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Psychometric Properties of an Amharic Version of the Felder-Soloman Index of Learning Styles

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Abstract: Felder-Soloman Index of Learning Styles (ILS) was translated to Amharic for the purpose of using it among Amharic speaking community in more meaningful manner. It was done by astudent who was pursuing Master's Degree inPsychology for thesis work. The data was collected from 243 students of some selected secondary schools of Southern Region of Ethiopia. The data was subjected to reliability and validity investigation in order to test whether the Amharic version fit with these important psychometric qualities and agree with the original English version of ILS.The results indicated that the reliability of the subscales of the Amharic version of ILS approximated to the original English version and the content validity calls for further considerationson the items to modifycontents and linguistic presentations.

Key Words:construct(s), Learning styles, questionnaire, scale(s)

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I. INTRODUCTION

This study focuses on the evaluation of psychometric characteristics of the Amharic version of the Felder Soloman Learning Styles (ILS). ILS is one of many other learning styles identification instruments. Among many other things,emphasizing on identification of the students' learning style is very important when we talk about learning style and other learning theories. Because the introduction of learning style theories into the theories of learning is primarily due to the strong claim of the theorists and proponents that teaching through learning style-matched method could improve students' learning performance and achievement – "matched hypothesis". However, sometimes some studies come up with supporting findings whereas others end with very contradicting results. Nevertheless, it is difficult to conclude that learning style-matched instruction result in students' achievement [1], it is possible to conclude that learning style matched instruction could be considered as one of the factors that affect students' learning by contributing a certain percent of variance though the amount of contribution is needed to be investigated by large scale empirical studies.

Research on matching hypothesis requires a selection of specific learning style model out of highly growing models and scales. Selection of appropriate learning style models is a difficult task since the models and inventories are too many and the selection criteria vary from one purpose to another. Coffieldet. al.[2] critically evaluated and categorized the learning style models and inventories into different characteristics. The purpose of their analysis was to choose more efficient model and scale for the post-16 learning in UK. Most of the criteria implemented by the researchers are serious and could be used for other purposes with necessary considerations. Coffield and his research associates identified 71 models and from which they chose 13 on the basis of:

1. *their theoretical importance in the field as a whole*
2. *their widespread use, either commercially or academically*
3. *their influence on other learning style models ([3]: p 1).*

However, the above criteria of selection may not be comprehensive to be used for all purposes. For example, regarding the first criterion, there is vagueness because 'theoretical importance' of a model with respect to post-16 learning is different from considering the theoretical importance of a model for practicing in a given organization and research uses. That is, the theoretical importance is determined from the point of view of the nature of the work under consideration. More specifically, some models are appropriate in business area for managers and workers others are more useful in education sector for students and teachers and yet others work in other diverse situations. Therefore, I would like to use the above criteria with some modifications in addition to other criteria which were used in Coffield's report for evaluating and judging the qualities of the selected models as follows:

1. the theoretical consistency with the purpose intended

2. the applicability in the field of education
3. the extent of use in research and practice
4. stimulation for research and practice
5. psychometric soundness of the instrument which substantiate the model

These criteria help to pin point towards the model intended. To begin with the first criterion, as mentioned above selection of learning style model in instructional situation isassociated with the matching hypothesis, it has to focus on models which underpin the concept of learning style as flexibly stable. Firstly, the stability nature of learning style helps to measure the existing behaviour to predict the learning performance (students' achievement) that could happen in the future. Secondly, theories under this family also characterize learning styles as modifiable because human mind is highly complex and flexible to adapt to situations even when the circumstance is not matching person's natural tendency. On the contrary, considering learning style theories that support fixed trait could lead to labelling students and later lead to some kind of stigmatization. According to Coffieldet. al.[3]&[2], the selected 71 learning style models are categorized into five families. The first family advocates the learning style and preferences as constitutionally based, the second assumes learning styles reflect deep-rooted features of the cognitive structure; the third considers learning styles as one of stable personality type; the fourth takes the learning style as flexibly stable learning preferences; and the last one entitles learning as learning approaches and strategies. The first three families promote enduringly stable concept which is liable to stereotyping students which implies a kind of conviction that traits cannot bemodified [2]. Finally, the last one does not encourage the idea of specific instructional measures to match existing styles.

According to Coffield's[2] 13 selected models, there are 4 under 'flexibly stable' family of which I have chosen as theoretical foundation for this study. Allinson and Hayes' Cognitive Style Index (CSI) satisfies the four main psychometric measures (internal consistency, test-retest reliability, construct validity and predictive validity) but it is designed for organizational and business context. Herrmann Brain Dominance Instrument (HBDI) fulfils the test-retest reliability and construct validity measures and can be used in teaching and learning. Honey and Mumford's Learning Styles Questionnaire (LSQ) meets test-retest reliability and it can be used in teaching and learning but very popular tool with practitioners in such areas as industrial trainers. Kolb's Learning Style Inventory (LSI) is widely used and fits the requirement of test-retest criterion. Felder-Soloman Index of Learning Styles (ILS) is not chosen to be discussed deeply in Coffield's report, however, it is widely used [4] and as some external research indicates, it is an appropriate psychometric instrument to measure the learning styles of engineering students [5]. McCarthy's 4MAT System is widely used but it is not learning style instrument by itself, it is a method that suggests instructional strategies which is based on Kolb's Experiential Learning Theory. The rest under 'flexibly stable' family – Questionnaire of Practice-oriented Learning (QPL), The A-E Inventory, and Kirton Adaption-Innovation Inventory (KAI) – are not widespread and influential. Therefore, from this family there are two instruments that are suitable for this study, namely ILS and HBDI. Because of its accessibility and simplicity to use, I have preferred ILS to HBDI, which is expensive and requires training and certification to administer. Detailed justifications whether to use or reject the widely used instruments will be further explained in the next section.

Felder - Silverman's learning style model

Richard M. Felder and Linda K. Silverman presented their model as it consists of four dimensions. The first dimension is sensing-intuitive, of which sensing learners are concrete thinkers, practical, oriented toward facts and procedures, whereas intuitive learners are more abstract thinker, innovative, oriented toward theories and basic meanings. The second dimension is visual-reflective, of which visual leaner favour to visual displays like pictures, charts and graphs while verbal learners like written and articulated explanations. The third dimension is active-reflective, of which active learners learn by trying things out, interested in working with others as reflective learners learn by thinking things through, favour working isolated or with a single known partner. Finally, the fourth dimension is sequential-global, linear thinking process, learn in small ascending steps, whereas global learners are holistic thinkers, learn in large leaps [6].

There are strong justifications to select Felder-Soloman'sinstrumentto adapt. Primarily, it has imperative theoretical foundations which support my assumptions that learning styles are relatively stable [7] &[6]. So it is possible to reliably measure the constructs (indicators) that characterize students' individual variations in perceiving, interacting and responding to the environment. Secondly, the theory claims "learning style preferences can be affected by a student's educational experience" [6]. That is, the strong learning preference of a student on a given scale could decrease and a preference on other dimension could strengthen on the basis of provision of guided practices. So I speculatethat the individual tendency to learn in certain way, whether it is learned or inherited, a person could adapt a certain learning style through a long period of teaching and learning experience. Thirdly, as different studies indicated, the three scales (active/reflective, visual/auditory, and sensing/intuitive) are orthogonal [8]&[5]. That is, they should independently measure

separate constructs with negligible correlation to each other as they were intentionally included in the instrument. Otherwise the instrument is dubious to be considered as valid measure of the proposed constructs. Nevertheless, sequential/global and sensing/intuitive dimensions exhibit moderate relations. Such inter-scales correlation may be psychometrically problematic however the developers argue that it indicates the construct validity of the instrument. Generally, psychometrically ILS is proper instrument for assessing learning styles for the purpose it was primarily developed [5]&[9].

The ILS was developed by Richard Felder and Barbara Soloman[10]. It was used to identify students' preference of learning styles. The questionnaire was developed on the basis of a model of eight variables constructed on four dimensions. The dimensions are active-reflective, sensing-intuitive, visual-verbal, and sequential-global. Each dimension runs horizontally and independently with no clear influence on other dimensions (i.e., it is orthogonal). However, as research by Felder and Spurlin ([6] p. 108), on the validity of the instrument indicated, three of the dimensions (active-reflective, sensing-intuitive, and visual-verbal) are fairlyorthogonal (independent) whereas sequential-global and sensing-intuitive appeared to be correlated moderately.

The questionnaire consists of 44 items - 11 items were constructed to measure each dimension. Students responded to each item by selecting one of two options. For example, the item "I understand something better after'I have tried it out' or 'thought it through'" are the two options between which the students should choose. The items measure the different dimensions as shown by Table 1.

Table 1: The distribution of items on each dimension in the questionnaire

Dimensions	**Number of items**
Sensing-intuitive	2, 6, 10, 14, 18, 22, 26, 30, 34, 38,42
Visual-verbal	3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43
Active-reflective	1, 5, 9, 13, 17, 21, 25, 29, 33, 37,41
Sequential-global	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44

According to Felder and Soloman[11], the interpretation for each dimension is as follows:

- If the score on a scale is 1-3, the respondent is fairly well balanced on the two dimensions of that scale.
- If the score on a scale is 5-7, the respondent has a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favours that dimension.
- If the score on a scale is 9-11, the respondent has a very strong preference for one dimension of the scale. The respondent may have real difficulty in learning in an environment which does not support that preference.

Effects of learning styles on student's achievement

Sometimes researchers compare the impact of leaning style on students' achievement with other factors. Mismatch of learning styles with teaching methods could not be the only factor for low achievement, but many findings indicated its significant effect on students' achievement, and interest. According to Felder and Spurlin[6], the amount of knowledge acquisition is partly affected by the learning styles, teaching methods and students' natural potential. Further they pointed out that the absence of matching the learning styles with teaching methods possibly leads students to change their field of study and even to drop out:

When the learning styles of most students in a class and the teaching style of the professor are seriously mismatched, the students are likely to become uncomfortable, bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum and themselves, and in some cases change to other curricula or drop out of school([6] p. 103).

Other researchers argue that mismatch of learning style with teaching methods could have impacts on achievement. The impacts could be stimulation of personal growth and creativity and avoidance of boredom [2]. On the contrary, according to Felder andHenriques[12], matching teaching styles with learning styles can considerably improve academic achievement, student attitudes towards learning, and student performance at the primary and secondary school level, at the college level, and specifically in foreign language instruction.

I have conviction that individual differences are important because they are expressions of the uniqueness of personality, and our individual configurations that bestow us our identities [13].These differences should be encouraged in order to profit from talents of our students.

Method

Statistical analysis on basic psychometric properties (reliability test by using Cronbach alpha and content validity by using factor analysis) was conducted on Amharic version of ILS. In addition comparison of reliability coefficients of the current study with the previous ones was carried out.

II. RESULTS AND DISCUSSIONS

Under this section statistical analyses (reliability and validity) were conducted using SPSS version 23 and the results were presented in tables and figure with interpretations.

Comparison among reliability coefficients of various studies

The Cronbach alpha coefficient was conductedto determine the reliability (internal consistency) for each of the four scales of the ILS on the sample of 243 students. Table 2 shows the previous studies results to compare with the current study which were conducted on original English version of ILS.The Cronbach alpha values obtained in this study (see Table 3) shows a close magnitude compared to the results obtained from the five previous studies. The current study's alpha value ranges between 0.556 and 0.686. That is the **Sensing/Intuitive** and **Sequential/Global** are low and **Active/reflective** and **Visual/Verbal** are relatively approach to the acceptable level when rounded to the first decimal place (0.7). Here two important questions should be raised: 1) how is the psychometric quality of the Amharic version of ILS; and 2) do the subscales of satisfy the acceptable range of the internal consistency reliability? As to Tuckman (as cited in Litzinger, Lee, Wise & Felder [14]) the acceptable alpha value for the instruments which measure knowledge and skill is above 0.75 but for attitude and performance instruments it should be 0.50 or above. According to these criteria the reliability (internal consistency) of Amharic version of ILS is acceptable because all the four scales are above o.50.

Table 2: Cronbach Alpha Coefficients

A-R	**S-I**	**Vs-Vb**	**Sq-G**	**N**	***Source***
0.60	0.77	0.74	0.56	572	Litzinger, Lee, Wise and Felder
0.56	0.72	0.60	0.54	242	Livesay*et al.*
0.62	0.76	0.69	0.55	584	Spurlin
0.51	0.65	0.56	0.41	284	Van Zwanenberg*et al.*
0.60	0.70	0.63	0.53	557	Zywno

Source Litzinger, et al.[14]

Table 3: Internal Consistency Reliability

	Cronbach's Alpha	N of Items
Active/reflective	0.654	11
Sensing/Intuitive	0.556	11
Visual/Verbal	0.686	11
Sequential/Global	0.632	11

Classical item analysis

Classical item analysis was conducted on the ILS items to see whether therewere items negatively affecting the reliability of the scales. The classical item analysis presented in Table 4 helps to identify the weakest and/or negatively affect the reliability of the scale and remove those bad items to increase the reliability of the scale scores. The items in blue and bold in the table show the "weakest" itemsunder each scale. In other words, the itemsthat would be removed are supposed to increase the reliability of the scale scores.

Table 4: Item-Total Statistics

A-R Scale	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted	S-I Scale	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
ARQ1	.423	.413	.610	SIQ2	.467	.408	.470
ARQ5	.522	.363	.590	SIQ6	.279	.238	.520
ARQ9	**.126**	**.387**	**.665**	SIQ10	.197	.223	.541
ARQ13	.223	.308	.648	**SIQ14**	**.069**	**.257**	**.572**
ARQ17	.534	.493	.587	SIQ18	.428	.612	.481
ARQ21	**.156**	**.517**	**.660**	**SIQ22**	**-.008**	**.178**	**.590**
ARQ25	.212	.278	.650	**SIQ26**	**-.058**	**.220**	**.600**
ARQ29	.250	.525	.643	SIQ30	.143	.287	.554

ARQ33	.271	.352	.639	SIQ34	.316	.529	.511
ARQ37	.367	.453	.621	SIQ38	.367	.376	.498
ARQ41	.306	.267	.632	SIQ42	.442	.450	.477

ARQ = Affective/Reflective Question
SIQ = Sensing/Intuitive Question

Vi-Ve Scale	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted	Sq-G Scale	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
ViVeQ3	.451	.340	.643	SGQ4	.251	.320	.615
ViVeQ7	.454	.341	.643	SGQ8	.400	.330	.585
ViVeQ11	**.193**	**.366**	**.687**	SGQ12	.213	.146	.623
ViVeQ15	.358	.351	.659	SGQ16	.254	.426	.614
ViVeQ19	.315	.399	.666	SGQ20	.246	.284	.616
ViVeQ23	**.167**	**.357**	**.691**	**SGQ24**	**-.014**	**.479**	**.665**
ViVeQ27	.258	.263	.676	SGQ28	.261	.229	.613
ViVeQ31	.243	.338	.678	SGQ32	.212	.244	.622
ViVeQ35	.328	.412	.664	SGQ36	.421	.347	.580
ViVeQ39	.386	.358	.655	SGQ40	.490	.482	.565
ViVeQ43	.520	.419	.630	SGQ44	.459	.546	.571

ViVeQ =Visual/Verbal Question
SGQ = Sequential/Global Question

Table 5 shows the effect of removing items that increase reliability alpha values under each of the four scales. The Sensing-Intuitivescale shows the greatest increase in reliability with the removal of the three weakest items in that scale (0.107 point increase). While the increment of the alpha values under Active-Reflective, Visual-Verbal and Sequential-Global scales arerelatively low (between 0.018and 0.033). However, the contributions are not negligible.

Table 5: Comparison of alpha values for original scale versus weakest item removed from each scale

Scale	α of 11 items	α of bad items removed	Number of items removed
Active-Reflective	0.654	α of 9 items (0.680)	ARQ9 & 21 removed
Sensing-Intuitive	0.556	α of 8 items (0.663)	SIQ 14, 22 & 26 removed
Visual-Verbal	0.686	α of 9 items (0.704)	ViVeQ 11 & 23 removed
Sequential-Global	0.632	α of 10 items (0.665)	SGQ 24 removed

In this reliability analysis, there are no items with Squared Multiple Correlations below 0.10 (the desired level). Items withSquared Multiple Correlations below 0.10 could be considered potentially problematic since it isthe degree of item score variance accounted for by the scores for the other items in the scale considered as weak. This may be because the scale contains manyelementsthat are not strongly related.

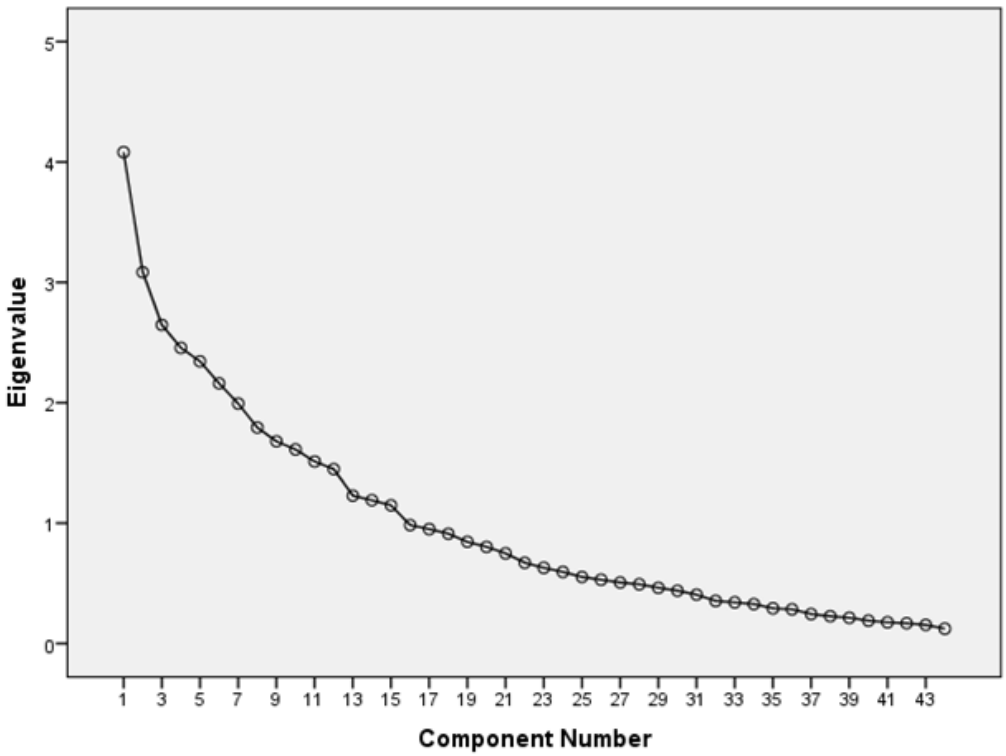

Figure 1: Scree Plot

As "Scree Plot" shows (see Figure 1) the eigenvalues are ordered from the largest to the smallest value. This analysis shows more than four factors in the instrument.

Table 6: Rotated Eight Component Matrix[a](Factor loadings less than 0.1 are not included)

	Components							
	1	2	3	4	5	6	7	8
ViVeQ7	0.742					-0.128	-0.294	-0.100
ViVeQ43	0.707				0.171			
ViVeQ31	0.619				-0.199		0.149	
ViVeQ39	0.588	0.149						-0.177
ViVeQ35	0.572	-0.104		-0.154		-0.100		0.334
ViVeQ3	0.504	0.192	0.143		0.267	0.107		
ViVeQ19	0.416	-0.245	0.171	-0.121	0.193		-0.114	0.359
SGQ44		0.703	-0.169		0.200		0.107	
SGQ36		0.691	0.152	0.112		-0.225		0.128
SGQ40		0.635	-0.129	0.123	0.151		0.173	0.114
SGQ24		-0.524		0.404	0.200		0.177	
SGQ32		0.467	-0.220		-0.209	-0.110		0.124
SGQ12		0.378		0.133				-0.117
ARQ9	0.244	-0.374				0.131	0.149	
SGQ4		0.350				0.187	0.140	0.285
SGQ20	-0.158	0.338	0.154	-0.195	0.269			0.285
ARQ29			0.678	-0.183		-0.413		
ARQ41	-0.111		0.636					
ARQ33			0.634	-0.168		-0.24		
ARQ17			0.621			0.463		
ARQ1	0.105		0.550			0.252		
ARQ5	0.176	-0.119	0.523		-0.263	0.298	0.102	
ARQ37	0.151	-0.289	0.494		-0.215			

SIQ18				0.816				
SIQ34				0.743			-0.108	0.134
SIQ42	0.160	0.200	-0.109	0.592			0.363	
SGQ8		0.256	-0.153	0.470	-0.106			-0.182
SGQ16		-0.105		0.429	0.398	-0.207		
ViVeQ23					0.685			
ViVeQ27				-0.109	0.651			0.205
ViVeQ15	0.213				0.620			
ViVeQ11	0.130	0.337			0.403		0.238	-0.225
ARQ21		-0.137	-0.143			0.779		
ARQ25						0.681		
ARQ13						0.514	-0.359	
SIQ26				0.167		-0.170	-0.612	0.147
SGQ28	-0.119		-0.128	0.152	0.272		0.591	
SIQ6						-0.110	0.53	0.109
SIQ22		0.102			0.132	-0.292	0.446	-0.319
SIQ38	0.186			0.210	-0.146		0.430	0.261
SIQ14	0.229		-0.123	-0.192	-0.227	-0.309	0.354	0.155
SIQ10		0.163	-0.103		0.133		-0.106	0.618
SIQ30					-0.202		0.226	0.596
SIQ2	-0.121			0.509	0.138			0.587

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

As mentioned above, depending on the components suggested by the instrument developers, the questionnaire is supposed to hold four dimensions and two preferences under each dimension. That is, the factor analysis software (SPSS version 23) is ordered to extract eight factors.Thus, Table 6 indicateseight factors. The items in the Active-Reflective,Sensing-Intuitive and Sequential-Global scales are related tothree factors;and items in the Visual-Verbal are related toone factor.This result indicates that the scalesare measuring more than one factor. That is, the scale having relation with two factors may refer to the two categories under each dimension. The question is do these factors exactly belongs to the specified side of the dimension. To answer this question further analysis of the content of each item is critically required. Relating to two factors does not necessarily hamper the construct validity of each subscale. But a scale relating to more than two factors mayaffect the constructs suggested by the developers who claimed two constructs under each scale(dimension).In addition, there are some overlaps between scales, i.e. two scales share the same factor which indicates that the factors are notorthogonal. Finally, there are some items which do not load effectively on any factors (SGQ12, SGQ4, SGQ20, and SIQ14). Revision of these items in the scales may increase the reliability of the instrument.

As I mentioned above, the removal of items increase Chrombachalpha slightly, which may not bring significant improvement on the instrument,neither does bring improvement on construct validity. I would suggestsome changes on the contents and response structure (from ipasative to rating scale type) may increase reliability and construct validity by clearly presenting the question and increasing the options of responses.

III. CONCLUSION

The Cronbach alpha values (reliability coefficients of subscales) obtained in this study close to the results obtained from the five previous studies which were conducted on original English version of the instrument.As to Tuckman (as cited in [14]) these results are acceptable since the instrument is attitude measureand for which alpha value 0.50 or above is tolerable. Regarding the content validity as factor analysis indicated some items of the subscales relate to more than two factors so that those items require some linguistic and content modifications through further studies, bearing in mind that the content validity issues of the original version is also not yet concluded.

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