Propiedades psicométricas de la escala de estrategias de aprendizaje ACRA-Mx en población universitaria mexicana
Psychometric properties of the Learning Strategies Scale ACRA-MX in Mexican undergraduates
Propriedades psicométricas da escala de estratégias de aprendizagem ACRA-Mx em uma população universitária mexicana

Carlos Saúl Juárez Lugo
Universidad Autónoma del Estado de México, México
csjuarezl@uaemex.mx
https://orcid.org/0000-0002-2630-4841

Resumen

El objetivo de este trabajo fue analizar las propiedades psicométricas de una versión abreviada de la escala ACRA, para lo cual se usó una muestra de 1010 estudiantes universitarios mexicanos. Si bien esta escala fue diseñada para evaluar las estrategias de aprendizaje en estudiantes españoles de educación secundaria, se ha implementado con alumnos universitarios de países de habla hispana, pero sin contar con evidencia de su validación. En concreto, se emplearon los cuestionarios ACRA y CEVEAPEU para medir las estrategias de aprendizaje, y el CHAEA para determinar los estilos de aprendizaje. La validez de constructo se determinó mediante análisis factorial exploratorio. La solución final dio como resultado un instrumento de 4 escalas, 21 factores y 68 reactivos, con una consistencia interna adecuada (alfa de Cronbach desde .779 hasta .862). Asimismo, se desarrollaron normas percentiles que facilitarán la interpretación de los resultados. En conclusión, se puede afirmar que la escala de estrategias de aprendizaje ACRA-Mx es un instrumento simplificado y homogéneo, con evidencia de validez y confiabilidad para evaluar las estrategias de aprendizaje en la población de estudio. Además, constituye una herramienta sólida para el trabajo psicoeducativo de tutores académicos, orientadores escolares y profesores interesados en mejorar el rendimiento académico y promover aprendizajes significativos en los estudiantes universitarios.

Palabras clave: estrategias de aprendizaje, propiedades psicométricas, análisis factorial exploratorio, estudiantes universitarios.

Abstrac

This research was done with the aim of analyzing the psychometric properties of a simplified version of the ACRA scale in which a sample population of 1010 Mexican undergraduates was used. The ACRA scale was designed to evaluate the learning strategies in secondary school Spanish students. Even though it has been employed in Hispanic countries in undergraduates there is no evidence related to ratification. The ACRA and the CEVEAPEU were used to measure the learning strategies, whereas the CHAEA measured the learning styles. Construct validity was calculated according to the exploratory factor analysis. The results report a research instrument of 4 sections, 21 factors and 68 questions with an accurate inner consistency (Cronbach's alpha from .779 to .862). To conclude, the Learning Strategies Scale (ACRA-Mx) is a simplified and homogeneous research instrument that provides evidence of validity. In addition, it is reliable in evaluating the learning strategies of the studied sample. What is more, it is an effective tool for psychoeducation. It assists academic tutors, counsellors, and professors who are interested in academic performance improvement, as well as how undergraduates acquire significant learning.

Key words: learning strategies, psychometric properties, exploratory factor analysis, university students.

Resumo

O objetivo deste trabalho foi analisar as propriedades psicométricas de uma versão abreviada da escala ACRA, para a qual foi utilizada uma amostra de 1.010 estudantes universitários mexicanos. Embora esta escala tenha sido concebida para avaliar estratégias de aprendizagem em estudantes do ensino secundário espanhol, foi implementada com estudantes universitários de países de língua espanhola, mas sem evidências da sua validação. Especificamente, os questionários ACRA e CEVEAPEU foram utilizados para medir as estratégias de aprendizagem, e o CHAEA para determinar os estilos de aprendizagem. A validade de construto foi determinada por meio de análise fatorial exploratória. A solução final resultou num instrumento com 4 escalas, 21 fatores e 68 itens, com consistência interna adequada (alfa de Cronbach de 0,779 a 0,862). Da mesma forma, foram desenvolvidas

normas percentuais que facilitarão a interpretação dos resultados. Concluindo, pode-se afirmar que a escala de estratégias de aprendizagem ACRA-Mx é um instrumento simplificado e homogêneo, com evidências de validade e confiabilidade para avaliar estratégias de aprendizagem na população estudada. Além disso, constitui uma ferramenta sólida para o trabalho psicoeducacional de tutores acadêmicos, orientadores escolares e professores interessados em melhorar o desempenho acadêmico e promover aprendizagens significativas em estudantes universitários.

Palavras-chave: estratégias de aprendizagem, propriedades psicométricas, análise fatorial exploratória, estudantes universitários.

Introduction

Learning strategies, according to Monereo (2004), are part of a broad and complex process of conscious and intentional decision-making by the student that allows the student to select and recover the conceptual, procedural and attitudinal knowledge necessary to achieve the learning objectives. learning established in a specific educational situation. Therefore, their main function is to facilitate the assimilation of information from the environment into the student's cognitive system, a process that involves the management and supervision of the assimilated data, as well as its classification, categorization, storage and recovery for its availability. in future learning experiences (Monereo, 1990).

These strategies are a current component in the study plans of higher education institutions. Furthermore, they are closely linked to the curricular design of procedural content (Coll, 2001) and to academic tutoring programs aimed at encouraging their use and improving students' academic performance (Juárez-Lugo *et al* ., 2012; Pérez *et al.* ., 2018) because they are associated with the construction of a more comprehensive, optimal and meaningful type of learning (Hernández, 2012). For this reason, Gargallo (2002) and Pozo (2008) agree that low academic performance is explained, in part, by the limitations that university students show in their cognitive and self-regulation operations when trying to solve specific school activities.

In this context, the theory of strategic learning, also known as *information processing theory* (Hernández, 2012), describes the process of assimilating school content as a sequence of cognitive and metacognitive actions that people put into practice to address the assigned activities.

Based on this theory, Román and Gallego (2001) propose a broad model that begins with the execution of attention and repetition strategies aimed at the cognitive process of information acquisition. The essence of this lies in identifying relevant information and discriminating that which does not meet the objectives of the proposed study activity and then incorporating it into people's knowledge structures through actions such as exploring the content and structure of the study material. , and then carry out different types of underlining that allow you to discriminate and classify important data to begin memorizing it.

The next step is coding, which has the responsibility of incorporating the information into long-term memory to make it useful, comprehensive and meaningful, essential elements to consolidate a base of school knowledge that leads to optimal academic performance (Bruning *et al.* , 2012). During this process, strategic students use complex memorization techniques, elaboration and organization of information in order to connect new knowledge with previous knowledge to generate broader and more complex structures of meaning that give meaning to academic content (González and García- Señorán , 2006). These forms of coding require more time and effort on the part of students, since they seek to give a higher level of meaning to the information to achieve deep learning.

Once the information being learned is stored in long-term memory, the cognitive retrieval process is responsible for evoking the knowledge structures when they are requested (Beltrán and Fernández, 2001). According to the proposed theoretical model and the quality of the coded information, the student will resort to the knowledge provided in the graphic organizers to develop the appropriate response for the learning activity (Castillo and Polanco, 2005). In this way, the student is prevented from consulting the original material and challenges them to make a cognitive effort to work with the processed information.

In their model, Román and Gallego (2001) propose the existence of learning strategies responsible for controlling affective states and directing cognitive activities to achieve learning goals. Thus, the behavioral aspects of the student himself—such as self-control, self-management, self-knowledge, his motivation to study and the richness of social interactions—acquire importance, since they optimize or hinder the effectiveness of the cognitive strategies implemented in his learning process. learning academic content.

Now, to measure learning strategies in students, several instruments have been created, among which the ACRA Learning Strategies Scale, proposed by Román and Gallego (2001), stands out, one of the most used in Spanish-speaking countries. This was originally

conceived in 1994 to evaluate the cognitive processes of Spanish students in compulsory secondary education (12 to 16 years old), which offers the possibility of applying it at other educational levels, although it should be noted that there is no evidence of its relevance. theoretical.

For this reason, authors such as Gargallo *et al.* (2009) question the theoretical structure of the original ACRA scale, since the psychometric properties with university students do not support its suitability as proposed in the instrument. Furthermore, an imbalance is observed in the number of items that make up the factors or strategies, since while some have up to six statements, others only have two. For example, strategies such as epigraphing, linear underlining, and repeated review of the acquisition scale have only two items each, while factors such as self-control and escape motivation from the support scale have only one item each, which contravenes the principle theoretical in the construction of instruments, which suggests that a variable must be composed of at least three items to measure it; Otherwise, the content validity is questioned and the reliability of the factor itself is affected (Hair *et al* ., 1999; Zamora, 2009).

In addition to this, two of the four response options ("Never or almost never" and "Always or almost always") can be considered ambiguous for interpretation because their wording does not clearly define the operational property that is intended to be measured, which unnecessarily increases the imprecision of the ordinal level of measurement (Kerlinger and Lee, 2002). Finally, the cognitive process of a high school student may be different from the way a college student processes information. It is known that university students, particularly those with complex thinking (Pozo, 2008), take cognitive shortcuts, they have a list of preferred strategies according to the cognitive nature of the learning objective when the knowledge is declarative, procedural or contextual (Gargallo, 2002), and that does not necessarily respond to the didactic sequence established by the teacher (Pozo and Monereo, 1999).

Based on the above, De la Fuente and Justicia (2003) conducted a study in which they administered the original ACRA scale to a sample of 866 students from a Spanish university, of which 294 were men and 554 women. After conducting an exploratory factor analysis with different methods and rotations, they found that the best factor solution consisted of an instrument with 3 dimensions, 13 subfactors and 44 items. In fact, internal consistency—measured using Cronbach's alpha—ranged between .54 and .85 for the three dimensions identified: cognitive and metacognitive strategies, learning support strategies, and study

habits. Consequently, the authors concluded that this theoretical structure did not align with the original conception of the instrument based on the phases of information processing.

In another study carried out by Juárez-Lugo *et al.* (2015) administered the ACRA scale to 1011 university students from an institution in Mexico, of which 61.1% were women and 38.9% men. After conducting an exploratory factor analysis with Varimax rotation , they reported a theoretical structure of three scales: processing, support and acquisition, with 16 factors and 65 items in total. Internal consistency, measured using Cronbach's alpha, was .885, .884 and .817, respectively for each scale.

For their part, Wong Fajardo *et al.* (2019) administered the ACRA scale to 569 students from three universities in Peru, of which 302 were women and 267 men. The psychometric analysis focused on calculating internal consistency, construct validity through item-scale correlation and between scales, which allowed them to conclude that the instrument was reliable and valid in its original theoretical structure.

Likewise, González (2020) conducted a study with 400 Peruvian students from a private university to whom the ACRA scale was administered with the intention of adapting it to this population. Although this author, after conducting an exploratory factor analysis, suggested a different theoretical structure, he did not provide statistical evidence to support this claim.

For this reason, Cohen and Swerdlik (2007) highlight that an educational evaluation instrument must meet at least the psychometric characteristics of reliability, validity and scale. The first refers to the stability, precision and predictability in the measurement of a construct (Magnusson, 2009) , while validity is crucial in a psychoeducational test, since it ensures that the instrument is exhaustively measuring what it intends to measure. This is evaluated through factor analysis, which identifies whether the items designed to examine the concept show coherence in the formation of their factors according to the theoretical assumption of the instrument. Finally, once reliability and validity have been demonstrated, the measurements are scaled or classified, establishing norms that determine the significance of the scores. This allows not only to compare the direct scores with those of the population to which the individual belongs, but also to accurately identify the magnitude and direction of that behavioral trait (Yela, 1997).

Having explained all of the above, it can be stated that it is essential to have psychopedagogical instruments that comply with the psychometric properties of reliability, validity and scale to evaluate how university students process disciplinary knowledge.

Now, in the case of the subject of this research, there are contradictory indications about the factorial stability of the original ACRA scale derived from its structure and design, among which the imbalance in the number of items in the factors, the options of response and its application to university students, since this was designed for Spanish secondary education students.

Taking these observations into consideration, the present research aims to analyze the factor structure of the ACRA Learning Strategies Scale (Román and Gallego , 2001) in a sample of Mexican university students to provide evidence of its psychometric properties when administered to this group. population.

Material and methods

Design of the investigation

A quantitative, cross-sectional and correlational study was carried out with the intention of knowing the psychometric properties of the ACRA learning strategies scale administered to the Mexican university population.

Participants

The final sample was non-probabilistic and was made up of 1010 university students (equal number of men and women). Participants were selected from public higher education institutions located in the Metropolitan Zone of the Valley of Mexico, Mexico. They represented diverse professional backgrounds in areas of knowledge that included physical-mathematical and engineering sciences, biological and chemical sciences, social sciences, and humanities and arts. The average age was 20.6 years, with a standard deviation of two years, and a range that went from 17 to 24 years.

Instruments

To measure learning strategies, the following instruments were used:

1. Learning Strategies Scale (Román and Gallego , 2001): This instrument consists of 119 items distributed in 32 factors and 4 scales (acquisition, encoding, information retrieval and a support scale to explore metacognitive and socio-affective strategies). The items evaluate students' habitual use of learning strategies and techniques, and four response options are used (Never or almost never, Sometimes, Quite a few times, and Always or almost always). The reliability of the instrument, measured using Cronbach's alpha coefficient, was .813, .899, .747 and .889, respectively for each of the scales.

2. Questionnaire for the Evaluation of Learning Strategies in University Students (CEVEAPEU) developed by Gargallo *et al.* (2009): This consists of 88 items that measure two factors: a) affective strategies of support and control of the social environment linked to academic learning, and b) information search, selection and processing strategies frequently used by the student. The measurement is carried out using a 5-point Likert-type scale that ranges from "strongly disagree" to "strongly agree." In the Spanish university population, this instrument has demonstrated an internal consistency measured by Cronbach's alpha coefficient of .819 for scale I and .864 for scale II.

3. Honey -Alonso Learning Styles Questionnaire (Alonso *et al.* , 1997): This evaluates learning styles through 80 affirmative statements, 20 corresponding to each of the styles: active, reflective, theoretical and pragmatic. The measurement is carried out dichotomously, where the respondent indicates whether he agrees (+) or disagrees (-). Reliability, measured through Cronbach's alpha coefficient, was .62, .72, .65 and .58 , respectively for each learning style.

Procedure

The instruments were presented using the Google forms tool, where informed consent was included. The electronic links were shared by the work team with the participants during the 2023 B school period. The inclusion criterion in the sample was that the participants completed the instruments in their entirety and accepted informed consent. The exclusion criteria included the lack of response to any item of the instruments or to sociodemographic data.

To evaluate the original ACRA instrument, internal consistency was calculated using Cronbach's alpha coefficient and an exploratory factor analysis was performed using the principal components method with varimax rotation . The factors were determined according to the following criteria: the items must have a saturation or factor loading equal to or greater than .50, there must be conceptual congruence between the items that make up a factor and it must be composed of a minimum of three items (Martínez, 1995 ; Yela, 1997). To evaluate external validity, type I analysis of variance (ANOVA I) was used considering the frequency of the use of learning strategies and the level of academic performance categorized by the 33rd and 66th percentiles, as well as the chi-square test. The data were analyzed using the SPSS statistical package, version 25.

Results

Reliability

The reliability of the ACRA instrument in its original version, administered to Mexican university students, was evaluated with the Cronbach's alpha coefficient technique. The values obtained were the following: for the acquisition scale it was .802, for the encoding scale it was .913, for the recovery scale it was .826 and for the support scale it was .890. These figures are consistent with what was reported by Román and Gallego (2001), which suggests adequate reliability of the instrument in this population.

Construct validity

For the construct validity analysis, a procedure similar to that described by Román and Gallego (2001) was followed in the creation of the original ACRA. That is, an exploratory factor analysis (EFA) was carried out for each of the four scales that theoretically describe how students process information on a daily basis: acquisition, encoding, recovery and support. The calculation of Bartlett's sphericity test—which evaluates whether the correlation matrix differs significantly from an identity matrix—and the Kaiser-Meyer- Olkin (KMO) index—which indicates whether the magnitude of the partial correlation coefficients between the variables is optimal to carry out the analysis (Zamora, 2009)—supported the relevance of carrying out an EFA on each scale of the instrument.

The most adequate factor solution found for the 20 items and seven original factors of the acquisition scale had the following characteristics (KMO = .785; Bartlett p = .000): three factors with 12 items that explained 47.81% of the total variance and an internal consistency of .778 (table 1). The first factor was composed of five items related to the mental and aloud review strategy, which refers to the repetition strategy. The second included four items that explore linear and idiosyncratic underlining techniques, and the third included three items, two exploration statements and one epigraphy statement, which together allude to the exploration strategy.

Table 1. Factor structure of the acquisition strategies scale (ad)

Scale	Factor	Description	Items
Acquisition (12 items)	I repetition (alpha = .645)	Repeat, think and reflect on the content to identify relevant information and memorize it in the short term.	8, 9, 10, 11, 12
	II underlined (alpha = .631)	Uses underlining techniques associated with greater cognitive effort (e.g., epigraphic and idiosyncratic).	4, 5, 6, 7
	III exploration (alpha = .614)	When you begin to study, you recognize the content and structure of the material; it is a superficial reading.	1, 2, 3

Note. The item number and description correspond to the proposed version (see annex 1).

Source: self made

The factor analysis carried out on the 12 factors and 46 items of the coding scale (KMO = .829; Bartlett p = .000) revealed a solution of seven factors and 22 items that explain 60.41% of the total variance, with a consistency internal of .837 (table 2).

The first factor retained the four original items from the mnemonic strategy. The second included three items related to the strategy of establishing intra-content relationships , and the third was structured with three items that referred to the use of the technique of preparing a summary to group relevant information. In the fourth, the factor analysis grouped three items that refer to the self-questioning strategy . Factors five and six presented a similar situation, with three items each, which brought together statements referring to the application of knowledge and working with images, respectively. Finally, the seventh factor had three items that are interpreted as part of the paraphrasing strategy.

Table 2. Factor structure of the coding strategies scale (co)

Scale	Factor	Description	Items
Coding (22 items)	I mnemonics (alpha = .747)	Use associative or comprehensive memorization to learn (acrostics, acronyms, rhymes, key words).	19, 20, 21, 22
	II relationships intra-content (alpha = .690)	Reorganize and relate previous knowledge with new information on the topic or with other subjects.	1, 2, 3
	III Grouping (alpha = 689)	Through the summary, it groups the relevant information on the topic, using what was previously underlined.	16, 17, 18
	IV self-questions (alpha = .661)	Questions are posed to answer before and during the study.	10, 11, 12
	V applications (alpha = .626)	To learn, apply knowledge in your daily life, socially or at work.	7, 8, 9
	VI images (alpha = .639)	When studying, associate the topic with images to be able to learn them.	4, 5, 6
	VII paraphrase (alpha = .549)	Use your own words, paraphrase, come up with new ideas to learn the topics.	13, 14, 15

Note. The number and description of the item correspond to the proposed version (see annex 1).

Source: self made

From the factor analysis carried out on the four factors and 18 items of the recovery scale (KMO = .812; Bartlett p = .000), a solution of four factors and 12 items was obtained that explain 56.87% of the variance, with a internal consistency of .759 (table 3). It is observed that the number of items is reduced and they are grouped differently.

The first factor was composed of three statements of the five original ones of the clue search strategy ; the second included three original items from the coding search strategy; The third grouped an item of search for clues, one of search of coding and one of the response planning strategy, for a total of three statements and, finally, the fourth factor was made up of two items of the written response strategy. and one for response planning.

Table 3. Factor structure of the recovery strategies scale (re)

Scale	Factor	Description	Items
Recovery (12 items)	I search for clues (alpha = .657)	To remember what has been learned, evoke events, similarities and emotions associated with important information.	4, 5, 6
	II search for encodings (alpha = .651)	Evokes main ideas, mnemonics, images through which I elaborate the information	1, 2, 3
	III response planning (alpha = .558)	Before responding to the activity, consider the teacher's correction and assess whether the information evoked is correct.	7, 8, 9
	IV written response (alpha = .562)	When faced with a written assignment, prepare a script to respond, taking care of the neatness and order of the document.	10, 11, 12

Note. The number and description of the item correspond to the proposed version (see annex 1).

Source: self made

The support scale, which originally had nine factors and 35 items (KMO = .861; Bartlett p = .000), yielded a factorial solution configured by seven factors and 22 items that explained 58.55% of the variance, with a consistent internal of .845 (table 4).

The first factor included four original items from the self-knowledge strategy, which refer to the role and importance of cognitive strategies in student learning; The second, composed of three items, refers to the intrinsic motivation that the university student uses when studying; The third was made up of three strategies from the original factor of regulation and evaluation of the learning process; The fourth is related to the planning strategy and included one regulation item and two planning items; the fifth retained the three original items of counterdistracting strategies ; The sixth included statements that refer to

extrinsic motivation and, finally, the seventh factor included three items that can be considered as social interaction that the student uses in his learning process.

Table 4. Factor structure of the support strategies scale (ap)

Scale	Factor	Description	Items
Support (22 items)	I self-knowledge (alpha = .749)	Values the role that strategies that help you memorize and establish relationships between content have in your learning.	1, 2, 3, 4
	II intrinsic motivation (alpha = .659)	He recognizes that he studies to expand his knowledge, feel proud of himself, and speaks words of encouragement to himself.	17, 18, 19
	III self-assessment (alpha = .749)	Check if the strategies you use to learn are effective; If not, look for alternatives.	8, 9, 10
	IV planning (alpha = .588)	Plan your time and work plan, program strategies prior to an evaluation.	5, 6, 7
	V counterdistractors (alpha = .632)	Avoid situations or thoughts that distract you when studying.	11, 12, 13
	VI extrinsic motivation (alpha = 642)	He recognizes that he studies to achieve rewards, social status and avoid negative consequences.	20, 21, 22
	VII social interaction (alpha = .545)	He positively values the recognition of other people and is encouraged to exchange opinions on the topics he studies.	14, 15, 16

Note. The number and description of the item correspond to the proposed version (see

annex 1).

Source: self made

After applying exploratory factor analysis (EFA) to the data of 1010 university students from the Metropolitan Area of the Valley of Mexico, the theoretical structure of the instrument was configured as follows: the four original scales were maintained (acquisition, encoding, recovery and support), with 21 factors and 68 items. From now on, we will refer to this new structure as ACRA-Mx. This version of the instrument presents the following important psychometric characteristics.

Discriminant and convergent validity

The ACRA-Mx scale showed very weak correlations between the total score of the four learning strategies scales and the four learning styles of the CHAEA questionnaire. On the other hand, with the CEVEAPEU questionnaire, a high average correlation was observed between its corresponding cognitive, metacognitive and social factors.

These results suggest that the ACRA-Mx, with its new factorial structure, has adequate discriminant validity, since it differs in its content from what the learning styles questionnaire evaluates, a construct associated with strategies, and is very similar. what is measured by the learning strategies evaluation questionnaire in university students.

External validity

The academic performance variable was used as an external validity criterion, given that there is evidence that students who use learning strategies more frequently and effectively tend to have a higher grade average compared to those who use these strategies less. frequency (Bernabé *et al* ., 2022; Martínez *et al* ., 2023; Ninacuri *et al* ., 2023). Therefore, the *academic performance variable* was categorized into three groups: low, medium and high, using the 33rd and 66th percentiles.

According to the results of the type I analysis of variance carried out with the learning strategies measured through the ACRA-Mx and the grouped academic performance of the university students, significant differences were observed between the averages of the frequency of use of the learning strategies between the three academic performance groups [$F_{(2, 1007)} = 7.27$, $p \leq .001$]. *Post hoc* contrast with the HSD Tukey test indicated that the difference was statistically significant ($p = .000$) between the high performance group (M = 187.91) compared to the low performance group (M = 180.25). This same trend was observed in the four scales of the ACRA-Mx test.

These results confirm that the factor structure proposed for the ACRA-Mx scale in the present study distinguishes the cognitive processes that university students with different academic performance put into practice when processing information, and that are associated with the frequency in the use of strategies Learning. In other words, the ACRA-Mx allows us to differentiate university students according to their academic performance and the frequency of use of learning strategies.

Item-total correlation

The analysis of item homogeneity was carried out using Pearson's correlation coefficient (r). The results indicated that the 68 items that make up the ACRA-Mx scale correlated positively and significantly ($p \leq .01$) with the corresponding scale score.

Correlation values ranged between r = .363 and r = .593, and the majority of items exceeded the threshold of .4, suggesting that all 68 items are relevant to the scale.

Furthermore, the correlations between the score of the four scales and the total score of the instrument were high and significant (acquisition r = .779, p < .01; encoding r = .880, p < .01; recovery r = .817, p < .01; and support r = .862, p < .01). These data indicate that the ACRA-Mx scale measures the strategies that university students use most frequently when studying or carrying out learning activities. Furthermore, the organization and distribution of the statements in each of the four scales reflect the cognitive processes indicated by the theory of strategic learning.

ACRA-Mx scale

The objective of confirming the psychometric qualities of the ACRA-Mx scale in its abbreviated version (Annex 1) was carried out by applying it to a sample of 422 university students from various disciplines. Of these, 213 were men and 209 women, from different public institutions of higher education in the Metropolitan Area of the Valley of Mexico, with a mean age of 21.14 years, a standard deviation of 2.03 years and an age range of 18 to 25 years.

The instrument was administered through an electronic form, with the response alternatives modified from four to five options: 1 = never, 2 = almost never, 3 = sometimes, 4 = quite a few times, 5 = always. This adaptation was made because the original ACRA scale presents a response modality that can be imprecise in its interpretation. For example, the option *never or almost never* may be ambiguous because it makes it difficult to clarify how often the student uses a specific learning strategy, which increases vagueness at the ordinal level of measurement (Kerlinger and Lee, 2002). .

The reliability of the ACRA-Mx instrument, calculated using Cronbach's alpha coefficient, was .825 for the acquisition scale, .862 for the encoding scale, .811 for the recovery scale, and .874 for the support scale. The correlations between the items and the total score of the corresponding scale ranged between r = .316 and r = .592, while the correlations between the 21 factors and their respective total score per scale fluctuated between r = .498 and r = .819. Furthermore, the correlations observed between the scales and the total score of the instrument were high and significant (acquisition r = .823, p < .01; encoding r = .885, p < .01; recovery r = .831, p < . 01 and support r = .863, p < .01).

The AFE ratified the theoretical structure of the ACRA-Mx based on the sample of 422 university students, with values very similar to those obtained with the 1010 students of the same educational level from the aforementioned region. This confirms that the instrument exhaustively measures what it proposes to measure, that is, construct validity is met, one of the most important requirements of a psychoeducational test.

On the other hand, the results of the type I analysis of variance indicate that the level of academic performance distinguishes between the scores obtained on the four scales and the total score of the ACRA-Mx test. In fact, significant differences are observed between the averages of the frequency of use of learning strategies between the three academic performance groups [F (2, 419) = 8.76, p ≤ .001]. Post hoc comparison with the HSD Tukey test reveals that the contrast between the high performance group (M = 242.86) compared to the low performance group (M = 228.60) is statistically significant (p <= .000).

These results were corroborated by the chi-square test (X2 = 29.73, p < .001), which indicates a statistically significant association between the frequency of the use of learning strategies and the level of academic performance. Furthermore, it can be seen that university students in the high performance group use learning strategies more frequently compared to the low performance group, a trend that is noted in the four scales of the ACRA-Mx test.

With the results of this version of the scale, the interpretation scales were calculated using the method suggested by Alonso *et al* . (1997). The scale table allows you to interpret and diagnose, individually or in groups, the frequency with which university students use learning strategies when studying (table 6).

Table 6. Scales of the ACRA-Mx scales (n = 422)

Scale	10% Frequency very low	twenty % Frequency low	40 % Frequency moderate	twenty % Frequency high	10 % Frequency very high
Acquisition	0 – 32	33 – 37	38 – 45 Average (40.92)	46 – 50	51 – 60
Coding	0 – 57	58 – 65	66 – 78 Average (71.73)	79 – 87	88 – 110
Recovery	0 – 34	35 – 39	40 – 47 Average (42.85)	48 – 53	54 – 60
Support	0 – 63	64 – 73	74 – 86 Average (79.06)	87 – 95	96 – 110
ACRA	0 – 193	194 – 217	218 – 254 Average (234.57)	255 – 278	279 – 340

Source: self made

Discussion

The objective of the present study was to provide evidence of validity and reliability regarding the ACRA learning strategies scales proposed by Román and Gallego (2001), with a sample of Mexican university students. In this sense, the review of the literature revealed contradictory indications of factor stability in the ACRA instrument. For example, De la Fuente and Justicia (2003) questioned the original structure with Spanish university students, while Juárez-Lugo *et al* . (2015) did so with Mexican university students, and González (2020) confirmed these discrepancies with Peruvian university students. In addition, studies have been carried out on alternative versions of the ACRA, such as that of Jiménez *et al* . (2018) in Spain with psychology students, who proposed a solution with 3 factors and 17 items, that is, they reduced the 44 proposed by De la Fuente and Justicia (2003), who, in turn, had made a reduction of the 119 items from the original ACRA.

These studies share the proposal of a theoretical structure different from that of the original ACRA, which results in psychopedagogical instruments that, although they evaluate learning strategies in university students, deviate from what was proposed by Román and Gallego (2001) and from the information processing theory that supports it (Bruning *et al* ., 2012). These differences make it difficult to compare studies that use these scales, since the techniques included in each of the factors are contextualized in different learning strategies.

For example, in the original ACRA, statement number 12 (" I express what I have learned in my own words instead of literally repeating... what the book or teacher says ") belongs to the response planning learning strategy of the cognitive process of the recovery scale. However, in the instrument proposed by De la Fuente y Justicia (2003), this item is located in the strategy called *comprehension* , within dimension III (study habits).

Likewise, in the questionnaire proposed by Juárez-Lugo (2015), this item remains in the response planning strategy, but within a cognitive process that they called *support* . In the present study, item 12 was configured in the written response strategy, of the original cognitive recovery process, so that better conceptual congruence was maintained without altering too much the original structure of the ACRA.

The results of this research, compared to other studies, stand out for having samples of university students from various academic backgrounds and from different higher education institutions (with equal numbers of men and women) from a large urban region of Mexico. Furthermore, the best factorial solution of the ACRA-Mx scale managed to maintain a balance between what the information processing theory points out, what was proposed by Román and Gallego (2001) with respect to the independent scales that measure the learning process through strategies. of learning, the responses of university students to the instrument and the factor analysis procedure.

On the other hand, the theoretical structure proposed in this study considered at all times the cognitive processes of acquisition, encoding and recovery, with a transversal axis of a metacognitive and socio-emotional nature. Likewise, the successive selection of items that saturated a factor with values equal to or greater than .50, considered the conceptual congruence of its content (Nunnally , 1991; Zamora, 2009), which resulted in a simplified and homogeneous version in the majority. of the factors. For example, the strategy called *underlining* in this study grouped together linear and idiosyncratic underlining learning techniques, which corresponds to the findings of Juárez-Lugo (2015) with a Mexican population and those of Jiménez *et al.* (2018) with a Spanish population of psychology students.

Finally, it should be noted that the *learning strategies construct* is broad and complex, and the self-report scales designed to measure it have numerous items and diverse theoretical structures (Gargallo *et al* ., 2009; Pintrich and Degroot , 1990). Consequently , Pozo (2008) has suggested that, in addition to having a diverse repertoire of learning strategies, it is more important to recognize the strategic behavior determined by a set of specific and

homogeneous learning strategies and techniques, as the scale intends to evaluate. ACRA-Mx presented in this research, the result of a rigorous factor analysis.

Conclusion

The results obtained in this study suggest that the ACRA-Mx scale emerges as an instrument with adequate psychometric properties to evaluate the learning strategies commonly used by university students, a function that other researchers also try to fulfill through the original ACRA scale, designed for students. of secondary education in Spain.

Furthermore, the ACRA-Mx version addresses the problem of excessive length of the original instrument by reducing the items to just over half, without sacrificing the psychometric properties of validity and reliability. Likewise, it meets the rigorous requirements of factor analysis for psychoeducational instruments, both in factor loadings and in the minimum number of items per factor, and simplifies and standardizes learning strategies according to the most frequent cognitive processes in university students, such as the use of underlining, graphic organizers, and paraphrasing, and highlights intrinsic motivation.

On the other hand, the structure of the ACRA-Mx scale allows its results to be compared with other studies, since it retains a significant similarity with the original scale in terms of cognitive processes, strategies and learning techniques used by university students. Furthermore, this proposal offers a scale table to classify and interpret the frequency of use of learning strategies, now on a five-point scale instead of four, which facilitates the development of more precise diagnoses of the student's strategic behavior.

Finally, we recognize the richness with which the original ACRA scale explores the learning process of students from different educational systems, although it should be noted that the ACRA-Mx scale is offered as a solid and brief tool for psychoeducational work that academic tutors, School counselors and teachers can use it with university students to try to improve academic performance and build meaningful learning.

Future lines of research

It is crucial to confirm the psychometric properties of the ACRA-Mx scale in various populations of university students, as well as evaluate its applicability at other educational levels and analyze its predictive capacity with respect to academic performance. In addition, a line of research is contemplated that validates the relationship between the answers provided by students on the scale and their effectiveness in processing information, which could influence the achievement of meaningful learning and better academic performance.

References

Alonso, C. M., Gallego, D. J. y Honey, P. (1997). *Los estilos de aprendizaje. Procedimiento de diagnóstico y mejora.* Ediciones Mensajero.

Beltrán, J. A. y Fernández, M. P. (2001). Estrategias de aprendizaje. En J. A. Bueno y C. Castanedo (coord.), *Psicología de la educación aplicada* (pp. 413-444)*.* Editorial CCS.

Bernabé, M. L., Suárez, P. R., Espinoza, M. E., Armijos, I. M. y Medina, A. A. (2022). Estrategias de aprendizaje en estudiantes universitarios ecuatorianos: un estudio de caso en la provincia de Esmeraldas. *Revista Andina de Educación*, *5*(2), 1-8. https://doi.org/10.32719/26312816.2022.5.2.9

Bruning, R. H., Schraw, G. J. y Norby, M. M. (2012). *Psicología cognitiva y de la instrucción* (5.ª ed.). Pearson.

Castillo, S. y Polanco, L. (2005). Bases psicopedagógicas del aprendizaje del alumno-estudiante. En J. L. Posadas (ed.), *Enseña a estudiar…aprende a aprender: didáctica del estudio* (pp. 1-46). Pearson Prentice Hall.

Cohen, R. J. y Swerdlik, M. E. (2007). *Pruebas y evaluación psicológica*. McGraw Hill.

Coll, C. (2001). *Psicología y currículum. Una aproximación psicopedagógica a la elaboración del currículum escolar.* Laia.

De la Fuente, J. y Justicia, F. (2003). Escala de estrategias de aprendizaje ACRA- abreviada para estudiantes universitarios. *Revista Electrónica de Investigación Psicoeducativa y Psicopedagógica, 1*(2), 139-158. http://www.investigacion-psicopedagogica.org/revista/articulos/2/espannol/Art_2_16.pdf

Gargallo, B. (2002). *Procedimientos. Estrategias de aprendizaje. Su naturaleza, enseñanza y evaluación.* Humanidades Pedagogía.

Gargallo, B., Suárez, J. y Pérez, C. (2009). El cuestionario CEVEAPEU. Un instrumento para la evaluación de las estrategias de aprendizaje de los estudiantes universitarios. *Revista Electrónica de Investigación y Evaluación Educativa, 15*(2), 1-31. https://revistaseug.ugr.es/index.php/RELIEVE/article/view/17098

González, G. (2020). Escala de estrategias de aprendizaje ACRA: Adaptación psicométrica en estudiantes universitarios peruanos. *PsiqueMag*, *9*(2), 40-50. https://doi.org/10.18050/psiquemag.v9i2.2741

González, S. G. y García-Señorán, M. M. (2006). Estrategias de codificación y rendimiento académico en estudiantes de secundaria. *Educación, Desarrollo y Diversidad*, *9*(3), 5-20. https://dialnet.unirioja.es/servlet/articulo?codigo=6089297

Hair, J. F., Anderson, R. E., Tatham, R. L. y Black, W. C. (1999). *Análisis multivariante*. Prentice Hall.

Hernández, G. (2012). *Miradas constructivistas en psicología de la educación.* Paidós Educador.

Jiménez, L., García, A. J., López, J. y Saavedra, F. (2018). Evaluación de las estrategias de aprendizaje mediante la escala ACRA abreviada para estudiantes universitarios. *Revista Psicodidáctica, 23*(1), 63-69. http://dx.doi.org/10.1016/j.psicod.2017.03.001

Juárez-Lugo, C. S., Pichardo-Silva, K. y Rodríguez-Hernández, G. (2015). Características psicométricas de la Escala ACRA en población universitaria mexicana. *Revista de Educación y Desarrollo, 34*, 15-24.

Juárez-Lugo, C. S., Rodríguez, G., y Luna, E. (2012). El cuestionario de estilos de aprendizaje CHAEA y la escala de estrategias de aprendizaje ACRA como herramienta potencial para la tutoría académica. *Revista Estilos de Aprendizaje, 10*(10), 1-28. https://doi.org/10.55777/rea.v5i10.965

Kerlinger, F. N. y Lee, H. B. (2002). *Investigación del comportamiento. Métodos de investigación en ciencias sociales* (4.ª ed.). McGraw Hill.

Magnusson, D. (2009). *Teoría de los test*. Trillas.

Martínez, R. (1995). *Psicometría: teoría de los test psicológicos y educativos.* Síntesis.

Martínez, Y. A., Valverde, A., Yaque. L. M. y Sarian, M. (2023). Estrategias de aprendizaje y desempeño académico en estudiantes de una universidad confesional privada. *Mendive Revista de Educación*, *21*(2), 1-12. https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/3200

Monereo, C. (1990). Las estrategias de aprendizaje en la educación formal: enseñar a pensar y sobre el pensar. *Infancia y Aprendizaje,* (50), 3-25.

Monereo, C. (2004). *Estrategias de enseñanza y aprendizaje. Formación del profesorado y aplicación en la escuela.* Grao.

Ninacuri, J. R., Bárcenas, G. C., López, H. R., Flores, M. D. y Calero, R. L. (2023). Estrategias de aprendizaje y desempeño académico. *Revista de Ciencias Sociales y Humanidades*, *8*(37). http://doi.org/10.46652/rgn.v8i37.1075

Nunnally, J. (1991). *Teoría psicométrica*. Trillas.

Pérez, M. G., Leyva, H. P., Ocampo, F. y De Luna, C. (2018). Propuesta de estrategias de aprendizaje acorde a los estilos de aprendizaje de los estudiantes de ingeniería de la ESCOM del IPN. *Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, *17*, 1-26. DOI: 10.23913/ride.v9i17.373

Pintrtich, P. and Degroot, E. (1990). Motivational and self regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *8*(1). 33-40. http://rhartshorne.com/fall-2012/eme6507-rh/cdisturco/eme6507-eportfolio/documents/pintrich%20and%20degroodt%201990.pdf

Pozo, J. I. (2008). *Apéndices y Maestros. La psicología cognitiva del aprendizaje.* Alianza.

Pozo, J. I. y Monereo, C. (1999). *El aprendizaje estratégico*. Aula XXI Santillana.

Román, J. M. y Gallego, S. (2001). *Manual ACRA: Escala de estrategias de aprendizaje.* TEA.

Wong Fajardo, E. M., Livia Segovia, J. y López Pérez, Ángela M. (2019). Análisis psicométrico de las escalas de estrategias de aprendizaje (ACRA) en estudiantes de tres universidades peruanas. *Educare et Comunicare. Revista de Investigación de la Facultad de Humanidades*, *7*(1), 26-40. https://doi.org/10.35383/educare.v7i1.223

Yela, M. (1997). *La técnica del análisis factorial. Un método de investigación en psicología y pedagogía.* Biblioteca Nueva.

Zamora, S. (2009). *Análisis factorial: una técnica para evaluar la dimensionalidad de las pruebas*. Centro Nacional de Evaluación para la Educación Superior, A. C.

Appendix 1

ACRA-Mx learning strategies scale for university students

From the original ACRA instrument by José-María Román Sánchez and Sagrario Gallego Rico (2001).
Adapted to Mexico by Dr. Carlos Saúl Juárez Lugo.

Instructions

This scale aims to identify the learning strategies most frequently used by students when they are assimilating the information contained in a text, an article, some notes, etc., that is, when they are studying.

You may have used each learning strategy more or less frequently. It may be that some you have never used and others, however, many times. This frequency is precisely what we want to know.

To do this, five possible degrees of response have been established according to the frequency with which you normally use these learning strategies:

Never
Hardly ever
Sometimes
Quite a few times
Always

To answer, read the sentence that describes the strategy, then select the option that best fits how often you use it. Always in your opinion and from the knowledge you have of your learning processes.

Scale I

Information acquisition strategies

1. Before starting to study, I read the index, or the summary, or the sections, tables, graphs, bold or italics of the material I must learn.

2. When I am going to study a material, I write down the important points that I have seen in a first superficial reading to more easily obtain an overview.

3. When I start studying a lesson, I first skim it all.

4. In the books, notes or other material that I must learn, I underline in each paragraph the words, data or phrases that seem most important to me.

5. I use signs (admirations, asterisks, drawings, etc.), some of them only intelligible to me, to highlight those information in the texts that I consider important.

6. I use pencils or pens of different colors to promote learning.

7. I use underlining to facilitate memorization.

8. I repeat the lesson as if I were explaining it to a classmate who doesn't understand it.

9. To check what I am learning about a topic, I ask myself questions section by section.

10. Even if I don't have to take an exam, I usually think and reflect on what I read, studied or heard from the teachers.

11. After analyzing a graph or drawing from the text, I spend some time learning it and reproducing it without the book.

12. I have them ask me about the underlinings, paraphrases, diagrams, etc., made when studying a topic.

Scale II

Information coding strategies

1. I reorganize or carry out, from a personal point of view, new relationships between ideas and content in a topic.

2. I relate or link the topic I am studying with others that I have studied, with data or knowledge previously learned.

3. I apply what I learn in some subjects to better understand the contents of others.

4. I associate the information and data that I am learning with fantasies from my past or present life.

5. When studying I put my imagination into play, trying to see, as in a movie, what the topic suggests to me.

6. I establish analogies by making metaphors with the issues I am learning (e.g.: "the mind works like a computer").

7. I use what I learn, as much as possible, in my daily life.

8. I try to find possible social applications in the content I study.

9. I am interested in the application that the topics I study may have to the work fields I know.

10. During the teachers' explanations, I usually ask myself questions about the topic.

11. Before the first reading, I ask myself questions whose answers I hope to find in the material I am going to study.

12. When I study, I ask myself questions suggested by the topic, which I try to answer.

13. I try to learn the topics in my own words instead of memorizing them verbatim.

14. I make critical notes on the books and articles I read, either in the margins or on separate pages.

15. I arrive at new ideas or concepts based on the data, facts or particular cases contained in the text.

Revista Iberoamericana para la
Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

16. I summarize the most important thing about each of the sections of a topic, lesson or notes.

17. I make summaries of what has been studied at the end of each topic.

18. I prepare the summaries using the previously underlined words or phrases.

19. To remember data when studying, I usually use mnemonics such as acrostics or acronyms (tricks such as CHON: Carbon, Hydrogen, Oxygen, Nitrogen).

20. I build "rhymes" or "fillers" to memorize lists of terms or concepts.

21. In order to memorize sets of data, I mentally place the information in places in a well-known space ("loci" technique).

22. I learn unfamiliar or abstract names or terms by developing a "keyword" that serves as a bridge between the known name and the new one I remember.

Scale III

Information retrieval strategies

1. Before speaking or writing, I remember words, drawings or images that are related to the "main ideas" of the material studied.

2. Before speaking or writing, I evoke mnemonics (rhymes, acronyms, acrostics, fillers, loci, keywords or others) that I used to encode the information during the study.

3. When I have to present something orally or in writing I remember drawings, images, metaphors..., through which I elaborated the information during learning.

4. It helps me remember what I have learned to evoke events, episodes or anecdotes (that is, "keys"), that occurred during class or at other moments of learning.

5. I find it helpful to remember other themes or issues (i.e. "thematic clusters") that are related to what I really want to remember.

6. Putting myself in a mental and emotional situation similar to the one experienced during the teacher's explanation or at the time of the study makes it easier for me to remember important information.

7. In order to better recover what I have learned, I take into account the corrections and observations that teachers make in exams, exercises or assignments.

8. To remember information, I first look for it in my memory and then decide if it fits what I have been asked or if I want to answer.

9. Before I start speaking or writing, I think and mentally prepare what I am going to say or do.

10. When I have to do a free essay on any topic, I write down the ideas that come to mind, then I organize them and finally write them down.

11. When doing an exercise or exam, I worry about its presentation, order, cleanliness, and margins.

12. Before doing written work, I make an outline, script or program of the points to be discussed.

Scale IV

Processing support strategies

1. I have reflected on the function of those strategies that help me focus attention on what seems most important to me (exploration, underlining, headings, etc.).

2. I have realized the role that learning strategies play in helping me memorize what interests me, through repetition and mnemonics.

3. I am aware of the importance of elaboration strategies, which require me to establish different types of relationships between the contents of the study material (drawings or graphs, mental images, metaphors, self-questions , paraphrases, etc.).

4. I have thought about how important it is to organize information by making diagrams, sequences, diagrams, concept maps, matrices.

5. In the first moments of an exam, I mentally program those strategies that I think will help me better "remember" what I have learned.

6. Before starting the study, I distribute the time I have available among all the topics I have to learn.

7. When exams approach, I establish a work plan establishing the time to dedicate to each topic.

8. Throughout the study I check if the "learning" strategies that I have prepared work for me, that is, if they are effective.

9. At the end of an exam, I assess or check whether the strategies used to remember the information have been valid.

10. When I verify that the strategies I use to "learn" are not effective, I look for other alternatives.

11. When I have family problems, I try to resolve them beforehand, if I can, to better concentrate on studying.

12. If I am studying and I get distracted by thoughts or fantasies, I fight them by imagining the negative effects of not having studied.

13. I make sure that in the place I study there is nothing that could distract me, such as people, noise, clutter, lack of light and ventilation, etc.

14. I am satisfied that my colleagues, teachers and family positively value my work.

15. At work, I am encouraged to exchange opinions with my colleagues, friends or family about the topics I am studying.

16. I avoid or resolve, through dialogue, conflicts that arise in personal relationships with classmates, teachers or family members.

17. I study to expand my knowledge, to know more, to be more expert.

18. I try hard in my studies to feel proud of myself.

19. I give myself words of encouragement to stimulate myself and keep me on task.

20. I seek to have prestige among colleagues, friends and family, excelling in my studies.

21. I study to achieve short-term rewards and to achieve a comfortable social status in the future.

22. I make an effort to study to avoid negative consequences, such as reprimands, repression, upsets or other unpleasant situations in the family, etc.