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Design and Psychometric Properties of the Strategies for Meaningful Learnings Scale

Luz Marina Méndez Hinojosa*
Universidad Autónoma de Nuevo León, MEXICO

María Leticia Segura Arévalo
Universidad Autónoma de Nuevo León, MEXICO

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Abstract: In higher education, it is essential that students apply what they have learned to solve problems in their community. Meaningful learning is the main means to increase the accumulation of knowledge and achieve the transfer of learning, which is why the present study aimed to: design and evaluate the psychometric properties of a scale that measures the application of learning strategies that promote meaningful learning. The participants were 890 university students from Northeast Mexico, with an average age of 20.35 years (SD = 3.94). The sample was randomly divided into two: an exploratory factor analysis was carried out with the first sample and a confirmatory factor analysis was made in the second sample. The results obtained confirm the eight-dimensional structure, which showed an adequate fit to the data ($\chi 2$ / gl = 3.57, GFI = .96, AGFI = .95, NFI = .94, RMSEA = .08 and SRMR = .07), high parsimony (RP = .93), in addition to good internal consistency ($\omega \geq .80$) and convergent validity (AVE ≥ .40). In conclusion, the scale presents adequate psychometric properties to measure the frequency of use of strategies that promote meaningful learning in Mexican university students.

Keywords: *Factor analysis, learning strategies, meaningful learning, reliability, validity.*

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Introduction

Obtaining the appropriation of the knowledge in the classrooms and causing its transference to contexts different from the surroundings where they were acquired has been, without a doubt, during great time the main preoccupation in the superior education. Learning process includes understanding the acquisition and modification of knowledge, abilities, strategies, beliefs, attitudes, and conducts (Castañeda, 2004). Learning is a complex and multifactorial construct, the responsibility of this action has been assigned to the national educational system, which has been considered, for many years, as an indispensable element in the development of society, by pointing it out as an important factor for training of individuals who are capable of developing their potential to the maximum and who influence the future of society. This means that the university must always keep in mind its role in the community that surrounds it, which is none other than solving the social problems that concern its discipline.

To know if an educational model is working, it is necessary to see how it is meeting the needs of the surrounding society. The role of education in society must be to train citizens with a critical spirit with sufficient theoretical and practical knowledge that leads them to respond to the conflicts, contradictions and inequalities that continually arise in their environment (García, 2001). When this work is not being fulfilled, it is imperative to analyze what is happening inside educational institutions, turning our gaze to the classrooms. In classrooms, the main actors are students and teachers, and the product of this interaction is learning. Now, producing learning and establishing value judgments about the learning of students is a daily activity that leads us to conclusions that are expressed in grades that will give a verdict on the student, but sometimes it is necessary to detect what it is that leads the student to learn.

Elucidating the sequence of steps used by a professor, or by the student, to produce their learning in an intentional way can expose innumerable deficiencies as to why learning does not occur in its maximum expression in all students. Now, studying what happens in classrooms and the explanation of the teaching-learning process could only be interpreted in an adequate way if it is analyzed through a theory, in this case a learning theory.

There are various theories that have approached learning from their very particular point of view and have been

* **Corresponding author:**
Luz Marina Méndez Hinojosa, Universidad Autónoma de Nuevo León, Mexico. ✉ lucymendezhinojosa@hotmail.com

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categorized in various ways, according to different authors. A useful and practical categorization is the one presented by Mayer (2000) who identifies three learning paradigms: the first could include behavioral learning theories, the second would characterize cognitive learning theories, and the third paradigm, the theories of constructivist learning.

According to Mayer (2000), behaviorist theories were developed in the first half of the 20th century and consider learning as a consolidation of responses, where the role of the student is to receive reinforcements and the teacher to administer them; cognitive theories are developed in the third quarter of the last century and this type of theory explains learning as the passive acquisition of knowledge, while the teacher is responsible for presenting perfectly organized information to the student in such a way that its processing is easy; and finally, the constructivist theories, which emerged in the last two decades of the 20th century, which conceive learning as the elaboration of knowledge, where teachers cognitively guide students, who in turn understand the information by participating directly in the construction of representations of reality.

Behavioral and cognitive theories present the teaching-learning process as a sequence of steps where the owner and possessor of knowledge is the teacher, who is the one who transfers the information to the students already in its final form, without the possibility of construction active any on the part of the student. To make up for the mistakes that have been made in teaching for years, constructivist theories of learning have arisen several years ago. In general, constructivist theories make a bet in favor of an active student as a constructor of himself and of meanings within the classroom; as well as a re-constructor and co-constructor, of the knowledge that society and culture contribute (Hernández Rojas, 2006).

In relation to the constructivist theory, Hernández Rojas (2006) recognizes various types of constructivism, which, from their own "gaze" interpret learning as the result of the student's interaction with different knowledge.

Among the different types of constructivism mentioned by Hernández Rojas (2006), is the psychogenetic theory of Jean William Fritz Piaget, the sociocultural theory of Lev Semiónovich Vygotsky, the theory of assimilation or meaningful learning of David Paul Ausubel and the theory of strategic learning, whose developers are contemporary researchers in educational psychology, Carles Monereo Font and Juan Ignacio Pozo Municio. Each of these authors have been pioneers in the development of interpretations and explanations of learning, each one giving a different variable greater weight or relevance as a provocative source of knowledge, but giving the student the main role in said task.

The theory of assimilation or meaningful learning is the main construct of this study. A phrase that summarizes meaningful learning and its possible implications is the one expressed by Ausubel (1978) who stated that if he had to reduce all educational psychology to a single principle, he would say the following: the single most important factor influencing learning, it is what the learner already knows. Therefore, it indicates that it is necessary to inquire what the student knows and teach accordingly.

From the brief theoretical review presented, it is necessary to inquire whether university students use strategies in the classroom that help them activate their previous knowledge and establish an anchor between what is already known and what is new to be known. In this way, we arrive at an additional construct: learning strategies, since only through a strategy is it possible to corroborate the application of a theory in the classroom, and any strategy that is devised must start from the knowledge of how the subject learns and what are the variables that must be manipulated in the educational context to favor this learning; therefore, strategies arise from learning theories (Castañeda, 2004).

In this regard, Araujo and Chadwick (1993) also indicated that these procedures or set of actions carried out by the teacher in the classroom, do not arise in an isolated way or without a theoretical foundation that supports it, on the contrary, the root of the strategies, both teaching and learning, is based on psychological theories that have tried to explain what happens in the learner.

Specifically, learning strategies, in accordance with the assimilation theory, are defined as the procedures that the student uses in a deliberate, flexible and adaptive way to improve their processes of meaningful information learning (Díaz Barriga & Hernández Rojas, 2010)

Over time, learning strategies have been analyzed from different perspectives. There are numerous instruments that have characterized and categorized learning strategies from their very particular point of view. Table 1 shows the most widespread and open access instruments, including their dimensions and the number of subjects used for their validation.

Table 1. Instruments That Measure the Construct of Learning Strategies

Instruments	Dimensions, scales or subscales		Items	Sample
Evaluation Questionnaire for Strategic Information Processing for University Students (CPEI-U) (2011) (Castellanos et al., 2011)	Positive Attitude towards the Study		7	University students
	Selection and Use of Strategies.		18	
	Strategic and Personal Control.		12	
	Strategic Metacognition and Distractor Correction.		22	
Self-Employment Strategies Questionnaire (CETA) (López-Aguado, 2010)	Expansion Strategies		9	University students
	Collaboration Strategies		11	
	Conceptualization Strategies		8	
	Planning Strategies		10	
	Exam Preparation Strategies.		6	
	Participation Strategies		6	
Learning Strategies Questionnaire for University Students (CEA-U) (Cabrera et al., 2007)	Motivational strategies		27	University students
	Cognitive Strategies		22	
	Metacognitive strategies		8	
Learning Strategies Scale, abbreviated for university students (ACRA) (De la Fuente Arias & Justicia, 2003)	Cognitive and Learning Control Strategies		25	University students
	Learning Support Strategies		14	
	Study habits		5	
Evaluation Questionnaire of the Learning Strategies of University Students (CEVEAPEU) (Gargallo et al., 2009)	Scale of Affective, Support and Control Strategies (or self-management)	Motivational strategies	20	1,672 students college sports
		Affective Components	8	
		Metacognitive Strategies in Context Control, Social Interaction and Resource Management Strategies	15 10	
	Strategies Related to the Information processing	Strategies search and Selection and Information	8	
		Strategies of Processing and Use of the Information	27	
Motivated for Strategies Learning Questionnaire (MSLQ) (Pintrich et al., 1993)	Motivation Scale	Goals of Intrinsic Direction	4	380 university students
		Goals of Extrinsic Direction	4	
		Value of the Task	6	
		Beliefs of Control	4	
		Self-efficacy for the Learning	8	
		Anxiety	5	
	Scale of Strategies of Learning	Repetition	4	
		Elaboration	6	
		Organization	4	
		Critical Thinking	5	
		Metacognitive self-regulation	12	
		Administration of the Time and the Atmosphere	8	
		Regulation of the Effort	4	
		Learning of Pairs	3	
		Search of Aid	4	

Source: own elaboration

As indicated in Table 1, there are no instruments that specifically examine strategies for meaningful learning. Similarly, the instruments that contain them usually have only one item per strategy and do not assess how it is applied in the learning situation. Therefore, the objective of the present study is to design and evaluate the psychometric properties of a scale that measures the application of learning strategies that promote meaningful learning.

The reason for including in the single instrument strategies that produce meaningful learning is because, from our opinion (formed from numerous bibliographical revisions on the subject) and according to Mayer (2000) and Ausubel (2002), the meaningful learning is the main means to increase the accumulation of knowledge and to obtain the transference of the learning to other contexts.

Methodology

Research Design

The present investigation with quantitative approach is of instrumental type (Montero & León, 2005) and had a nonexperimental design of cross section and the objective of this is: Design and evaluate the psychometric properties of a scale that measures the application of learning strategies that promote meaningful learning.

Sample

Through convenience sampling, a sample of 890 higher education students was formed, pertaining to faculties of a university of the Northeast of Mexico, of which 43.70% were studying a bachelor's degree in psychology, 12.80% were enrolled in sports organization, 12.60% in biological sciences, 11.2% in accounting, 10.80% in social work and 8.92% in law. Regarding sex, 311 were men and 579 women. The age varied of a minimum of 17 to a maximum of 60 years. The average age was of 20.35 years [*IC* 95% (20,02, 20,63); *SD* = 3.94]. Its distribution showed positive asymmetry, *Sk* =6.64 and noticeable aiming, *K* = 65.90. The men had a mean age of 20.74 years [*CI* 95% (20.27, 21.29); *SD* = 4.42] and women 20.16 years [*CI* 95% (19.88, 20.48); *SD* = 3.69]. The age average was statistically nonequivalent between both sexes, [$t_{(873)}$ = 2,06, p = .040].

Measurements

Strategies for Meaningful Learnings Scale (SMLS). Taking as a referential theoretical framework the theory of meaningful learning (Ausubel, 1978; Ausubel et al., 1978, 1983) and its application in teaching strategies by Díaz Barriga and Hernández Rojas (2002, 2010). The Strategies for Meaningful Learnings Scale (SMLS) is made up of 46 positive items, with a Likert-type format, distributed in 8 subscales, whose response options are: Always, Many times, Sometimes, Rarely and Never, with a score of 5 to 1. The items of each subscale are indicators of the application, by the student, of a learning strategy that favors meaningful learning. The initial distribution of the items by subscale was as follows: i) Objectives and Intentions (3 items), ii) Guided Discussion (9 items), iii) Tree Diagram (3 items), iv) Conceptual Maps (10 items), v) Summary (7 items), vi) Box Diagram (4 items), vii) Synoptic Table (4 items), viii) Positive, Negative and Interesting (6 items). The factorial structure of the instrument after its evaluation is presented in results section.

Procedure

To design and evaluate the psychometric properties of the instrument, the stages proposed by Carretero-Dios and Pérez (2005) and Muñiz and Fonseca-Pedrera (2019) were applied.

First, the suitability of developing an original instrument was justified and it was delimited with the construct to be analyzed: the learning strategies that produce meaningful learning in students. The context and type of application were defined; in addition to the administration format

Next, the conceptual delimitation of the construct to be evaluated was carried out, that is, the measurement variable was defined. For this, an extensive bibliographic review on learning strategies was carried out. Its classical and contemporary exponents, antecedent research and instruments designed by other authors were analyzed. The strategies that promote meaningful learning were chosen, preferring the aforementioned authors as the theoretical reference model (Ausubel, 1978; Ausubel et al., 1978, 1983; Díaz Barriga & Hernández Rojas, 2002, 2010). Eight learning strategies were chosen and each dimension of the instrument was represented by a strategy.

Subsequently, Likert-type items were written in the first person for each of the dimensions (strategies) selected based on the criteria for writing the items set forth by Edwards (1983) and exemplified by Méndez and Peña (2006). The number of response options was assigned according to the educational level of the students.

The content validity of the items was analyzed through the Delphi method. For the analysis of content validity, 4 experts were asked to evaluate whether each of the elements measured what was intended. For which, the conceptual definitions of each of the strategies were presented to the experts.

As a result of the expert judgment, the pilot scale was designed, which was applied to a sample of 30 subjects with characteristics similar to the sample.

Permits were requested from the directors of the educational institutions where the data collection would take place and the interviewers were trained.

A sample was used for convenience. The students were derived from a public university in the Northeast of Mexico and were invited to participate voluntarily in the study, signing the corresponding informed consent. After explaining the objective of the investigation and giving the pertinent instructions, the questionnaire was applied. No type of financial, material or academic gift was given for participation. The scale was presented in printed form and the application was carried out in the classrooms, collectively and self-administered.

The design and implementation of this study followed the ethical code established by the American Psychological Association (APA, 2016).

Once the instrument was applied, the data reported by the participants were coded to assess the psychometric properties. For those items in which no response was found, the mean obtained in the item for the total sample was assigned as a value. After obtaining the database, the subjects were distributed into two random samples.

Analysis of Data

Concerning the evaluation of the construct validity of the scale, an exploratory factor analysis (EFA) was performed with sample number one. The EFA was performed using the unweighted least squares extraction method with Oblimin rotation.

Regarding the EFA, the Kaiser-Meyer-Olkin (KMO) index must be greater than .50 to be acceptable, and the Bartlett test of sphericity must be statistically significative (p <.05). Both analyzes lead to the rejection of the hypothesis of independence of the variables with which it follows that it is appropriate to continue with the factor analysis. The factorial loads of each element must be greater than or equal to .40 (Hair et al., 1999). When selecting the number of factors (figure 1) in the EFA, the K1 Rule (eigenvalues> 1) was used as a basis.

Confirmatory factor analysis (CFA) was used to contrast the model of eight first order factors and one second order. Pearson's product-moment correlation matrix was used and the discrepancy function was minimized by the Unweighted Least Squares (ULS) method. The assumption of normality of the model was determined by the Mardia multivariate kurtosis coefficient, which should not be greater than 10 (Kline, 2015). The estimates with 95% confidence intervals were carried out by the repetitive sampling method of percentiles corrected for bias with the simulation of 2,000 samples (Bishara & Hittner, 2015). The fit to the model data was assessed by means of six indices: Relative Chi-Square (X^2/Gl), Goodness of Fit Index (*GFI*) of Joreskog and Sorbom and its Adjusted Formula (*AGFI*), Bentler and Bonett Normed Fit Index (*NFI*), Standardized Mean Square Error (*SRMR*), Mean Square Approximation Error (*RMSEA*). Values Of $X^2/Gl \leq 2$, *GFI* And *NFI* ≥ .95, *AGFI* ≥ .90, *SRMR* and *RMSEA* ≤ .05 are considered a good fit. Values Of $X^2/Gl \leq 5$, *GFI* and *NFI* ≥ .90, *AGFI* ≥ .95, *SRMR* And *RMSEA* ≤.10 indicate an acceptable fit (Byrne, 2016).

The Parsimony Ratio (*PR*) and the Parsimonious Indices of Goodness of Fit (*PGFI*) and of Normed Fit (*PNFI*) were estimated. Values of *PR* ≥.75, *PGFI* ≥ .50 and *PNFI* ≥ .60, are considered adequate (Byrne, 2016; James et al., 1982).

The convergent validity of the factor was estimated [reliability composed of McDonald's omega, ω ≥ .70, measurement weights (λ ≥ .50) and mean variance extracted (*AVE* ≥ .44 for three indicators, .37 for four indicators, .32 for five indicators, .28 for six and .25 for seven or more indicators)] (Moral, 2019).

In the description of the distributions, the minimum and maximum values were determined, the arithmetic mean, standard deviation and the adjustment to normality were contrasted by the Kolmogorov-Smirnov test with the correction for the significance of Lilliefors.

There were no missing cases in the sample. In each test, the typical scores were calculated to determine the absence of atypical cases by means of the Z score, for which the values should not be greater than ± 3. In the same way, the Mahalanobis distance procedure (D^2) was carried out to search for multivariate atypical cases that exceeded the significance limit p < .001 (Tabachnick & Fidell, 2019). There were no atypical cases of the above.

Statistical anayzes were performed with SPSS and AMOS software, both version 24.

Results

Content validity analysis

The Delphi method resulted in the elimination of three items whose content was not related to the definition of the strategy. Two of these belonged to the concept maps strategy and the other belonged to the summary strategy. In addition to this, two items were modified so that the way in which they represented what the conceptual definition said could be better understood.

Eight Factor Structure

The structure detected in the EFA was eight factors (eigenvalues greater than the 1,364 intersection point); Seven factors (F1, F2, F3, F4, F5, F7 and F8) were grouped according to the proposed theoretical structure and one factor (F6) was made up of the three items that made it up (related to its original theoretical structure) and by two more items which theoretically belonged to another factor. On the other hand, the sample adequacy measure reached a Kaiser-Meyer-Olkin value of .884, which indicates that the elements are related, the Bartlett test of sphericity was significant [$\chi 2$ (666) = 9199.782, p <.001] rejecting the hypothesis of independent elements. Table 2 shows the six factors obtained after the EFA, the saturation of each item (λ) and the total variance explained, which was of 64.8%. Items with factor loadings

lower than λ <.40 (Velicer & Fava, 1998) were eliminated. In Table 3 the items are included that were eliminated in each subscale.

Table 2. Factorial Matrix of the Strategies for Meaningful Learnings Scale (SMLS)

Item	Factor							
	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**
OI1	.089	-.344	-.230	-.124	-.154	-.221	**.779**	.000
OI2	.160	-.452	-.294	-.198	-.211	-.251	**.813**	.057
OI3	.116	-.378	-.134	-.121	-.131	-.337	**.724**	.060
DG3	.116	**-.753**	-.223	-.042	-.127	-.301	.392	.008
DG4	.155	**-.804**	-.225	-.164	-.160	-.314	.316	.125
DG5	.118	**-.748**	-.262	-.116	-.065	-.297	.447	.029
DG6	.065	**-.774**	-.189	-.065	-.086	-.280	.385	.044
DG7	.172	**-.740**	-.214	-.112	-.214	-.346	.373	.051
DLL1	.182	-.340	**-.757**	-.162	-.371	-.282	.334	.037
DLL2	.249	-.318	**-.842**	-.159	-.358	-.285	.345	.069
DLL3	.404	-.213	**-.596**	-.207	-.308	-.223	.198	.165
MC1	.289	-.342	**-.515**	-.162	-.316	-.280	.319	.064
MC2	.246	-.326	**-.531**	-.102	-.248	-.267	.254	.051
MC3	**.557**	-.256	-.243	-.252	-.324	-.312	.256	.194
MC4	**.647**	-.185	-.266	-.290	-.326	-.253	.163	.266
MC5	**.738**	-.035	-.095	-.199	-.299	-.239	.034	.357
MC6	**.508**	-.189	-.276	-.245	-.307	-.286	.178	.253
MC7	**.598**	-.202	-.314	-.344	-.307	-.307	.233	.236
MC8	**.551**	-.269	-.281	-.147	-.236	-.283	.269	.095
MC9	**.599**	-.110	-.197	-.181	-.281	-.197	.062	.207
RE3	.439	-.032	.021	-.324	-.221	-.333	.052	**.576**
RE4	.217	-.100	-.093	-.256	-.194	-.222	.043	**.831**
RE5	.261	-.097	-.032	-.276	-.205	-.287	.097	**.812**
DC1	.206	-.343	-.459	-.251	**-.662**	-.341	.310	.100
DC2	.333	-.123	-.270	-.309	**-.856**	-.267	.155	.189
DC3	.358	-.134	-.270	-.343	**-.940**	-.299	.182	.227
DC4	.329	-.108	-.219	-.278	**-.869**	-.274	.144	.235
CS1	.136	-.130	-.095	**-.754**	-.172	-.264	.145	.215
CS2	.165	-.153	-.142	**-.818**	-.276	-.313	.192	.199
CS3	.279	-.021	-.024	**-.853**	-.328	-.244	.094	.315
CS4	.307	-.070	-.109	**-.831**	-.348	-.297	.130	.326
PNI1	.117	-.400	-.142	-.287	-.294	**-.586**	.376	.160
PNI2	.169	-.268	-.040	-.238	-.270	**-.557**	.296	.159
PN3	.227	-.319	-.203	-.303	-.305	**-.709**	.311	.237
PNI4	.197	-.299	-.184	-.277	-.247	**-.757**	.254	.174
PNI5	.285	-.268	-.223	-.230	-.212	**-.661**	.201	.202
PNI6	.288	-.259	-.161	-.249	-.206	**-.736**	.185	.324

In Table 3 the items are included that were eliminated in each subscale.

Table 3. Items eliminated with .40 inferior factorial loads

Subscale	**Item**
Guided discussion	DG1. I read the content to be able to question my teachers (or classmates). DG2. I ask myself about possible doubts. DG8. I make sure to have understood all the content correctly DG9. I do closings uniting the ideas of my classmates, the professor and mine.
Conceptual maps	MC10. I add examples.
Summary	RE1. When I must study a content, I make summaries. RE2. When I must present a class, I make summaries to facilitate my presentation. RE6. To each other to include the similar concepts in new ideas that include them (for example: liquid, solid and gas= states of the matter). RE7. To replace several statements by one new one created by me.

Test of the Model of Eight Factors of First Order and One of Second

The described model (Figure 1) with its independent remainders of measurement was specified before. In Table 4, are the values of reliability composed for the scale.

Factors F1, F2, F4 to F8 showed good internal consistency (ω ≥ .80) and convergent validity (*AVE* ≥ .25). Whereas the F3 obtained excellent values of internal consistency (ω ≥.90) and convergent validity (*BIRD* ≥.69).

The coefficient of Mardia was equal to 182.34, reason why the CFA by the ULS method was made. All the weights of measurement were significant (p <.001) and the kindness of 2 adjustment varied of [acceptable χ/gl = 3,57, *NFI* =.94, *SRMR* =.07 and *RMSEA* =.08 (90*IC* 0,07,09)] to good (*GFI* =.96 and *AGFI* =.95). The parsimony was high (*RP* =.93). The relation between the kindness of adjustment and parsimony was good (*PGFI* =.85 and *PNFI* =.88).

Table 4. Reliability Composed of Each Factor of the Strategies for SMLS

Factor	ω	*AVE*
F1	.84	.42
F2	.87	.58
F3	.90	.69
F4	.88	.64
F5	.81	.60
F6	.80	.57
F7	.83	.50
F8	.80	.40

Notes. ω = Omega of McDonald and *BIRD* = extracted average variance.

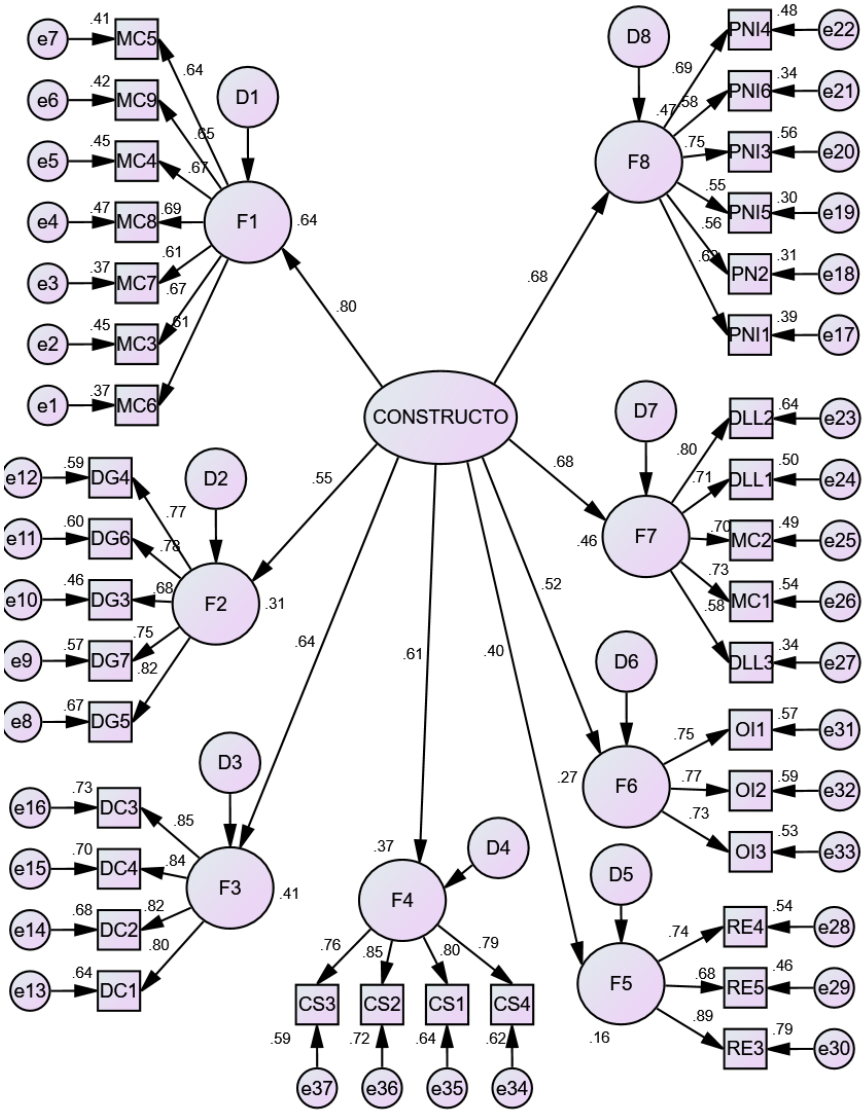

Figure 1. Model of Measurement for the SMLS with Weights of Measurement Standardized by ULS

Note: Constructo=Learning Strategies, F1=Conceptual maps, F2= Guided Discussion, F3=Box Diagram, F4=Synoptic Table, F5=Summary F6=Objectives and Intentions, F7=Graphical Representations and F8=Positive, Negative and Interesting.

Statistical Descriptive Eight Factors of the Strategies for Meaningful Learnings Scale (SMLS)

The distribution of the eight factors showed to negative asymmetry and leptokurtosis. None of the factors are adjusted to a normal distribution. Table 5 shows the minimum and maximum scores, average values (means with a 95% confidence index) and standard deviation of each factor.

Table 5. Statistical Descriptive and Test of Normality for Eight Factors SMLSis

Statistical		F1	F2	F3	F4	F5	F6	F7	F8
Value	***Min***	7	5	4	4	3	3	5	6
	Max	35	25	20	20	15	15	25	30
M		27.27	16.12	14.63	14.20	13.55	9.37	14.89	22.51
(*CI* 95%)		(26.72, 27.84)	(15.67, 16.56)	(14.23, 15.05)	(13.77, 14.61)	(13.36, 13.74)	(9.09, 9.65)	(14.42, 15.33)	(22.08, 22.90)
SD		5.73	4.71	4.32	4.30	2.03	2.97	4.73	4.26
g1		-1.31	-.12	-1.02	-.68	-1.87	-.01	-.01	-.64
g2		2.22	-.58	.36	-.25	4.37	-.74	-.50	.46
KSL	D_{max}	.12	.06	.15	.12	.26	.09	.06	.09
	p	<.001	< 0.01	<.001	<.001	<.001	<.001	<.001	<.001

Notes. M (IC 95%) = arithmetic mean and its estimate with 95% confidence intervals, SD = Standard deviation, g1 = coefficient of skewness, g2 = coefficient of kurtosis, Dmax = maximum absolute differences, KSL = Kolmogorov-Smirnov test with Lilliefors correction.

Discussion

The objective of this study was to design and evaluate the psychometric properties of a scale that measures the application of learning strategies that promote meaningful learning and in response to this, it can be stated that the EFA and the CFA provided evidence in favor of the validity of construct of the SMLS. Well, each factor proved to have convergent validity and with this it is known that the items accurately measure each dimension (Cheung & Wang, 2017). In addition, the internal consistency reliability revealed that the factors in 80% or 90% of the variations in the test scores is adequate (Viladrich et al., 2017). Therefore, it is possible to point out that the instrument presented, in Appendix A (Spanish version) and in Appendix B (English version), accurately measures the construct that it claims to measure (Moses, 2017).

Now, the conceptualization of each factor is closely related to the theoretical references that were the basis of its design. The first factor includes the characteristics of the learning strategy *conceptual maps,* whose object is to represent meaningful relationships between concepts, establishing a hierarchical order and joining the concepts through lines and link words (Díaz Barriga & Hernández Rojas, 2010; Novak & Gowin, 1988; Pimienta, 2007). It is precisely the hierarchy that facilitates the anchoring of a new knowledge with a previous knowledge.

A second factor is made up of the strategy *guided discussion*. Guided discussion is commonly initiated by the teacher, but as a learning strategy it involves the student interacting through dialogue and questioning in the classroom. The student's intervention has the purpose of reducing a verbalistic monologue of the teacher and Cooper is defined as guided discussion as "an interactive procedure from which the teacher and the students talk about a certain topic" Cooper (1990, p.114)

According to Pimienta (2007) *the box diagram* is a scheme that is made up of a series of boxes that simulate boxes. In the upper box, the upper theme or central idea is noted and in the second level the information on each of its themes is synthesized. The previous characteristics have been conceptualized in the third factor of the SMLS.

A fourth factor is made up of the defining characteristics of the learning strategy *synoptic table*. A synoptic table, structured by columns and rows, organizes the information on one or more central topics that are part of the content to be learned. According to Díaz Barriga and Hernández Rojas (2010) there are two types of synoptic tables: simple and double column. In the simple ones, different variables or characteristics of certain topics are developed. In the double column ones, opposite relationships of the variables that develop in themselves are expressed. Each cell of the synoptic table acts by facilitating the relationship between the knowledge that the student already has and that which he is acquiring.

Positive, negative, and interesting (PNI) is a strategy that allows the identification of the greatest possible number of ideas about an event, event or something that is observed (Espíndola, 2000; Pimienta, 2007); It consists of proposing a series of ideas on a specific topic considering positive and negative aspects, doubts, questions and curious aspects. The

meaningful learning is developed in strategy when the student responds making use of his previous knowledge and the experiences of his companions. The characterization of strategy PNI is in factor five.

The sixth factor was the only factor that was not organized in the expected way as it included characteristics of the key diagram strategy and concept maps. As much the diagram of keys, like the conceptual map, is graphical representations of the information that are organized of logical and hierarchic form establishing relations of inclusion between the concepts or ideas (Pimienta, 2007). So, this factor will be called *graphical representations*. And for the interpretation of this factor it will have to be understood like a strategy that organizes the information without counting on the specific requirements of a conceptual map.

The seventh factor is called *objectives and intentions*. The objectives are enunciated that describe with clarity the learning activities and the effects that are tried to obtain in the learning of the students when finalizing an experience, session, episode, or school year. As a learning strategy, it consists of the student making sure to know what is expected of him, which will make him alert during the class in relation to what is important to meet such expectations, thus producing meaningful learning (Castañeda, 2004; Díaz Barriga & Hernández Rojas, 2002, 2010).

A last factor was composed of the strategy *summary*, in this factor the summary is conceptualized as a short and precise version of the content of a document that contains the main ideas of the text to be learned, where the most important points of the document are emphasized the information, without any criticism (Díaz Barriga & Hernández Rojas, 2002, 2010).

Conclusion

It is expected that the interest in strategies that promote meaningful learning will increase through this study in both teachers and students; However, it is necessary to add that the great variety of contents and school activities make it necessary to apply strategies related to behavioral and cognitive paradigms, since sometimes it is essential to memorize certain information to be able, in a second moment of learning, to organize it within of the mental schemes with which the student has and favor his connection with the previous knowledge.

Likewise, it is emphasized that for the student to apply or not a learning strategy, it must have been previously modeled by the teacher; Therefore, in accordance with Hernández Rojas (2006), teachers need to support, collaborate, and promote the constructivist activity of their students in the classrooms, since without their participation, it would not progress or would not take place (Hernández Rojas, 2006).

Recommendations

It is recommended to try to work with random samples and with characteristics different from those of the study; including university level students, both from public and private schools. Practicing researchers are recommended to initially replicate the study with a small sample with similar characteristics, but adding other ways of measuring the use of learning strategies, such as participant observation or interview, in order to triangulate the information obtained. They could also include in their studies relationships between the use of strategies and academic performance. For which the use of revision strategies could be requested before an exam.

Limitations

Finally, it is indicated that as a limitation of the study, there is the use of a non-probabilistic sampling, for which the inferences must be taken with due caution within the sample of students collected. In addition, the study design was cross-sectional, so the temporal stability of the scores or the factorial structure could not be verified

Authorship Contribution Statement

Méndez: Conceptualization, design, analysis, written. Segura: Data collection, traduction, editing/reviewing, supervision.

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Appendix A (Spanish version)

MC3. Realizo una lista de los conceptos comprendidos en el tema.

MC4. Identifico qué conceptos pertenecen a cierta categoría para poder decidir cómo acomodarlos (por ejemplo: rojo, verde y azul pertenecen a la categoría de colores primarios).

MC5. Hago notar el concepto principal ubicándolo en la parte superior.

MC6. Doy un formato distinto al concepto principal del tema cuando lo ubico en un lugar que no sea la parte superior.

MC7. Elaboro un borrador del mapa para poder corregirlo.

MC8. Escribo "palabras" en las líneas entre los conceptos.

MC9. Encierro en un círculo o un recuadro los conceptos.

DG3. Realizo preguntas durante la exposición de la clase.

DG4. Cuestiono a mis profesores (o compañeros) para saber cómo relacionar lo que exponen con mis conocimientos.

DG5. Hago preguntas que contienen respuestas que incluyen lo que dice el texto.

DG6. Cuestiono críticamente pero con justificación a profesores (o compañeros) sobre lo que se está revisando.

DG7. Realizo preguntas a profesores (o compañeros) sobre conocimientos adquiridos en sesiones anteriores relacionados con el tema.

DC1. Estudio esquematizando la información en recuadros.

DC2. Sitúo en el recuadro de arriba el tema principal.

DC3. En los recuadros siguientes (para abajo o a un lado) escribo los subtemas que comprenden el tema principal.

DC4. Debajo (o a un lado) de los subtemas sintetizo la información (escribiendo un resumen o definiciones) que explica el subtema.

CS1. Cuando tengo que comparar varios temas, trazo una tabla como la siguiente:

Tema (s)	Aspecto A	Aspecto B

CS2. Uso tablas para contrastar información contraria de un tema, como la siguiente:

Tema (s)	Causas	Consecuencias

CS3. Antes de realizar una tabla comparativa identifico los elementos a comparar.

CS4. Una vez identificados los elementos pienso en sus características para poder hacer la comparación.

PNI1. Para mejorar mi comprensión de ciertos temas pido opinión de un experto.

PNI2. Para aprender más de cierto tema, busco información adicional a la que me da el profesor.

PNI3. En contenidos nuevos a aprender, pienso en los aspectos buenos (o beneficios) de éstos.

PNI4. Al conocer nuevas procedimientos relacionados con mi disciplina, analizo sus desventajas o dificultades.

PNI5. Cuando aprendo algo nuevo, me cuestiono en qué me pudiera servir en mí vida profesional.

PNI6. Cuando adquiero conocimientos nuevos, razono sobre sus aspectos interesantes o curiosos.

DLL1. Cuando expongo clase utilizo llaves para organizar la información.

DLL2. Cuando tengo que estudiar utilizo diagrama de llaves para apoyarme.

DLL3. Al hacer un diagrama de llaves acomodo la información general del lado izquierdo y la particular del lado derecho.

MC1. Cuando tengo que exponer clase lo hago mediante mapas conceptuales.

MC2. Cuando estudio prefiero usar mapas conceptuales que otra técnica.

OI1. Leo los objetivos de ésta en el programa.

OI2. Pregunto al profesor cuáles son las metas a lograr en dicha sesión.

OI3. Me aseguro de haber entendido perfectamente de qué se tratan los objetivos o metas.

RE3. Al hacer un resumen incluyo las ideas principales.

RE4. Omito información que no es importante cuando hago un resumen

RE5. Suprimo información repetitiva al hacer un resumen

Appendix B (English version)

MC3. I make a list of the basic concepts in the subject.

MC4. I identify which concepts belong to a certain category in order to decide how to accommodate them (for example: red, green and blue belong to the category of primary colors).

MC5. I emphasize the main concept by placing it at the top.

MC6. I format the main concept of the topic differently when I place it somewhere other than the top.

MC7. I make a draft of the map to be able to correct it.

MC8. I write "words" on the lines between the concepts.

MC9. I circle or box the concepts.

DG3. I ask questions during the class presentation.

DG4. I question my teachers (or classmates) to find out how to relate what they expose with my knowledge.

DG5. I ask questions that contain answers that include what the text says.

DG6. I question teachers (or classmates) critically but with justification about what is being reviewed.

DG7. I ask questions to teachers (or classmates) about knowledge acquired in previous sessions related to the topic.

DC1. I study outlining the information in tables.

DC2. I place the main topic in the box above.

DC3. In the following boxes (below or to the side) I write the subtopics that comprise the main topic.

DC4. Below (or to the side of) the subtopics I summarize the information (by writing a summary or definitions) that explains the subtopic.

CS1. When I have to compare several topics, I draw a table like the following:

Topic (s)	Aspect A	Aspect B

CS2. I use tables to contrast conflicting information on a topic, such as the following:

Topic (s)	Causes	Consequences

CS3. Before making a comparative table, I identify the elements to be compared.

CS4. Once the elements have been identified, I think about their characteristics in order to make the comparison.

PNI1. To improve my understanding of certain topics I ask for expert opinion.

PNI2. To learn more about a certain topic, I look for additional information to what the teacher provides.

PNI3. In new content to learn, I think about the good aspects (or benefits) of them.

PNI4. Upon learning about new procedures related to my discipline, I analyze their disadvantages or difficulties.

PNI5. When I learn something new, I question how it could help me in my professional life.

PNI6. When I acquire new knowledge, I reason about its interesting or curious aspects.

DLL1. When I present class, I use braces to organize the information.

DLL2. When I have to study I use a key diagram to support me.

DLL3. When making a key diagram, I arrange the general information on the left side and the particular information on the right side.

MC1. When I have to present class, I do it through concept maps.

MC2. When I study, I prefer to use conceptual maps than another technique.

OI1. I read the objectives of this in the program.

OI2. I ask the teacher what the goals are to achieve in that session.

OI3. I make sure that I have fully understood what the objectives or goals are about.

RE3. When making a summary I include the main ideas.

RE4. I omit unimportant information when summarizing.

RE5. I suppress repetitive information when making a summary.