frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 12 August 2025
DOI 10.3389/feduc.2025.1574155

OPEN ACCESS

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RECEIVED 10 February 2025
ACCEPTED 24 June 2025
PUBLISHED 12 August 2025

CITATION
Ipanaqué-Zapata M, Bazalar-Palacios J, Figueroa-Quiñones J, Quiñones-Negrete M, Velasquez-Castillo NA, Valle-Sandoval H, Rivera-Lozada O, Cayetano-Terrel P and Cerna-Salcedo A (2025) Validation of the autonomous learning strategies scale in Peruvian university students: evaluation of factorial models.
Front. Educ. 10:1574155.
doi: 10.3389/feduc.2025.1574155

Validation of the autonomous learning strategies scale in Peruvian university students: evaluation of factorial models

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Autonomous learning is a fundamental competence in higher education, empowering students to take control of their academic development. Assessing this skill reliably requires robust measurement tools. This study aimed to evaluate the factorial structure and internal consistency of the Autonomous Learning Strategies Scale (CETA) among university students in Peru. We included 418 college students from professional education programs in Peru who participated in the study. The CETA, designed to assess multiple dimensions of autonomous learning, was subjected to rigorous psychometric evaluation. First-order, second-order, and bifactor models were tested through exploratory and confirmatory factor analyses. Reliability was examined using Cronbach's alpha and McDonald's Omega coefficients. The second-order factor model with six underlying dimensions demonstrated the best fit indices and model stability. Inter-factor correlations were moderate and conceptually coherent with the scale's theoretical structure. The findings support the second-order model as the most reliable and valid representation of the CETA. This model is recommended for future research and practical applications in educational settings aimed at evaluating and fostering autonomous learning in university students.

KEYWORDS

psychometric, autonomous learning, university, students, Peru

1 Introduction

University students in the 21st century must commit to lifelong learning, preparing themselves to adapt to new situations that demand diverse competencies, which entails developing self-regulated learning skills (Redeker et al., 2012). According to Crispín et al. (2011), "autonomous learning is a process in which students self-regulate their learning and become aware of their own cognitive and socio-affective processes." In this context, autonomous learning becomes a fundamental pillar of higher education, wherein students are required to actively manage their own development, set goals, and select strategies to

achieve them (Zimmerman, 1989; Villoria and Barroso, 2023). This capability enables the proactive construction of knowledge by leveraging resources, both formal and informal learning environments, and critical feedback (Council of the European Union, 2018).

In higher education, it is essential for academic programmes to promote autonomous learning and personal initiative, thereby fostering an interest in lifelong learning (Marcelo and Rijo, 2019). This approach not only facilitates the construction of meaningful learning but also enables students to actively manage the conditions under which their educational process develops (Yang and Kim, 2014). In a context where knowledge is constantly evolving, one of the main challenges is to prepare future professionals to select, update, and apply relevant information in various settings (Bozu and Canto Herrera, 2009).

Autonomous learning has become an essential competency for the holistic development of university students, enabling them to adapt to new situations in both their professional and personal lives. Universities have a responsibility to develop strategies that foster this competency, linking it to future work environments and promoting key skills such as initiative, critical thinking, self-regulated learning, and the use of metacognitive strategies (Peinado Camacho, 2020). In this regard, autonomous learning serves as a fundamental pillar in higher education, as it integrates knowledge, skills, and personal development, facilitating the management and construction of knowledge (Fuentes et al., 2023). Preparing students for the challenges of the 21st century involves not only imparting knowledge but also equipping them with the tools to learn continuously and effectively in a rapidly changing world.

The existing literature reflects various studies on autonomous learning in university students. In Peru, a study conducted in the city of Lima analysed the relationship between autonomous learning and digital educational resources in first-year students, finding that the levels of autonomous learning initial, intermediate, and advanced were evenly distributed (33.3%) (Melgarejo-Alcántara et al., 2022). Similarly, in the city of Chimbote, located in northern Peru, a study with education students reported that several autonomous learning strategies had significant impacts. These included planning, exam preparation, expansion, collaboration, conceptualization, and participation strategies. Overall, 50.93% of the students demonstrated a high level of competence in autonomous learning (Quiñones-Negrete et al., 2021). At the international level, at the Technical University of Machala in Ecuador, the average use of different strategies was assessed, revealing that exam preparation and expansion strategies were the most frequently used, whereas collaboration and planning were relatively less utilized (Espinoza-Freire et al., 2017). Similarly, at the University of Jaén in Spain, the most prevalent strategies among education students were related to exam preparation and intellectual engagement with the content of subjects included in the curriculum (Pegalajar, 2020).

In higher education, the use of strategies for autonomous learning has become a key tool for developing advanced competencies in future professionals. In this context, the creation and validation of specific surveys to assess skills related to autonomous learning is essential. Having structured instruments allows for an accurate measurement of students' achievement levels, organized into scales that facilitate the identification of areas for improvement and the implementation of concrete actions to optimize learning management in their professional training.

Various studies conducted in different countries have addressed the need to develop and validate instruments for effectively measuring autonomous learning in university students. In Peru, Valdez et al. (2022) utilized the CETA and in-depth interviews to assess autonomous learning strategies in 20 students. The questionnaire, comprising 45 items organized into six factors (collaboration, expansion, conceptualization, planning, exam preparation, and participation), demonstrated a high reliability coefficient ($\alpha = 0.898$). The results indicated that conceptualization strategies were the most frequently used, followed by participation, expansion, exam preparation, and planning (Valdez et al., 2022). Similarly, in Spain, López-Aguado (2010) developed an instrument to measure autonomous learning strategies among students at the University of León, assessing its reliability and validity. Cronbach's alpha was used to determine the internal consistency of the CETA subscales. The results showed high reliability levels for expansion strategies ($\alpha = 0.849$) and conceptualization ($\alpha = 0.857$), while collaboration ($\alpha = 0.812$) and planning ($\alpha = 0.750$) obtained acceptable but lower values. These studies highlight the importance of validated instruments for evaluating autonomous learning strategies, enabling the identification of key areas for competency development in higher education (López-Aguado, 2010).

Although the instrument developed by López-Aguado (2010) showed solid psychometric properties in its original application in the Spanish university context, it is important to consider that educational practices, cultural expectations and learning environments may differ significantly from one country to another. In that sense, instruments that work adequately in one specific environment do not necessarily work the same in another (Cheung and Rensvold, 2002). In fact, research has shown that, when scales are applied in different cultural contexts, their internal structure may change due to factors such as linguistic particularities, educational traditions or students' perceptions (Van de Vijver and Leung, 2011; Byrne and Watkins, 2003). Several studies have attempted to examine the psychometric validity of self-regulated or autonomous learning instruments in different educational contexts. For example, Tanimura et al. (2023) validated a self-regulated learning strategy scale for nursing students in Japan, highlighting cultural and disciplinary influences on factor structure. Similarly, Toering et al. (2012) evaluated the reliability and validity of a self-regulation of learning scale in the context of sports and education, emphasizing the importance of context-specific validation. While some Latin American studies have explored autonomous learning strategies, few have examined in depth whether the factor structure of these instruments holds across different regions (González Cástulo et al., 2017). This raises the need to validate the scale specifically with university students in Peru to ensure that it accurately reflects how this population understands and applies autonomous learning strategies.

The present study addresses a significant knowledge gap by evaluating different factorial models for the psychometric validation of the instrument in a Peruvian university population. This need is particularly relevant in the Peruvian context, where the higher education system is characterized by marked heterogeneity in educational quality, access to technology, and pedagogical approaches across public and private institutions, as well as between urban and rural areas. Furthermore, the recent shift to remote education during the COVID-19 pandemic has exposed substantial deficiencies in the development of autonomous learning skills, underlining the urgency of employing valid and context-sensitive

tools to assess these competencies. Although some previous descriptive studies exist, rigorous psychometric analyses of the CETA in the Peruvian context are lacking, thereby limiting its application in both research and educational planning. This study seeks to be the first to address this need, making a significant contribution by ensuring that the instrument is both applicable and reliable within this specific context. To this end, a thorough analysis of the instrument's internal structure will be conducted using exploratory factor analysis (EFA) to identify underlying dimensions and confirmatory factor analysis (CFA) to test the proposed model (Tavakol and Wetzel, 2020). Additionally, the reliability of the instrument will be evaluated through the calculation of Cronbach's alpha and the Omega coefficient, ensuring internal consistency and robustness for future research applications.

2 Materials and methods

2.1 Study design and setting

We conducted a validation study to evaluate the psychometric properties of the Autonomous Learning Strategies Questionnaire (CETA). This design was appropriate given the study's objective of assessing the instrument's validity and reliability through established validation protocols and psychometric analyses (Arafat, 2016; Arafat et al., 2016).

A cross-sectional survey design was adopted, with data collected from college students at a major private university in Peru between July and December 2024. This university operates on three campuses located in various urban regions of the country, including Chimbote, Piura, and Ayacucho. These cities represent the two main geographical areas of Peru: coastal (the first two cities) and highland (the third).

2.2 Participants

The study employed a descriptive cross-sectional survey to gather data from a total of 518 undergraduate students enrolled in a vocational training programme. Participants were selected using a purposive sampling method. Eligibility criteria included being enrolled in the second academic semester of 2019 and providing informed consent. We approached all invited students, but five (0.9%) declined to participate. Therefore, the final sample comprised 513 students who completed the questionnaire.

2.3 Variables and instruments

The study variable is autonomous learning, defined as the ability to reflect on learning processes in order to align them with the achievement of objectives (González Cástulo et al., 2017). The Self-Employed Strategies Questionnaire (CETA) developed by López-Aguado (2010) was used, composed of 45 items on a Likert scale (1 = Never; 5 = Always), with six dimensions of strategies (expansion, collaboration, conceptualization, planning, exam preparation, and participation). The instrument demonstrated adequate reliability with an α Cronbach's α equal to 0.898 and validity factor loadings greater than 0.4, both in the original study and in a previous study conducted with Peruvian population (López-Aguado, 2010; Quiñones-Negrete et al., 2021); however, none of the previous studies evaluated the scales in different structural factor models.

2.4 Procedure

The data collection process was carried out at a Peruvian university during the last academic semester (July–December 2024), for which the necessary permissions were requested both at the institutional level and from the professional education school. After receiving approval from the university administrators, the research team contacted lecturers teaching courses with larger student populations across different academic years to ensure wider reach. Permissions were requested during virtual classes, and the key points of the study (title, objective, and focus) were explained to participants to inform them about the study's purpose. Furthermore, to facilitate data collection, a form was created on the Google Forms platform, and a link was provided to participants. This form included the informed consent, where participants voluntarily agreed to participate in the study. If they chose not to accept, the questionnaire was automatically closed. The duration of the questionnaire was between 20–30 min, ensuring confidentiality throughout the process.

2.5 Statistical analysis

For the data analysis, the statistical software R was used. The analysis begins by addressing the internal consistency of the different factorial models through exploratory factor analysis, employing the weighted least squares mean and variance adjusted (WLSMV) estimator, reporting the factor loadings of the items within the dimensions and the total scale. It is important to note that a factor loading is considered adequate with values greater than 0.40 (Gil-Monte and Zúñiga-Caballero, 2010). Additionally, the relationship between the instrument's dimensions was evaluated through Pearson's correlation, with significance set at $p < 0.05$.

Subsequently, confirmatory factor analysis of the structural models was performed, presenting the goodness-of-fit indicators (X2, CFI, TLI, GFI, SRMR, RMSEA). The X2 indicator is considered more appropriate when it shows the lowest values (Brown, 2015). The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are considered adequate when they are greater than or equal to 0.90 (Brown, 2015). The Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) are deemed adequate when they are less than or equal to 0.08 (Brown, 2015).

Four structural models were tested for the psychometric validation of the CETA scale in Peruvian university students: (M1) a first-order uncorrelated factorial model, where each factor is modeled separately without allowing interactions among them; (M2) a first-order correlated factorial model, where interaction among the six variables is allowed, reflecting the likelihood that autonomous learning techniques may be connected; (M3) a second-order hierarchical model, which postulates that the first-order factors are manifestations of a higher-order general factor reflecting general autonomous learning; and (M4) a bifactor model,

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where each item loads simultaneously on a general factor and a particular factor, allowing for the examination of both the general and specific dimensions of the construct (Rodriguez et al., 2016; Reise, 2012). In that sense, the bifactor model is especially useful for determining the presence of multidimensionality and the degree to which a single general construct explains the typical variability in item response (Dunn and McCray, 2020).

Finally, the reliability analysis of the structural models was conducted using the Cronbach's Alpha (α) and Omega (Ω) indicators. These indicators are considered acceptable when the values are greater than or equal to 0.50.

TABLE 1 Factor loadings for the factorial structure models of the CETA instrument.

Dimensions	M1-M2	M3	M4	
	λ*	λ*	λ**	λ*
D1: expansion strategies				
P8	0.806	0.711	0.001	0.745
P9	0.684	0.713	−0.409	0.611
P14	0.747	0.781	−0.361	0.697
P16	0.531	0.661	−0.53	0.512
P18	0.846	0.699	0.035	0.744
P19	0.596	0.616	−0.217	0.58
P25	0.462	0.602	−0.187	0.576
P40	0.563	0.571	0.31	0.682
P45	0.719	0.731	0.148	0.811
D2: collaboration strategies				
P15	0.443	0.657	−0.415	0.535
P21	0.628	0.714	−0.394	0.612
P22	0.639	0.575	−0.472	0.435
P23	0.575	0.475	−0.522	0.29
P24	0.738	0.65	−0.356	0.56
P26	0.713	0.626	−0.029	0.668
P27	0.687	0.597	0.054	0.658
P31	0.644	0.66	−0.454	0.523
P33	0.687	0.726	−0.391	0.637
P37	0.698	0.773	0.05	0.843
P38	0.642	0.637	−0.008	0.679
D3: conceptualization strategies				
P3	0.635	0.629	−0.371	0.539
P5	0.786	0.717	−0.03	0.755
P6	0.848	0.800	−0.079	0.831
P7	0.65	0.576	−0.478	0.425
P11	0.707	0.689	−0.648	0.463
P13	0.72	0.753	−0.469	0.624
P32	0.674	0.729	−0.291	0.673
P43	0.711	0.861	−0.04	0.9
D4: planning strategies				
P10	0.674	0.635	−0.599	0.438
P12	0.793	0.674	−0.519	0.513
P17	0.653	0.731	−0.439	0.612
P39	0.619	0.68	−0.135	0.664
P44	0.713	0.744	−0.179	0.716
D5: exam preparation strategies				
P20	0.589	0.74	−0.398	0.632
P29	0.573	0.715	−0.224	0.671
P34	0.807	0.769	−0.128	0.757
P35	0.86	0.791	0.022	0.824
P36	0.89	0.763	0.036	0.801
P42	0.589	0.694	0.169	0.762
D6: participation strategies				
P1	0.618	0.571	0.041	0.616
P2	0.799	0.752	−0.165	0.73
P4	0.656	0.628	−0.117	0.618
P28	0.791	0.757	−0.127	0.751
P30	0.601	0.755	−0.299	0.684
P41	0.691	0.701	0.067	0.746

λ*, Factor loadings of the items within the dimensions; λ**, Factor loadings of the items directly related to the second-order variable; M1, First-order model without correlated items; M2, First-order model with correlated items; M3, Second-order model; M4, Bifactor model.

2.6 Ethics statement

The study was conducted by the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the University Los Angels of Chimbote. All subjects gave informed consent for their inclusion before participating in the study.

3 Results

For the psychometric validation analysis of the CETA scale in Peruvian university students, four study models were tested: first-order uncorrelated (M1), first-order with correlated factors (M2), second-order (M3), and bifactor (M4). The four models were evaluated based on the item distribution principle from the theoretical model validated by the original study of López-Aguado (2010). Table 1 presents the factor loadings (λ) through exploratory factor analysis, showing that for the first- and second-order models, the loadings within the dimensions are appropriately structured, with $\lambda > 0.40$. However, the bifactor model performs correctly in terms of item evaluation for each dimension, but presents unstable values when the items are directly evaluated with the second-order variable (CETA global scale), with λ values close to 0 and negative values, even though

there are no reverse-coded items in the scale. Additionally, it is important to mention that within the analyses conducted, the existence of a relationship between the factors of the CETA scale was evaluated, reporting a strong positive and significant relationship between the dimensions ($r > 0.50$, $p < 0.001$) (Table 1).

The evaluation of the confirmatory factor analysis presented goodness-of-fit indicators for each of the proposed models. The Comparative Fit Index (CFI) for the first-order model showed poor fit, as its value was well below 0.95; meanwhile, the indicators for the correlated, second-order, and bifactor models were above the threshold (0.95). The Tucker-Lewis Index (TLI) and Goodness of Fit Index (GFI) presented similar results to the CFI for the evaluated models, where the first-order model showed a poor fit (TLI and GFI < 0.95). In contrast, the correlated, second-order, and bifactor models showed good fit (TLI and GFI > 0.95). Regarding the Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA), the results showed that the correlated first-order model presented values slightly above the threshold (RMSEA and SRMR > 0.08). In contrast, the second-order and bifactor models presented good fit indicators below the threshold (RMSEA and SRMR < 0.08). Based on these results, it can be concluded that the bifactor model is the most suitable due to its superior values in each goodness-of-fit indicator. However, it is important to note that the bifactor model in the previous step showed unstable and negative factor loadings when the items were directly related to the global CETA scale, making the proposed second-order model more recommendable (Tables 2, 3).

In Table 4, the reliability analysis was obtained through the Cronbach's Alpha (α) and Omega index (**Ω**) indicators. All the evaluated models showed good reliability indicators (α and **Ω** > 0.70). It is important to mention that when the bifactor model was evaluated, the reliability indicators appeared unstable among them, as the variation between the indices was 0.421, and the indicator for the Likert scale of the items performed better with the omega index, which shows us a moderate reliability. Taking this into account, and considering the results of the second-order model, it would be concluded as more appropriate.

4 Discussion

The purpose of the study was to evaluate the psychometric properties of the CETA scale in Peruvian university students. The factorial structure of the CETA showed optimal fit indices in a second-order model underlying six factors. Furthermore, the correlations between factors were moderate, aligning with the distribution of the scale's composition. Finally, the CETA reported acceptable reliability values.

Our study demonstrated that the factorial structure of the CETA fits optimally to a second-order model composed of six interrelated factors. This finding confirms the multidimensional nature of the construct and supports the hierarchical organization of autonomous work strategies as interdependent processes. Our finding aligns with previous studies and is consistent with research that proposes similar structures in questionnaires focused on autonomous learning. For instance, the original development of the CETA with Mexican university students reported a factorial structure with optimal fit values in a model composed of six factors for self-regulated learning strategies (López-Aguado, 2010). In contrast to other instruments that focus on self-regulated learning, such as the Self-Report Scale for Self-Regulated Learning (SRL-SRS) by Toering et al. (2012) or the Self-Regulated Learning Strategy Scale for Nursing Students (SRLSS-NS) by Tanimura et al. (2023), the present study focuses on the validation of a scale designed to

TABLE 2 Correlation of the factors of the CETA instrument.

Factors	1	2	3	4	5	6
1. Expansion strategies	1					
2. Collaboration strategies	0.7252*	1				
3. Conceptualization strategies	0.7594*	0.6196*	1			
4. Planning strategies	0.7683*	0.7026*	0.765*	1		
5. Exam preparation strategies	0.7723*	0.6424*	0.7236*	0.7321*	1	
6. Participation strategies	0.7049*	0.5592*	0.6657*	0.6576*	0.7219*	1

*$P < 0.001$.

TABLE 3 Goodness-of-fit indicators for the confirmatory factor analysis of the presented models.

Indicator	M1	M2	M3	M4
X^2	49209.464	3065.15	3065.15	1814.076
CFI	0.234	0.966	0.966	0.985
TLI	0.198	0.964	0.964	0.984
GFI	0.369	0.961	0.961	0.977
SRMR	0.359	0.081	0.076	0.067
RMSEA	0.487 (0.484–0.491)	0.083 [0.080–0.086]	0.072 [0.071–0.073]	0.07 [0.065–0.074]

X^2, Chi-square; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; GFI, goodness-of-fit index, which measures the proportion of explained variance-covariance; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual.

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assess autonomous learning. Although both constructs are related and imply student involvement and responsibility, autonomous learning emphasizes the student's capacity for independent decision making, responsibility and autonomous involvement in their learning process, without necessarily relying on the structured sequence of planning, monitoring and evaluation characteristic of self-regulated learning (López-Aguado, 2010). In this sense, CETA is a specific tool that captures the broader competencies associated with autonomous learning, such as motivation, initiative and reflective thinking, especially in educational contexts where students are expected to take active control of their academic development.

Therefore, we confirm that autonomous work strategies operate in an integrated manner under a hierarchical framework, allowing students to combine different strategies to optimize their academic performance (Broadbent and Poon, 2015). In this sense, factors such as planning and exam preparation are relevant to the organization and establishment of concrete academic goals, as they positively influence performance (Hong et al., 2006; Kitsantas, 2002), while strategies of expansion and conceptualization promote processes of deepening and constructing meaningful knowledge (Camisón and Forés, 2010). Similarly, strategies of collaboration and participation are related to the social component of autonomous learning (Trickett and Espino, 2004), which aligns with constructivist theories that emphasize social interaction as an essential activity that facilitates learning (Bonk and Cunningham, 1998).

The CETA scale showed satisfactory internal consistency indicators, suggesting that the items within each factor are closely related and reliably measure the underlying constructs. In this sense, previous studies using similar tools focused on autonomous learning strategies have reported reliability coefficients in similar ranges. For example, in the original instrument by López-Aguado (2010), the CETA showed lower reliability values in 2 factors (Exam Strategies and Participation Strategies) compared to the values reported in our study. Likewise, although the Academic Self-Regulation Questionnaire (ASRQ) developed by Alivernini et al. (2011) in Italy is based on the construct of self-regulated learning and not on autonomous learning *per se*, it also reported good reliability in its four-factor model. In line with expert recommendations such as those of Nunnally and Bernstein (2011), who suggests that reliability coefficients above 0.70 are acceptable, the reliability indices found in the Peruvian version of the CETA indicate that it is a psychometrically sound instrument. It is important to note that the CETA is specifically designed to evaluate autonomous learning, understood as the student's ability to manage and take responsibility for his or her learning independently, which distinguishes it from the narrower framework of self-regulation that focuses on the use of metacognitive strategies.

Our findings have important theoretical and practical implications for the academic community. The psychometric validation of the CETA, as a reliable and valid tool, allows its application in university settings, as it promotes the evaluation and strengthens the evidence of students' use of strategies in their autonomous learning. Therefore, our results contribute to the study of learning strategies, with the validation of a multidimensional model and construct in the Peruvian university context. This will allow for replicating findings obtained in other cultures and

TABLE 4 Reliability of the CETA instrument according to the exposed models.

Model	Indicator	D1: expansion strategies	D2: collaboration strategies	D3: conceptualization strategies	D4: planning strategies	D5: exam preparation strategies	D6: participation strategies	Overall
M1	α	0.827	0.848	0.86	0.772	0.823	0.794	–
	Ω	0.837	0.862	0.871	0.782	0.83	0.812	–
M2	α	0.827	0.848	0.86	0.772	0.823	0.794	–
	Ω	0.852	0.857	0.871	0.778	0.848	0.81	–
M3	α	0.827	0.848	0.86	0.772	0.823	0.794	–
	Ω	0.852	0.857	0.871	0.778	0.848	0.810	–
M4	α	0.827	0.848	0.86	0.772	0.823	0.794	0.957
	Ω	0.78	0.741	0.741	0.595	0.817	0.793	0.536

α, Cronbach's Alpha; Ω, Omega Index. M1, First-order model without correlated items; M2, First-order model with correlated items; M3, Second-order model; M4, Bifactor model.

exploring and comparing the cultural particularities of the CETA within the Peruvian university community.

Additionally, the CETA is useful for designing pedagogical interventions focused on each of the dimensions assessed and proposed by the scale. For example, the factor proposed in the CETA regarding expansion strategies involves activities that stimulate exploration and deepening of knowledge, thereby promoting students' search for additional information. On the other hand, collaboration strategies highlight the importance of social learning, suggesting the promotion of teamwork and participation in group learning, which guarantees optimal reception of knowledge. Likewise, the factor related to conceptualization strategies emphasizes the need to foster critical thinking, which supports the development of skills to organize knowledge in a structured and methodical way. The planning strategies factor, on the other hand, highlights the importance of organization and setting clear goals for academic development. Furthermore, the exam preparation factor emphasizes the use of effective review and revision techniques prior to assessments, which influences performance. Finally, the participation strategies factor emphasizes the importance of frequent involvement in learning activities.

This study has several strengths that should be highlighted. First, it is the first scale in Latin America to assess autonomous learning strategies in a current context where self-regulation of knowledge with the support of technologies is key. Additionally, the sample size used is noteworthy, as it included university students from diverse Peruvian contexts, allowing for more representative results. Furthermore, the study presents various robust analysis models, and the second-order factorial model is identified with optimal fit indices, which demonstrate and ensure the structural validity of the CETA. However, this study also presents certain limitations that should be considered when interpreting the results. For example, the sample was composed only of Peruvian university students, which could limit the generalization of the findings to other educational levels (secondary, primary) or cultural contexts (regions). Therefore, future studies should expand the evidence to other populations, such as secondary school students and regions within Peru. Additionally, although robust statistical methods were used, the factorial invariance of the instrument was not evaluated across different subgroups (for example, by gender, age, or field of study). Future studies should include this analysis in their research to ensure additional evidence on the equivalence of the questionnaire across different groups.

5 Conclusion

It is concluded that the CETA scale in its Peruvian version, composed of 45 items and 06 factors, has provided psychometric evidence of its structure. Furthermore, the instrument has shown adequate reliability values, making it recommended for use in the Peruvian university educational context.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

MI-Z: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JB-P: Investigation, Writing – original draft, Writing – review & editing. JF-Q: Investigation, Writing – original draft, Writing – review & editing. MQ-N: Investigation, Writing – original draft, Writing – review & editing. NV-C: Investigation, Writing – original draft, Writing – review & editing. HV-S: Investigation, Writing – original draft, Writing – review & editing. OR-L: Investigation, Writing – original draft, Writing – review & editing. PC-T: Investigation, Writing – original draft, Writing – review & editing. AC-S: Writing – original draft , Writing – review & editing, Methodology, Supervision, Validation, Investigation, Visualization.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1574155/full#supplementary-material

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