlations among the Reflector, Theorist, and Pragmatist scales questioned Kolb's four-stage learning style model. Since there was no information about how the Activist, Reflector, Theorist, and Pragmatist learning styles were formed, some researchers suggested that the four learning styles may be better described as facets of the same underlying construct rather than four different constructs [16]. Swaile and Senior argued that due to the high association between Reflector and Theorist, there may be only three learning styles: the Pragmatist, Activist, and Reflector/Theorist [21]. In this study, high correlations among Theorist, Pragmatist, and Reflector were revealed. The results of the miniscales factor analyses and sum score factoring also suggested that there may have only two distinct learning styles: Active and Conservative and three facets (Theorist, Reflector, and Pragmatist) in the conservative construct. This two styles model is more consistent with the Chinese "Yin-Yang" philosophy where everything has two opposite sides. Since most of the previous validation studies in Western countries were from small number or homogenous groups of people, we suggested future study in large and heterogeneous samples to verify the two-style model in Western culture.

Internal consistency reliabilities are fair for the four style scales of the C-LSQ and slightly lower than those reported for the original LSQ. Cultural factor or some other factors may affect the response to some of the items in the LSQ. For example, the item "I thrive on the challenge of tackling something new and different" was agreed by more than 90 percent of the students and has poor correlation to other items of the C-LSQ. Further research should try to modify these items and to improve the internal consistency. However, the correlations of the four learning styles were similar to those reported by Swailes and Senior [21], and Cockerton et al [15].

Factor analysis with summed learning style scores extracted two unipolar factors (Factor 1 included Reflector, Theorist and Pragmatist, and Factor 2 included Activist). This result is different from the single bipolar dimension of Activist-Reflector reported by Allinson and Haynes [15] and another single bipolar dimension of Activist-Reflector/Theorist reported by Swailes and Senior [21]. In our data, factor loadings on the second factor also revealed substantial but negative values of Reflector scale and positive values of the Activist scale. A tendency of a bipolar dimension of Activist-Reflector could be observed. It was suggested that learning style refers to a broad characterization of how people prefer to tackle learning tasks in general [21]. These results suggested that cultural factors may modify a person's learning style but most of the learning style characterizations are cross-cultural.

We found no gender differences in learning

styles after the control of students' academic background. This result is consistent with Honey' s study, which revealed no obvious gender differences in learning style preferences although there were slightly more female Activists and male Theorists [13]. We found that medical students have a higher mean score in Theorist style than students of nursing, psychology, and liberal arts; however, such comparison has not been reported in the literature. Since we did not know the characteristics of the students who failed to response to our study, the frequencies of the four learning styles among the students might be distorted.

Most previous studies tried to reproduce the two bipolar learning styles structure of the LSQ. However, according to Kolb's experiential learning model, learning is a four-stage cycle where individuals circle through these four stages and hopefully a good learning can achieve all learning abilities. However, this ideal situation is difficult to achieve. Individuals may have multi-stages abilities but usually emphasize some abilities over others. Such that individuals learning styles may fall at some points between these two bipolar dimensions rather than fall on one pole. In addition, when we consider individual variations and data errors all together, reproduction of a two bipolar structure with empirical data can be difficult to achieve. Therefore, the attempts to reproduce the hypothetical bipolar dimensions of the LSQ may be inappropriate.

Our study verified Honey and Mumford's LSQ from a group of Taiwanese university students and allowed cross-cultural comparison of Kolb's learning style hypothesis. Comparing to most of the previous studies of the LSQ, our study has the advantage of a larger sample and more heterogeneous groups of students. Because the Chinese version may not fully equivalent to the original LSQ, the results of cross-cultural comparison should be interpreted with caution.

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Kolb 經驗學習結構模型之驗證

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Kolb 氏的經驗學習結構理論認為學習是經驗、觀察、構思與驗證的四階段歷程。 本研究的目的是翻譯編修中文版學者方式問卷（C-LSQ）並作跨文化的信效度檢定。研究對象是一所護理學校與一所綜合大學的學生，利用通識課程時間作問卷調查。C-LSQ 是由原問卷經中譯、反譯及前測修改而成，問卷共有 80 題，每種學習方式各有 20 題，回答方式為「同意」與「不同意」之二分評量。研究結果共得 720 份有效問卷，女生佔 55.1%，男生與醫學系學生的「理論者」比較多。四個分量表的內部一致性 Cronback's α值為 0.65、0.62、0.67 及 0.67。「理論者」與「省思者」及「理論者」與「實用者」具有意義的正相關（γ＝0.44 與 0.50）。「行動者」則與「省思者」具有意義的負相關（-0.20）。因素分析無法重現階段模型。使用 Gorsuch 之二階因素分析法，先將四個分量表分開以主軸因素法分析，再將獲得的 17 個小因素作第二階因素分析；在四因素模型中，「理論者」與「實用者」的小因素集中在同一因素，「行動者」與「省思者」的小因素則分散在其他三個因素。在二因素模型中，「行動者」與「理論者」的小因素分開在兩個因素。將四個量表作因素分析，「行動者」與其他三者分開在兩個因素，本研究支持只有積極者與保守者兩種學習方式，而在保守者中再分三種面相；結果並未顯示有文化差別存在。

關鍵詞：學習方式、醫學教育、心理計量、教學評估

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