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A multidimensional instrument for assessing academic writing skills among university students

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ABSTRACT

Academic writing is a key competence in higher education, closely linked to critical thinking and scientific production. However, its development is influenced by structural, pedagogical, and emotional factors, and there is a lack of validated instruments to assess its multidimensional nature in the Peruvian context. This study aimed to develop and validate a multidimensional instrument for assessing academic writing competencies in university students. A 59-item questionnaire was administered to 1,133 students from the Universidad Nacional de San Agustin de Arequipa. The instrument measured five dimensions: academic writing, metacognitive strategies, advising processes, information and communication technology (ICT) use, and emotional factors. Psychometric validation was conducted using exploratory factor analysis (EFA) based on polychoric correlations, followed by confirmatory factor analysis (CFA). Internal consistency was evaluated using Cronbach's alpha. The EFA revealed a stable five-factor structure, confirmed by CFA, indicating adequate construct and convergent validity, with average variance extracted (AVE) values above 0.50 for most constructs. The instrument showed excellent reliability (Kaiser–Meyer–Olkin (KMO)=0.99; $\alpha>0.90$; $p<0.001$). Some limitations in discriminant validity were identified due to high correlations between certain factors. The findings confirm the multidimensional nature of academic writing and support the validity of the proposed instrument. It is a reliable tool for diagnosing academic writing competencies and informing evidence-based pedagogical interventions in higher education.

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1. INTRODUCTION

Academic writing in current university systems is considered an essential competence within communicative development. Written academic discourse represents one of the fundamental tasks of scholarly work and must be characterized by a more regulated, communicative, and pragmatically oriented approach, leaving aside expressive and aesthetic components. Nowadays, reading and writing habits have diversified through digital media such as social networks, mobile devices, websites, and blogs of various types. Digital reading and writing have fostered the development of new skills, which poses a challenge in

educational contexts. This challenge implies that university students must achieve both an instrumental and epistemic level of reading and writing within an environment where multiple linguistic systems coexist, thus requiring information literacy as well [1]. Increasingly, written communication skills are recognized as a key requirement for postgraduate students across all disciplines. Various reports emphasize the importance of integrating academic writing into the curriculum rather than addressing it as an isolated skill [2]. In higher education, the ability to produce clear, rigorous, and persuasive academic texts is essential for academic and professional success. However, various studies show that university students face persistent difficulties in mastering the structural and discursive conventions of academic writing; that is, many university students struggle to produce well-structured, coherent, and academically rigorous texts, which affects the completion of their theses, their preparation for publication, and their overall academic success. In Latin America, and particularly in Peru, this situation is exacerbated by deficiencies in literacy skills upon entering university, as well as by contextual factors such as weak articulation between educational levels, limited training in disciplinary writing, and institutional constraints. As a result, many students experience significant challenges in mastering academic writing, often leading to low performance and failure to meet required standards. This difficulty is reflected in university students who struggle to produce coherent written work. Such problems are attributed to factors such as ineffective teaching methods, limited instructional time for writing skills, and insufficient learning resources [3].

Although several instruments have been proposed to assess academic writing skills in higher education, existing studies present important limitations. First, many instruments focus exclusively on structural or linguistic aspects of writing while neglecting metacognitive, emotional, and digital dimensions that may influence academic writing performance. Second, relatively few studies have examined multidimensional academic writing constructs using both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) within a rigorous psychometric framework. Third, evidence from Latin American higher education contexts, particularly in Peru, remains limited, despite the growing relevance of academic literacy in university education. Consequently, there is still a lack of validated multidimensional instruments capable of integrating structural, strategic, emotional, and information and communication technology (ICT)-related dimensions of academic writing within a single assessment model.

Addressing this gap is important because the availability of psychometrically robust instruments may support more accurate diagnosis, educational assessment, and evidence-based pedagogical interventions in higher education contexts. From a psychometric perspective, instrument validation is essential to ensure the reliability and validity of measurements in educational research. The EFA is commonly used to identify the latent structure of a construct when the dimensionality is not yet clearly established, whereas CFA allows researchers to empirically test a theoretically predefined factorial structure [4]. CFA provides a rigorous framework for evaluating construct validity through the specification of relationships among latent variables, observed indicators, and goodness-of-fit indices [5], [6]. In addition, psychometric validation procedures contribute to improving the precision, consistency, and interpretability of educational measurement instruments, thereby strengthening their applicability in higher education assessment contexts. The present study aims to analyze the academic writing skills of university students through the application of a questionnaire designed to identify strengths and weaknesses in this competence. A quantitative approach was adopted, employing exploratory and confirmatory factor analyses to validate the structure of the instrument. Additionally, the potential influence of emotional factors on writing performance was considered, given their relevance in the current academic context. This study aims to fill this gap by developing and validating a multidimensional instrument to assess academic writing in Peruvian university students. The specific objectives are:

- To design a questionnaire that evaluates five proposed dimensions of academic writing: academic writing (structure, coherence, and standards), metacognitive strategies, guidance, ICT use, and the emotional dimension.
- To analyze the underlying factorial structure of the instrument through an EFA using polychoric matrices, which are appropriate for ordinal items.
- To confirm the factorial structure of the construct through CFA.
- To validate the instrument by assessing its convergent and discriminant validity based on CFA results.
- To discuss the implications of the findings for diagnosis and pedagogical intervention in the context of Peruvian higher education.

The relevance of this work lies in providing an empirically validated tool that enables institutions and educators to accurately identify training needs in academic writing, design targeted interventions, and ultimately contribute to improving the quality of intellectual output and the communicative competence of future professionals and researchers in Peru.

2. RELATED WORK

2.1. Psychometric validation and educational assessment instruments

In a study conducted by Lobos-Rivera *et al.* [7] to analyze three frequent psychological conditions among university students, an instrument was developed through a digital survey administered via Google Forms. The psychometric properties of the depression, anxiety, and stress scale were evaluated using CFA. This process was supported by adequate goodness-of-fit indices: the comparative fit index (CFI) and the normed fit index (NFI) were slightly above 0.90. The goodness of fit index (GFI) and the adjusted goodness of fit index (AGFI) exceeded the value of 0.80, while the standardized root mean square residual (SRMR) was below 0.05, and the root mean square error of approximation (RMSEA) was below 0.10. All the aforementioned indices were considered acceptable. Sagredo-Ortiz and Kloss [8] present a study with the objective of designing and validating an instrument to assess academic writing strategies in university students from three different disciplinary areas. A quantitative instrumental methodology was employed, which included the design of the questionnaire based on theoretical models of academic writing and self-regulation, its application to a sample of university students, and a psychometric analysis using measures of sampling adequacy (Kaiser–Meyer–Olkin (KMO) and Bartlett's test), EFA for construct validity, and Cronbach's alpha coefficient for reliability. The results showed a factorial structure consistent with the theoretical framework and high levels of internal consistency, as well as differences in the use of academic writing strategies according to disciplinary area. In the discussion, the authors conclude that academic writing is a situated competence dependent on disciplinary context and emphasize that the validated instrument constitutes a useful and reliable tool for diagnosis and research on academic writing in higher education.

2.2. Factors influencing academic writing competence

Research by Rosdiana *et al*. [9] aimed to validate a questionnaire on metacognitive strategies for academic writing and examine their effect on academic writing performance in higher education students. Using factorial design analysis and CFA, the research evaluated 500 students from three universities in West Java who had previously received training in metacognitive strategies. The instruments included a refined 57-item questionnaire and academic writing tests assessing linguistic aspects, critical thinking, and idea expression. The results confirmed the validity and reliability of the instrument and identified eight interrelated metacognitive components: declarative, procedural, and conditional knowledge, planning, monitoring, evaluation, information management, and debugging strategies. Regression analysis showed that these dimensions explained 88% of the variance in academic writing performance. The findings indicate that metacognitive awareness and regulation significantly improve students' writing competence, highlighting the importance of validated instruments to assess and strengthen academic writing skills in higher education. Research by Wang [10] analyzed the academic writing competence in English among 154 postgraduate students from non-English disciplines and identified the main factors influencing their performance. Using a quantitative approach with questionnaire surveys and factor analysis (KMO=0.893), the results showed that although students recognized the importance of academic writing, many lacked sufficient knowledge and practical experience. Three main factors were identified: writing knowledge (35.79% of explained variance), motivation (16.51%), and teaching environment (14.94%). A strong positive correlation (0.927) was also found between technical writing knowledge and writing competence. The findings revealed that most students wrote primarily for graduation purposes, limiting deeper academic engagement, and only a small percentage considered themselves proficient writers. The study concluded that academic writing competence depends on the interaction between motivation, knowledge, and educational support, recommending student-centered teaching approaches, specialized writing courses, and institutional support resources to strengthen academic writing skills.

2.3. Digital technologies and academic writing

Previous research by Li and Mak [11] examined the effects of using an online collaboration tool on the development of academic writing skills among university students. The aim of the study was to determine whether a technology-mediated collaborative environment enhances the learning of source-based expository writing. The research adopts a quasi-experimental intervention design lasting 10 weeks, involving 69 first-year students enrolled in an English course at a Canadian college. The methodology included the administration of pre- and post-writing assessments, as well as standardized reading tests, comparing the performance of a control group and an experimental group. The results reveal statistically significant improvements in academic writing skills among students in the experimental group, particularly those with lower levels of language proficiency. The authors conclude that the use of digital collaborative tools, when integrated into a structured pedagogical framework, has a positive impact on academic writing development in the university context. Study by Khojasteh *et al*. [12] aims to develop and validate the artificial intelligence and academic writing questionnaire (AI-AWQ) to assess medical students' experiences and perceptions regarding the use of artificial intelligence (AI) in academic writing. A quantitative instrumental methodology

was employed, which included the construction of the questionnaire based on the literature on AI and academic writing, its application to a sample of medical students, and psychometric validation through EFA, along with tests of sampling adequacy and reliability analysis (Cronbach's alpha). The results revealed a clear and coherent factorial structure, as well as adequate levels of internal consistency across the identified dimensions related to use, perceived usefulness, ethical implications, and AI support in academic writing.

Additionally, in the discussion, the authors point out that the AI-AWQ constitutes a valid and reliable instrument for analyzing the impact of AI on academic writing in university contexts, highlighting its usefulness for future research and for the design of educational policies on the responsible use of AI in higher education. Research by Nabhan and Habók [13] proposed the development and analysis of the factorial structure of the digital literacy academic writing scale in order to evaluate the relationship between digital literacy and academic writing among university students. A quantitative instrumental methodology was used, based on the administration of the scale to a student sample and psychometric validation through EFA, accompanied by measures of sampling adequacy and reliability analysis. The results evidenced a consistent factorial structure, with dimensions associated with the use of digital tools, information management, academic text production, and ethical practices in digital environments, as well as adequate levels of internal consistency. In the discussion, the authors conclude that the scale constitutes a valid instrument for assessing digital literacy competencies related to academic writing and emphasize its relevance for understanding how digital skills influence writing performance in higher education contexts.

2.4. Challenges in academic writing in higher education

Research by Pineteh [14] analyzes the challenges faced by undergraduate students at a university of technology in South Africa. The study aims to identify the main academic writing difficulties, understanding their underlying causes, and proposing strategies for improvement. The study adopts a qualitative approach, drawing on interviews with students and lecturers, as well as written reflections from first-year students. The findings reveal persistent difficulties in mastering academic conventions, organizing and developing arguments, achieving textual coherence, and using sources appropriately. These challenges are associated with unequal prior educational trajectories, the use of English as a second language, and negative attitudes toward academic writing. Furthermore, the study identifies limited attention to formative feedback and systematic support during the writing process, which adversely affects students' learning. Based on these findings, the author emphasizes the need to integrate academic literacies into disciplinary curricula and to strengthen pedagogical support structures within higher education.

3. BACKGROUND

3.1. Exploratory and confirmatory factor analysis

Factor analysis is a fundamental statistical technique for examining the underlying structure of a set of items or variables. Through it, one can observe how items tend to group together, allowing for the identification of latent factors that explain the correlations among them, thereby contributing to the validation of the construct intended to be measured [4]. A distinction is made between EFA and CFA. EFA is a procedure used primarily to explore and generate hypotheses about the factor structure when no predefined theory exists; its purpose is to identify the number and nature of underlying factors without imposing an a priori structure. As noted by Vallejo [4], this method is considered more of a procedure for generating theories than for confirming them. On the other hand, CFA is used when the researcher has a pre-established theoretical model about the construct's structure. In this approach, the number of factors, the relationships among them, and the item loadings are specified in advance, and the model is subjected to goodness-of-fit tests to verify whether the empirical data align with the proposed structure [4]. CFA is particularly useful in advanced stages of instrument validation, where the goal is to confirm the stability and validity of a previously identified factor structure.

3.2. Polychoric matrices in factor analysis with ordinal data

An important methodological aspect in factor analysis, especially when working with ordinal data such as that from Likert-type scales, is the choice of the appropriate correlation matrix. Traditionally, in psychology and the social sciences, Pearson's correlation has been used, but this statistic is only applicable when the variables are on an interval scale and follow a normal distribution. Recent methodological research has shown that this approach may lead to biased estimations when applied to ordinal data, as it tends to underestimate the strength of underlying relationships between variables. In contrast, polychoric correlation matrices are recommended for ordinal indicators, as they provide more accurate estimations by modeling the relationships between latent continuous variables underlying observed categorical responses. Studies in structural equation modeling and factor analysis have demonstrated that the use of polychoric correlations

improves factor recovery, reduces estimation bias, and enhances model accuracy in both exploratory and CFA contexts [15]–[17].

4. METHOD

At this stage, the research is conducted and the methodological pipeline of the present study is presented, which was structured into sequential stages. First, data collection was carried out using a structured questionnaire designed to assess the use of AI in academic writing. Subsequently, during the instrument description stage, the theoretical foundations, dimensions, and items that comprise the questionnaire were detailed, along with the measurement scale employed. Next, an EFA was performed in order to examine the underlying structure of the instrument and identify latent dimensions based on the empirical data. Finally, a CFA was conducted to validate the proposed factorial model, evaluate its fit, and provide evidence of construct validity, as shown in Figure 1. To analyze the level of academic writing and to examine the dimensions of structure, emotion, and writing phases, a 59-item questionnaire was designed and stored in an Excel database. Subsequently, statistical analyses were conducted using RStudio and Google Colab environments employing the psych and Lavan packages.

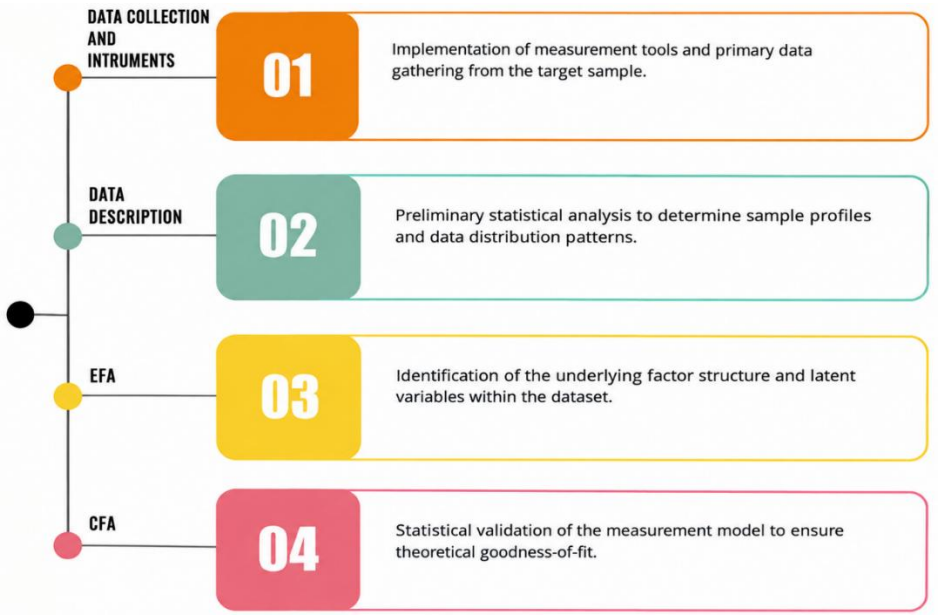


Figure 1. Pipeline

4.1. Data collection and instruments

A total of 1,133 students from the Universidad Nacional de San Agustín de Arequipa, aged between 16 and 30 years, were surveyed using a non-probabilistic convenience sampling method. Participation was voluntary, and the questionnaire was distributed through the university's institutional system. The inclusion criteria considered actively enrolled undergraduate students who voluntarily agreed to participate and properly completed the questionnaire. The instrument consisted of 59 items classified into five dimensions: academic writing (32 items), metacognitive strategy (14 items), advising (2 items), ICT management (3 items), and emotional dimension (8 items). These items were developed based on the operationalization of the study variables and their corresponding theoretical framework. To ensure content validity, the items were evaluated by a researcher with experience in educational research and scientific publications, who assessed the clarity, relevance, and coherence of each item. In addition, empirical validation was conducted through a pilot study applied to a sample of 40 students with characteristics similar to the target population. This process allowed the identification of aspects for improvement in item wording, comprehension, and instrument functionality. Based on the results of the pilot study and expert feedback, the corresponding adjustments were made, resulting in the final version of the instrument, which was subsequently administered to the entire study population. The responses corresponding to the first four dimensions were measured using a 5-point Likert scale: 1 (very easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (very difficult). In the case of the emotional dimension, a seven-point scale was used, ranging from 1 to 7.

4.2. Questionnaire

An ad hoc questionnaire consisting of 59 items was designed, distributed across five predefined theoretical dimensions based on a review of the literature on academic writing, as shown in Table 1. The instrument was developed to explore academic writing as a multidimensional process involving linguistic, cognitive, strategic, social, technological, and affective factors. The items were formulated to capture not only the structural and linguistic components of academic texts, but also the strategies employed during planning, drafting, revision, and evaluation. Furthermore, the questionnaire addressed the role of digital tools, interpersonal interactions, feedback, and emotional experiences in shaping writing practices. The five dimensions were established to ensure comprehensive coverage of the main aspects of academic writing relevant to the study. This framework provided a structured basis for examining participants' writing practices and experiences.

Table 1. Dimensions and items of the questionnaire

No	Dimension	Items	Description
1	Academic writing	32	Assesses skills related to structure, coherence, cohesion, American Psychological Association (APA) standards, citation, vocabulary, thematic organization, and adaptation to the discursive genre.
2	Metacognitive strategies	14	Addresses processes of planning, self-regulation, model consultation, revision, and evaluation of text quality.
3	Guidance	2	Measures the willingness to consult doubts with tutors and to incorporate teacher feedback
4	ICT management	3	Assesses the use of technological tools for writing, information searching, and process organization.
5	Emotional dimension	8	Explores affective states during writing, such as confidence/calmness, efficacy/competence, and well-being/discomfort.

4.3. Ethical considerations

The study received approval from the Research Ethics Committee of the Universidad Nacional de San Agustín de Arequipa (Record No. CEI-UNSA-2023-05). The principles of autonomy, confidentiality, and non-maleficence established in the Declaration of Helsinki were fully complied with. All participants were informed about the objectives of the study and the voluntary nature of their participation, and they provided informed consent before completing the questionnaire. The data were collected anonymously and used exclusively for research purposes.

4.4. Data description

This section explores the results obtained from 1,133 students of the Universidad Nacional de San Agustin de Arequipa who completed the questionnaire consisting of 59 items. Participants' ages ranged from 16 to 30 years, with a mean age of 19.5 years and a standard deviation of 2.78. Regarding gender, 56.2% of the respondents identified as female, 43% as male, and 0.8% as non-binary. With respect to academic field of study, the majority of participants belonged to the Arts and Humanities area (94.7%). The remaining students were distributed across Social and Legal Sciences (0.4%), Sciences (4.3%), Health Sciences (0.4%), and Engineering and Architecture (0.4%). Figure 2 illustrates the age distribution of the 1,133 respondents. The largest group, representing 45.10% (511 participants), was between 16 and 18 years old. This was followed by 36.01% (408 participants) aged between 19 and 21 years. A total of 12.18% (138 participants) were between 22 and 24 years old. Smaller proportions included 4.41% (50 participants) aged between 25 and 27 years, and 2.29% (26 participants) between 28 and 30 years of age, as shown in Figure 2.

Regarding specific training in academic writing, 33.5% of the respondents indicated that they had received formal instruction in this area, while 66.5% reported that they had not. Concerning self-assessment of their academic writing skills and competencies, students rated themselves as: very high (2.9%), high (35.4%), medium (51.2%), low (8.9%), and very low (1.5%), as shown in Figure 3.

4.5. Exploratory factor analysis

An EFA was conducted to examine the underlying structure of the 59-item questionnaire administered to students. Furthermore, factor analysis can be used to investigate the correlations between observed variables and to model these relationships through one or more latent variables [18]. The analysis was performed using the psych package in R, employing the maximum likelihood (ML) extraction method and varimax rotation to facilitate factor interpretability. The ML extraction method was selected due to its widespread use in factor analysis and its suitability for estimating latent variable models under multivariate normality assumptions. With large samples, ML estimators are asymptotically unbiased and achieve minimum efficient variance [5]. The present study (N=1133) substantially exceeds the minimum recommended sample

size of 200 cases for factor analysis [5], as well as the conservative criterion of 10 participants per item (10×59=590), supporting the suitability of the ML method for factor estimation. Three criteria were employed to determine the number of factors: eigenvalue >1 [19], scree plot [20], and parallel analysis [21]. Since the eigenvalue >1 criterion tends to overestimate factors when many variables are involved (59 items), it was complemented with additional methods. Parallel analysis compares real eigenvalues with randomly generated matrices, correcting the bias of the first criterion [5]. These procedures were used to improve the robustness and accuracy of factor retention decisions. Prior to conducting the EFA, sampling adequacy was assessed using the KMO measure and Bartlett's test of sphericity to confirm the suitability of the data for factor analysis. In addition, factor loadings and communalities were calculated to determine the items associated with each factor, considering loadings greater than 0.30 as relevant for factor definition.

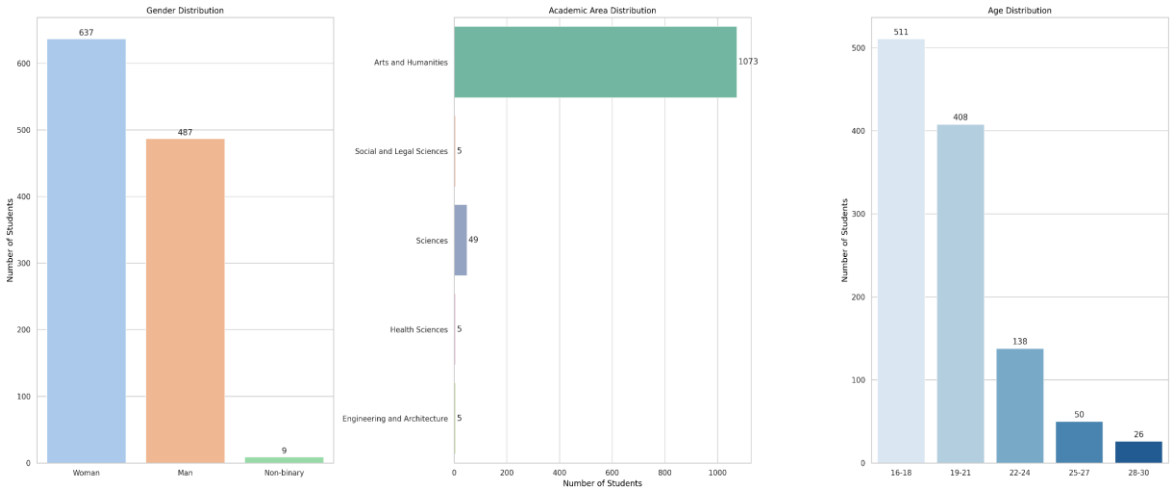


Figure 2. Age group diagram

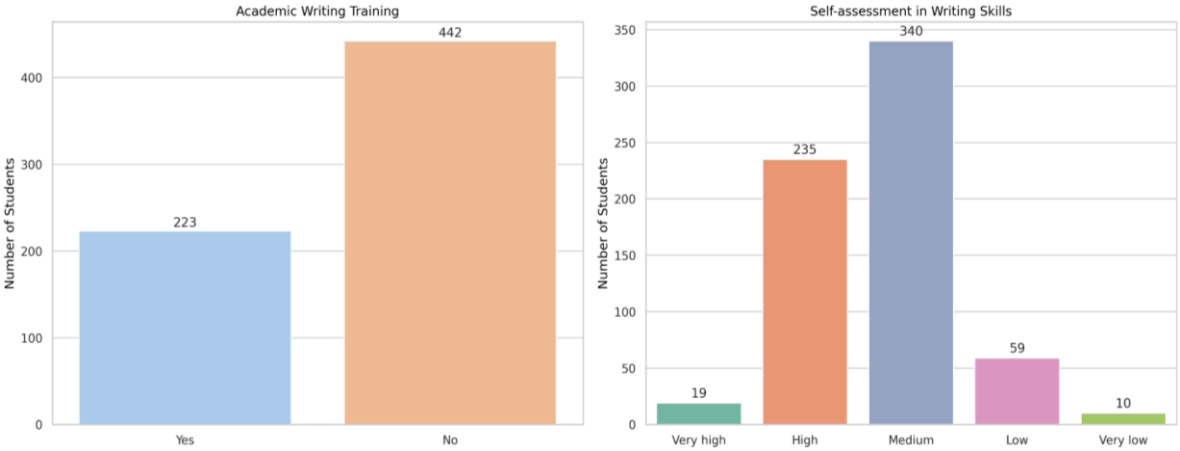


Figure 3. Diagram of specific training in academic writing and self-assessment of skills and abilities

4.6. Confirmatory factor analysis

The CFA was conducted to evaluate the internal structure of the 59-item instrument administered to students, as CFA evaluates whether an assumed relationship among manifest indicators and latent factors [22]. The factorial model was specified based on the structure proposed in the previous exploratory analysis, defining five factors: academic writing, metacognitive strategy, advising, ICT management, and emotional dimension, with items assigned to each factor according to theoretical considerations and EFA results. The analysis was performed using RStudio and the lavaan package through interactive notebooks on the Google Colab platform. The unweighted least squares (ULS) estimation method was employed. Due to the ordinal nature of the Likert-type responses, the CFA was estimated using an estimation method appropriate for categorical data, specifically the ULS estimator, which does not require multivariate normality and provides

robust parameter estimates. Additionally, correlations among latent factors were examined to assess the relationships between the underlying dimensions of the construct. Items were treated as ordinal variables, and correlations among factors were allowed in accordance with the theoretical model. Additionally, construct validity was assessed through convergent and discriminant validity analyses. Convergent validity was evaluated based on standardized factor loadings and the average variance extracted (AVE), whereas discriminant validity was examined by analyzing the correlations among latent factors and applying the Fornell–Larcker criterion.

5. RESULTS

5.1. Reliability analysis

The reliability of the instrument was assessed using Cronbach's alpha coefficient, obtaining a value of α=0.96, which indicates excellent internal consistency. Subsequently, the KMO measure of sampling adequacy and Bartlett's test of sphericity were conducted, as shown in Table 2. The results yielded a KMO value of 0.99 and a significance level of $p<0.001$, indicating that the data are suitable for the application of factor analysis, in accordance with Vallejo [4].

Table 2. Sampling adequacy and Bartlett's test of sphericity

Test	Result
KMO index	0.99
Bartlett's test of sphericity	$\chi^2(59)=3141$, $p<0.001$

5.2. Exploratory factor analysis

Using the SPSS software, an EFA was conducted. In addition, Figure 4 presents the scree plot, which allows the determination of the optimal number of factors to be extracted, since beyond the inflection point observed in the curve, the inclusion of additional factors does not lead to significant changes in the explained variance. Likewise, Table 3 shows the variance explained by each extracted factor, as well as the cumulative variance.

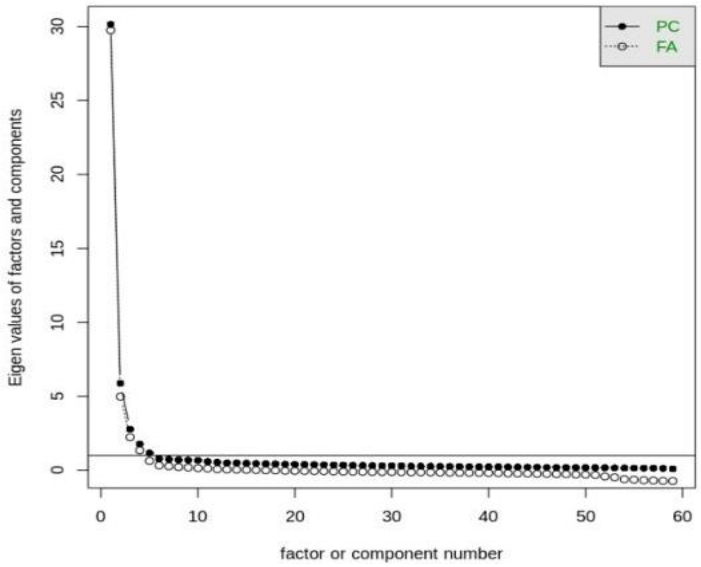


Figure 4. Scree plot

Table 3. Summary of variance explained by principal components

Measure	PA1	PA2	PA3	PA4	PA5
SS loadings	14.1979	6.6320	6.4966	14.7405	0.9080
Proportion of variance	0.2406	0.1124	0.1101	0.2498	0.0154
Cumulative variance	0.4905	0.6029	0.7130	0.2498	0.7284
Proportion explained	0.3304	0.1543	0.1512	0.3430	0.0211
Cumulative proportion	0.6734	0.8277	0.9789	0.3430	1.0000

Based on the EFA, five components were identified that group the instrument's indicators according to their conceptual affinity. The first component, presented in Table 4, groups indicators related to academic writing, textual coherence, appropriate use of language, text organization, and compliance with academic standards, constituting the main dimension of the construct under evaluation. The second component, shown in Table 5, is associated with the use of support strategies and resources for academic writing, including interaction with the tutor, the use of teacher feedback, consultation of previous models, and the use of technological tools for text revision and improvement. The third component groups indicators linked to the selection, integration, and management of academic information sources, as well as the application of citation standards and the adaptation of writing style to the type of assignment required, as shown in Table 6. The fourth component, presented in Table 7, relates to the ability to synthesize information, content adequacy, and the selection of relevant information for the development of academic work. Finally, the fifth component, shown in Table 8, consists of a single indicator related to searching for bibliographic sources in scientific databases, which, despite its lower percentage contribution to the total explained variance, was retained in the exploratory model due to its theoretical relevance within the analyzed construct.

Table 4. First principal component (51.12%)

Item	Description
D16	Express ideas clearly
D18	Structure and organize the information in the text
D19	Develop and maintain a guiding thread or theoretical or thematic focus in writing
D20	Consider the purpose and objective of the academic text during writing
D30	Write conclusions in a clear and orderly manner
D24	Establish connections between the different ideas and/or arguments presented
D12	Search for information in English
D28	Express one's own arguments clearly and precisely
D29	Develop conclusions consistent with what is presented in the text
D13	Use the necessary technological tools for academic writing (word processors)
D23	Present information in an appropriate logical and coherent order
D14	Include a variety of connectors to link ideas within a text
D21	Construct a coherent and well-connected text
D22	Follow an appropriate and coherent order in writing
D32	Include in the conclusion original contributions or ideas regarding the thesis addressed in the text
D31	Produce a summary of the written text
D3	Use spelling rules appropriately
D2	Prepare an index in the academic work that reflects a structured thematic organization
D26	Generate a title that is engaging and appealing
D4	Adapt the written text to established academic formats (indentation, line spacing, margins, tables, and figures)
D27	Adapt discourse to academic or scientific requirements
D1	Use extensive and varied vocabulary when writing
D6	Cite references within the text

Table 5. Second principal component (9.96%)

Item	Description
D43	Expressing doubts about academic writing and composition to the tutor
D47	Use the teacher/tutor's comments to revise the text
D45	Use academic work from previous courses as a reference for writing academic work
D49	Use technology such as spell checkers, style checkers, and translators to improve writing
D50	Compare the final result with other academic texts to assess the quality of the text produced
D44	Incorporate documentation and works found on the internet into the writing
D34	Search for models similar to the academic text you intend to write
D48	Assess the final quality of the written text
D37	Find technological resources (databases and research papers) to document the work
D36	Understand the purpose of the academic work to be done
D40	Apply technological tools to organize the writing process
D42	Improve writing by following the guidelines provided by the teacher
D33	Be clear about the type of text that is required
D39	Identify the different requirements of the text: organization and planning of the process
D38	Resolve any doubts that arise during the process by seeking the right support
D41	Identify what kind of resource I need to solve possible initial difficulties: tutor, internet, a classmate
D35	Use language appropriate to the academic text required
D46	Review the text after finishing writing it

Table 6. Third principal component (4.69%)

Item	Description
T51	Insecurity–security
T52	Distress–calmness
T53	Unproductivity–productivity
T54	Ineffectiveness–effectiveness
T55	Incompetence–competence
T56	Negativity–positivity
T57	Uselessness–usefulness
T58	Frustration–satisfaction
T59	Discomfort–well-being

Table 7. Fourth principal component (2.99%)

Item	Description
D8	Adapt the writing style to the requirements of the specific type of assignment (monographs, class activities, and final projects)
D9	Connect information from different sources (authors, research, and documents)
D7	Use references and ideas from other authors coherently in your writing
D5	Apply APA guidelines
D15	Incorporate information, facts, and contributions from other authors into the writing
D25	Write a title that suits the written text
D10	Select new information that is relevant and pertinent to the development of the work
D17	Select relevant information based on the topic and purpose of the academic work

Table 8. Fifth principal component (1.97%)

Item	Description
D11	Search scientific databases to obtain reliable bibliographic sources

To assess the validity of the proposed model, several goodness-of-fit indices were employed, which allow evaluation of the extent to which the hypothesized theoretical structure corresponds to the empirical data obtained. The indicators considered included the CFI, the Tucker–Lewis index (TLI), the RMSEA, and the SRMR, which are widely used in instrument validation studies due to their ability to provide a comprehensive assessment of model fit.

The CFA was conducted using the RStudio statistical environment, taking advantage of the processing resources available on the Google Colab platform, which enabled efficient analysis and ensured adequate estimation of the proposed model. For model specification, estimation, and graphical representation, specialized libraries for factorial and structural equation modeling were employed, specifically lavaan and semPlot, which are widely recognized in psychometric and educational research. The factorial model was specified based on the theoretical framework of the study and the structure of the designed instrument. Accordingly, five latent dimensions were defined: academic writing, metacognitive strategies, advising, ICT management, and emotional dimension. Each of these dimensions was measured by a specific set of items, which were directly assigned to their respective factors according to the conceptual logic underlying the instrument. Once the questionnaire data were incorporated into the corresponding database, the confirmatory factor model was estimated, taking into account the ordinal nature of the responses. The analysis yielded both global model fit indices and information regarding the relationships between the observed items and the latent dimensions to which they belong. This combined evaluation made it possible to determine whether the proposed structure adequately represents the construct under measurement.

Additionally, a graphical representation of the factorial model was generated to provide an integrated visualization of the relationships between the latent dimensions and the observed items, contributing to a clearer understanding of the instrument's internal structure and the interrelationships among its components. The results of the analysis are summarized in Table 9, which presents the main goodness-of-fit indices for the proposed model. Overall, these findings provide empirical evidence supporting the adequacy of the factorial structure and the suitability of the instrument for assessing the dimensions considered in the study. Furthermore, additional goodness-of-fit measures were computed to strengthen the evaluation of the model. The p-value associated with the Chi-square (χ^2) test was calculated, yielding $\rho = 1.090826 \times 10^{-231}$. In addition, the normalized χ^2 was obtained by dividing the χ^2 statistic by the model degrees of freedom (df), resulting in $\chi^2_{norm} = 2.596$. These results are complemented by the visualizations presented in Tables 10–14, which illustrate in detail the relationships between latent and observed variables, as well as the principal fit indices of the confirmatory factor model.

Table 9. Fit indices of the CFA

Fit index	Value
χ^2	4262.509
df	1,642
CFI	0.996
TLI	0.996
RMSEA	0.038
90% CI RMSEA (lower bound)	0.036
90% CI RMSEA (upper bound)	0.039
SRMR	0.046

Table 10. Results of the CFA: academic writing

Item	Estimate	Std.Err	z-value	P(>|Z|)	Std.lv	Std.all
D1	1.000	-	-	-	0.790	0.790
D5	0.841	0.009	94.508	0.000	0.664	0.664
D6	0.979	0.010	102.427	0.000	0.773	0.773
D7	0.906	0.009	98.485	0.000	0.716	0.716
D8	0.580	0.008	74.157	0.000	0.458	0.458
D9	0.863	0.009	95.939	0.000	0.682	0.682
D15	1.017	0.010	104.354	0.000	0.804	0.804
D25	0.983	0.010	102.628	0.000	0.776	0.776
D27	1.090	0.010	107.671	0.000	0.861	0.861
D2	1.109	0.010	108.454	0.000	0.876	0.876
D10	0.983	0.010	102.620	0.000	0.776	0.776
D11	0.265	0.007	38.110	0.000	0.209	0.209
D17	0.870	0.009	96.360	0.000	0.688	0.688
D3	1.082	0.010	107.331	0.000	0.855	0.855
D4	1.081	0.010	107.267	0.000	0.854	0.854
D12	1.120	0.010	108.943	0.000	0.885	0.885
D13	1.137	0.010	109.607	0.000	0.898	0.898
D14	1.127	0.010	109.232	0.000	0.891	0.891
D23	1.102	0.010	108.181	0.000	0.871	0.871
D24	1.141	0.010	109.789	0.000	0.902	0.902
D16	1.167	0.011	110.781	0.000	0.922	0.902
D18	1.151	0.010	110.156	0.000	0.909	0.909
D19	1.140	0.010	109.736	0.000	0.901	0.901
D20	1.128	0.010	109.266	0.000	0.891	0.891
D21	1.072	0.010	106.878	0.000	0.847	0.847
D22	0.982	0.010	102.597	0.000	0.776	0.776
D26	0.987	0.010	102.845	0.000	0.780	0.780
D28	1.079	0.010	107.180	0.000	0.852	0.852
D29	1.131	0.010	109.370	0.000	0.894	0.894
D30	1.152	0.010	110.200	0.000	0.910	0.910
D31	1.084	0.010	107.408	0.000	0.857	0.857
D32	1.094	0.010	107.839	0.000	0.864	0.864

Table 11. Results of the CFA: metacognitive strategy

Item	Estimate	Std.Err	z-value	P(>|Z|)	Std.lv	Std.all
D33	1.000	-	-	-	0.872	0.872
D34	0.984	0.009	109.742	0.000	0.858	0.858
D35	1.009	0.009	111.076	0.000	0.880	0.880
D36	1.025	0.009	111.885	0.000	0.894	0.894
D38	0.958	0.009	108.286	0.000	0.835	0.835
D39	0.957	0.009	109.883	0.000	0.861	0.861
D41	1.014	0.009	111.330	0.000	0.885	0.885
D42	0.962	0.009	108.537	0.000	0.839	0.839
D44	0.964	0.009	108.658	0.000	0.841	0.841
D45	0.988	0.009	109.926	0.000	0.861	0.861
D46	0.878	0.008	103.528	0.000	0.766	0.766
D48	1.020	0.009	111.634	0.000	0.890	0.890
D50	0.956	0.009	108.202	0.000	0.834	0.834

Table 12. Results of the CFA: counseling

Item	Estimate	Std.Err	z-value	P(>|Z|)	Std.lv	Std.all
D43	1.000	-	-	-	0.959	0.959
D47	0.983	0.009	106.692	0.000	0.943	0.943

Table 13. Results of the CFA: ICT management

Item	Estimate	Std.Err	z-value	P(>|Z|)	Std.lv	Std.all
D49	1.000	-	-	-	0.918	0.918
D37	0.894	0.009	102.704	0.000	0.820	0.820
D40	1.009	0.009	101.606	0.000	0.804	0.804

Table 14. Results of the CFA: emotional dimension

Item	Estimate	Std.Err	z-value	P(>|Z|)	Std.lv	Std.all
T51	1.000	-	-	-	0.829	0.829
T52	0.862	0.017	51.283	0.000	0.714	0.714
T53	1.050	0.019	55.929	0.000	0.870	0.870
T54	1.069	0.019	56.317	0.000	0.886	0.886
T55	1.056	0.019	56.054	0.000	0.875	0.875
T56	0.971	0.018	54.181	0.000	0.804	0.804
T57	1.069	0.019	56.320	0.000	0.886	0.886
T58	0.997	0.018	54.794	0.000	0.826	0.826
T59	0.973	0.018	54.224	0.000	0.806	0.806

Regarding incremental fit measures, GFI, CFI, TLI, and NFI indices present the χ^2 fit measure $\chi^2=1.09\times10^{-231}<0.05$. It is also concluded that, at a 5% significance level, there are significant differences between the observed data matrix and the estimated data matrix. This would indicate that the model is not appropriate; however, it is important to note that this test is sensitive to sample size, so the probability of rejecting the null hypothesis increases as the sample size grows. For this reason, it is necessary to complement this analysis with other measures that evaluate the quality of the model fit. The RMSEA was 0.03766, representing the amount of variability that cannot be explained by the factor model. This value, being below 0.05, suggests that the factor model is adequate. The structure and factor loadings of the model can be seen in the path diagram in Figure 5. The incremental fit measures are presented. The GFI was 0.99591, indicating that the factor model shows a better fit compared to a null model (where the variables are uncorrelated), based on the proportion of total variance explained. The CFI was 0.99556. This result indicates that, when comparing the χ^2 value between the proposed model and an independent model (without correlations among variables), the proposed model is appropriate. The TLI reached a value of 0.99556, also indicating that the proposed factor model is superior to the null model. This measure is especially useful as it is not sensitive to sample size. The NFI was 0.99574, which further supports the validity of the proposed model compared to the null model. Finally, the normed χ^2 fit measure was 2.5959. This value, being within the acceptable range of 2 to 3, confirms that the proposed factor model presents an adequate fit, as shown in Table 15. To consult the notebook used in this analysis, please access the following link: https://colab.research.google. com/drive/1c5JWwMj1KdYK2d3wJfiFDbeWm71cT6__?usp=sharing.

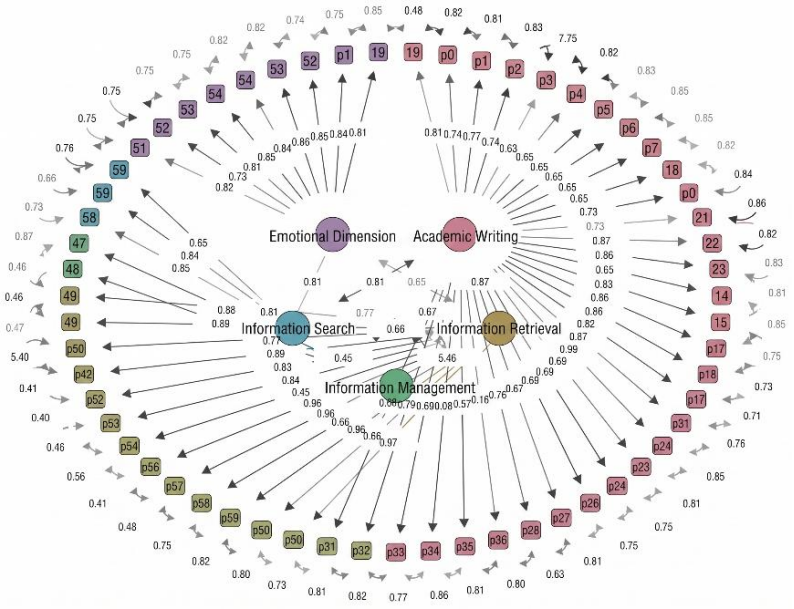


Figure 5. Path diagram of the CFA for information management dimensions

Table 15. Model fit indices

Fit index		Model results
Absolute fit indices	χ^2	1.09×10^{-231}
	RMSEA	0.03766
Incremental fit indices	GFI	0.99591
	CFI	0.99556
	TLI	0.99556
	NFI	0.99574
Parsimonious fit indices	Normed χ^2	2.5959

5.3. Instrument validity

The validity of the instrument was assessed through the analysis of convergent and discriminant validity. Regarding convergent validity, standardized factor loadings and the AVE were examined. As shown in Table 16, the AVE values exceeded the threshold of 0.50 for all factors, indicating that the indicators adequately represent their respective constructs. However, factor 5 presents an AVE value of 1.000, which is due to the fact that it is composed of a single item; therefore, this result should be interpreted with caution, as it does not constitute robust evidence of convergent validity. On the other hand, discriminant validity was evaluated using the Fornell Larcker criterion, comparing the square root of the AVE with the correlations between factors. As shown in Table 17, some correlations between constructs were high, particularly between factor 1 and factor 2 (r=0.872), as well as between factor 1 and factor 4 (r=0.832), exceeding the square root of the AVE values. These findings indicate that discriminant validity is not fully supported, suggesting a potential conceptual overlap between these dimensions.

Table 16. AVE for each factor

Factor	AVE
F1	0.686
F2	0.658
F3	0.664
F4	0.571
F5	1.000

Table 17. Correlation matrix between factors

Factor	F1	F2	F3	F4	F5
F1	1.000				
F2	0.872	1.000			
F3	-0.259	-0.240	1.000		
F4	0.832	0.741	-0.283	1.000	
F5	0.165	0.094	-0.150	0.330	1.000

6. DISCUSSION

The present study aimed to develop and validate a multidimensional instrument to assess academic writing in Peruvian university students. The results of the EFA confirm that academic writing is a multifaceted construct, structured into five clearly differentiated dimensions that jointly explain 70.73% of the variance. This structure is consistent with contemporary theoretical models that move beyond the reductionist view of writing as a mere linguistic product, instead understanding it as a complex process involving cognitive, metacognitive, social, affective, and technological dimensions [23]–[25].

6.1. The centrality of textual structure and coherence

Factor 1 (textual structure and coherence skills), which explains more than half of the variance (51.12%), emerges as the core dimension of the construct. This factor groups items related to logical organization, cohesion, expository clarity, and mastery of formal conventions such as APA standards and citation practices. Similar findings have been reported in both Spanish-speaking [26] and Anglo-Saxon academic contexts [27], where textual organization and discursive coherence remain major challenges for university students. The prominence of this dimension may reflect an instructional emphasis on final written products rather than on recursive processes such as planning, revision, and metacognitive monitoring [28].

6.2. The integration of metacognitive strategies, guidance, and ICT

Factor 2 integrates elements that the literature has traditionally treated separately: metacognitive strategies of planning and self-regulation, the active search for guidance, and the use of technological tools. This integration is particularly revealing, as it reflects how expert students simultaneously mobilize cognitive, social, and digital resources to solve writing problems [29]. The high weight of items such as "expressing doubts to the tutor" (D43) and "using teacher feedback" (D47) underscores the crucial role of dialogic feedback in learning to write, an aspect often neglected in massified university environments [25]. Likewise, the significant loading of technological items indicates that digital competence has become inseparable from academic writing in the digital era, not as an add-on, but as a constitutive part of the process [3]. This pattern may reflect that metacognitive regulation naturally leads students to seek external support and technological resources, indicating that these processes are functionally interdependent rather than independent.

6.3. The emotional dimension as a differentiated and critical factor

The emergence of factor 3 (emotional dimension) as an independent and robust component (α=0.942) empirically validates findings from numerous qualitative studies showing that academic writing is an affectively charged activity [30]. The identified emotional poles (confidence/insecurity, efficacy/inefficacy, and well-being/discomfort) are consistent with the constructs of writing anxiety and writing self-efficacy, which are widely associated with performance and the avoidance of academic tasks [31]. This separation indicates that emotional processes influence writing performance through mechanisms different from cognitive and metacognitive strategies. This result implies that pedagogical interventions that ignore the affective component will be incomplete. Writing programs that incorporate anxiety management workshops, reflective portfolios, or peer mentoring have been shown to be effective in improving both emotional states and the quality of written output [32].

6.4. Discursive adequacy and specialized search: specific dimensions

Factors 4 and 5, although they explain a smaller percentage of the variance, represent key dimensions of advanced and disciplinary writing. Factor 4 emphasizes the ability to adapt discourse to different genres and audiences, a fundamental skill for socialization within disciplinary communities [33]. Factor 5, focused on bibliographic searching in databases and in English, reflects the demands of contemporary scientific writing, where access to international literature is a sine qua non requirement. The relative independence of this factor may reflect that information literacy and foreign language proficiency constitute specific areas of difficulty requiring differentiated curricular attention. This independence also reinforces the idea that advanced academic writing skills require domain-specific competencies that develop separately from general writing abilities.

6.5. Pedagogical implications

The findings have direct implications for university teaching: explicit and systematic instruction of textual structure should be implemented through mandatory modules or workshops from the first semester, teaching not only formal conventions (APA) but also the rhetorical principles of organization and discursive coherence. In addition, the integration of metacognitive, social, and digital dimensions is essential, as courses should promote self-reflection on the writing process, encourage consultation among peers and with tutors, and incorporate the critical use of digital tools such as reference managers, grammar checkers, and intelligent translators. Attention to the affective dimension is also necessary, which involves creating low-stakes writing spaces, destigmatizing errors as part of the learning process, and developing mentoring programs that help build a positive writer identity. Finally, the development of advanced disciplinary competencies should be emphasized in later stages, focusing on the writing of specific genres (articles, technical reports, and research proposals) and on the search and management of specialized scientific literature. Likewise, the validated instrument may help universities identify specific weaknesses in academic writing and design targeted interventions integrating metacognitive support, teacher feedback, and digital literacy strategies. In addition, the findings may contribute to the development of institutional assessment policies aimed at progressively monitoring academic writing competencies in higher education.

6.6. Limitations and future directions

This study presents limitations that should be considered. Regarding the measurement model, discriminant validity was not fully supported, as high correlations were observed between certain factors, particularly between factors 1 and 2 (r=0.872), as well as between factors 1 and 4 (r=0.832). These findings may reflect a potential overlap between dimensions that were initially conceptualized as distinct. Additionally, factor 5, composed of a single item, presents methodological limitations, as it does not allow for a robust assessment of internal consistency or convergent validity. In this sense, future research should consider refining the factorial structure by exploring the potential merging of highly correlated factors and reconsidering the role of single-item dimensions. In addition, the study was based on self-reported responses and a cross-sectional design conducted within a single institutional context, using a convenience sample predominantly composed of students from the Faculty of Arts and Humanities of a single university. These aspects may limit the generalizability of the findings to other cultural, disciplinary, and educational settings, while the cross-sectional design prevents the examination of the temporal stability and evolution of academic writing competencies. Future research should replicate the analysis using probabilistic, multidisciplinary, and longitudinal samples, including participants from different institutions and fields of study. Finally, the instrument measures perceived skills; future studies could correlate these self-perceptions with objective evaluations of texts produced by students in order to establish the predictive validity of the questionnaire. Despite these limitations, the proposed instrument demonstrates promising psychometric properties and represents a valuable tool for diagnosing academic writing training needs in the Peruvian context.

7. CONCLUSION

This study developed and validated a multidimensional instrument for assessing academic writing competencies in Peruvian university students, providing empirical evidence for a five-factor structure composed of textual structure and coherence skills, metacognitive strategies and ICT use, emotional dimension, discursive adequacy, and specialized bibliographic search. The findings confirm that academic writing is a complex construct integrating cognitive, affective, social, and digital dimensions. From a theoretical perspective, the study contributes to the understanding of academic writing beyond purely linguistic approaches by supporting an integrative model that incorporates metacognitive regulation, emotional processes, and digital literacy within higher education contexts. In addition, the instrument demonstrated strong psychometric properties, supporting its usefulness for research and educational assessment. From a practical perspective, the validated instrument may assist universities in identifying specific weaknesses in students' writing competencies and designing targeted pedagogical interventions focused on academic literacy, metacognitive support, feedback practices, and digital literacy integration. The findings also highlight the importance of incorporating emotional and disciplinary dimensions into academic writing instruction and evaluation policies. Future research should confirm the proposed factorial structure through CFA using multidisciplinary and cross-cultural samples, particularly considering the high correlations observed between some factors and the methodological limitations associated with single-item dimensions. Future studies should also examine the relationship between self-perceived competencies and actual writing performance in authentic academic tasks.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

All participants provided informed consent prior to their participation in the study, and they agreed to the publication of anonymized data for research purposes.

ETHICAL APPROVAL

This study was conducted in accordance with applicable national regulations and institutional research guidelines. Participation was voluntary, and informed consent was obtained from all participants. The confidentiality and anonymity of the data were strictly ensured throughout the research process.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [DTCP], upon reasonable request.

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