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Determinants of Metacognitive Components of Writing in University Students

Determinantes de los componentes metacognitivos de la escritura en estudiantes universitarios

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Abstract

Academic writing in the university context requires specific cognitive and metacognitive processes. **Objective:** To analyze the determinants of two key metacognitive components in writing: planning and revision, in relation to the academic background and sociodemographic characteristics of health sciences students. **Methodology:** A total of 548 Colombian university students participated by completing two self-report questionnaires on metacognitive components of writing. Exploratory factor analyses were conducted to validate the instruments, followed by descriptive analyses to characterize the sample. Subsequently, analysis of variance (ANOVA) was applied to identify differences in the evaluated components based on sociodemographic variables. **Results:** The subcomponent of generation, related to planning, varied according to gender and age. Selection, another planning component, was associated with gender, with men scoring higher than women. Regarding revision, covert self-regulation was influenced by sociodemographic characteristics.

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Conclusions: The observed differences may be related to pedagogical practices, field of study, or individual factors. These findings should be considered when designing strategies to strengthen academic writing skills at the university level.

Keywords: metacognitive processes, educational and sociodemographic variables, academic writing, university students.

Resumen

La escritura académica en el contexto universitario requiere procesos cognitivos y metacognitivos específicos. **Objetivo**: analizar los determinantes de dos componentes metacognitivos clave en la escritura: la planificación y la revisión, en relación con antecedentes académicos y características sociodemográficas de estudiantes de ciencias de la salud. **Metodología**: participaron 548 estudiantes universitarios colombianos, quienes completaron dos cuestionarios de autorreporte sobre metacognición en la escritura. Se realizaron análisis factoriales exploratorios para validar los instrumentos y análisis descriptivos para caracterizar la muestra. Posteriormente, se aplicaron análisis de varianza (ANOVA) para identificar diferencias en los componentes evaluados según variables sociodemográficas. **Resultados**: el subproceso de generación, vinculado a la planificación, varió según género y edad. La selección, otro componente de planificación, se asoció al género, con puntajes más altos en hombres. En cuanto a la revisión, se encontró que la autorregulación encubierta estuvo influida por variables sociodemográficas. **Conclusiones**: las diferencias observadas podrían relacionarse con prácticas pedagógicas, el área de formación o factores individuales. Estos hallazgos deben considerarse en el diseño de estrategias para fortalecer la escritura académica en el ámbito universitario.

Palabras clave: procesos metacognitivos, variables educativas y sociodemográficas, escritura académica, estudiantes universitarios.

Introduction

Entering university entails significant personal and academic transitions. One of the most demanding challenges is the development of academic writing skills, which are essential for constructing knowledge, communicating ideas, and participating in disciplinary communities. However, many students continue to struggle with organizing ideas, integrating information, and adjusting their writing to communicative goals (De León, 2015; González and Vega, 2013; Ochoa and Aragón, 2004). These difficulties become more pronounced when writing and reading courses fail to align with disciplinary demands or to promote the transfer of strategies to other academic tasks (Henao et al., 2014; Gavidia-Anticona et al., 2024).

Although institutional reforms and initiatives; such as the REDLEES have been implemented to strengthen academic writing in Colombian higher education, progress remains limited. Writing difficulties are particularly persistent in fields such as the health sciences, where writing plays a critical role in clinical communication and patient safety (Lombardo et al., 2013). Understanding how writing skills develop requires not only examining the final texts but also analyzing the underlying cognitive and metacognitive processes.

Metacognition, understood as the awareness and regulation of one's cognitive processes (Flavell, 1979; Brown, 1987), is a central component of effective writing (Castelló et al., 2009; Zimmerman and Risemberg, 1997). Suárez and Cudmani (2009) distinguish metacognition, which involves reflection on the self, the task, and the learning process, from self-regulation, which entails planning, monitoring, and revising actions to overcome learning challenges. In writing, these dimensions interact to manage cognitive load, regulate rhetorical objectives, and control linguistic and emotional processes (Graham and Harris, 2000; Sun and Teng, 2022; Teng and Yue, 2022).

Writing demands the simultaneous coordination of multiple processes: planning, translating ideas into text, revising, and continuously monitoring progress (Lo Sardo et al., 2023). This recursive and multidimensional nature imposes high cognitive demands (Olive, 2021). Affective variables such as writing self-efficacy and anxiety also interact with metacognitive engagement, where self-regulatory strategies can mitigate anxiety and enhance performance and persistence (Han, 2024; Teng et al., 2024). Theoretical models such as those proposed by Flower and Hayes (1981) and Hayes (1996) identify three core processes in writing planning, transcription and revision, all mediated by metacognitive mechanisms.

During the planning stage, students must generate content, organize ideas, and set goals (Valencia and Caicedo, 2015). Transcription requires attention to syntax, cohesion, and coherence, while revision involves interpreting, reflecting on, and modifying the text (Alamargot and Chanquoy, 2001; Hayes, 1996). These operations are regulated by constant monitoring and strategic decision-making, particularly in demanding academic settings.

Despite its relevance, few studies have examined the determinants of metacognitive writing processes in university contexts. Some findings suggest that more advanced students demonstrate higher levels of self-regulation, possibly due to curricular demands to connect theory and practice (Hong et al., 2015). Academic success also varies across fields of study: students in health sciences, education, or design tend to show lower performance compared to their peers in computer science or engineering (Beekhoven et al., 2003; Jia and Maloney, 2015), possibly due to differing cognitive and self-regulatory demands.

Prior academic background also seems to influence university performance. Students from scientific high school tracks tend to perform better, perhaps because they developed relevant cognitive and metacognitive skills during secondary education (Morlaix and Suchaut, 2012; Zimmerman, 2002). However, few studies have explored how such prior trajectories influence writing processes at the university level.

Research has also documented differences according to gender and age. Female students often reach metacognitive maturity earlier and display stronger planning and effort regulation (Downing et al., 2013; Duckworth and Seligman, 2006; Mau and Lynn, 2001; Veenman et al., 2014). Although they may score lower in strategies such as elaboration or self-evaluation, they outperform men in goal setting and help-seeking behaviors (Kizilcec et al., 2017). Age is another relevant factor: older students tend to demonstrate more sophisticated metacognitive strategies and achieve better writing outcomes (Yilmaz, 2020; Zimmerman, 2002).

Based on previous research, a range of factors may act as determinants of students' metacognitive writing processes. These include three categories of variables: (1) individual variables, such as age, gender, self-efficacy, and writing-related anxiety; (2) educational variables, such as type of high school diploma, number of semesters completed, and disciplinary field; and (3) contextual or pedagogical variables, such as the design of writing instruction and the alignment between general writing courses and disciplinary tasks (Escorcia and Ros, 2019). Exploring how these factors interact can offer a more comprehensive understanding of the conditions that support or hinder the development of metacognitive writing skills in higher education.

In light of these considerations, the present study analyzes the cognitive and metacognitive processes involved in academic writing among university students, in relation to educational and sociodemographic factors. Specifically, we address the following research questions:

1. Do the cognitive and metacognitive processes used in writing differ according to educational background (type of high school, number of university semesters completed, and disciplinary field)?
2. Do such processes vary according to sociodemographic characteristics (age and gender)?

Method

Participants

The sample was 548 students enrolled at a Colombian university, and they were enrolled in health studies subjects (medicine, nursing, odontology, physiotherapy, bacteriology, speech therapy, optometry, photobiology, and nutrition science). Participants had a mean age of 17 years, and the majority were identifying as female (78%). Enrollment distribution by semester showed 48% of participants in their first, 32% in their second, 12% in third, and 8% in fourth semester. Multiple levels of study were chosen to explore differences and similarities between students who had just begun in higher education and those with some higher education experience. Table 1 presents the sample characteristics.

This study employed a non-probabilistic, purposive sampling strategy based on participant availability and institutional access during the academic semester. Although no a priori sample size calculation was conducted, we followed general recommendations for correlational studies with multivariate analyses, which suggest a minimum of 10 to 15 participants per variable (Hair et al., 2019). With a total of 548 students, the sample size exceeds this threshold, ensuring adequate statistical power for the analyses performed.

The participants were contacted directly in their classrooms and volunteered to complete the questionnaire after a brief explanation of the study's goals. The instrument was administered collectively during class time. Participation was anonymous and voluntary, and informed consent was obtained verbally before data collection. The study adhered to the ethical principles outlined in the Declaration of Helsinki, which states that "the well-being of the subject should take precedence over the interests of science and society" (World Medical Association, 2013, p. 2191). Additionally, the research followed institutional guidelines for conducting studies involving human participants to ensure confidentiality, voluntary participation, and informed consent.

Table 1
The characteristic of the sample

Disciplines	Semester					Sex	
	First	Second	Third	Forth	Total	W	M
Bacteriology	12	4	2	2	20	18	2
%	60	20	10	10	100	90	11
Infirmary	24	32	6	4	66	58	8
%	36	48	9	6	100	88	14
Medicine	106	70	32	22	230	178	52
%	46	30	14	10	100	77	29
Nutrition science	32	12	4	2	50	50	10
%	64	24	8	4	100	100	20
Odontology	36	10	8	4	58	36	22
%	62	17	14	7	100	62	61
Optometry	14	14	2	2	32	22	10
%	44	44	6	6	100	69	45
Physiotherapy	16	18	6	2	42	40	2
%	38	43	14	5	100	95	5
Speech therapy	26	14	4	6	50	30	20
%	52	28	8	12	100	60	67

Inclusion criteria were: (a) being an active undergraduate student in a health-related program, (b) being enrolled in one of the first four semesters, and (c) voluntarily agreeing to participate. Exclusion criteria included: (a) incomplete or inconsistent questionnaire responses, and (b) being a transfer student from another university or program.

Instruments and Procedure

The first step in constructing our methodology was developing and determining the reliability and validity of the instruments. Two self-reported questionnaires were adapted by the researchers from two existing instruments (Escorcia and Fenouillet, 2018; Escorcia and Gimenes, 2020). These instruments, validated in French, followed Zimmerman and Risemberg (1997) on self-regulation in writing and Raphael et al. (1989) on metacognitive knowledge of writing. The Metacognitive Components of Planning Writing Self-inventory (MCPW-I) (Escorcia and Fenouillet, 2018) measures processes related to selecting and organizing ideas, in particular metacognitive conditional knowledge, covert self-regulation, and environmental self-regulation. And the Questionnaire on Metacognitive components of revising (QCMR) measures rereading and rewriting aspects of writing through dimensions as metacognitive knowledge about the writing task, time management, monitoring strategies, metacognitive procedural knowledge, and help seeking. Both instruments are related to writing at university (writing syntheses, dissertations, or essays).

Inspired by these existing instruments, we adapted the French items by translating them into Spanish in order to assess the knowledge of students about their writing methods, taking into account the specificities of the task; other items probed knowledge of the criteria that define text quality as well as three categories of writing self-regulation strategies. The first category, environmental self-regulation with items identifying such actions as obtaining help from peers or experts. The second, covert self-regulation, with items assessing mental actions to manage idea generation, such as mental imagery, inner thought. The third and final, internal repetition of ideas; and behavioral self-regulation which concerns adjustments to behavior in the course of writing, such as in time management or the use of a quality checklist.

Table 2 presents the translation into English of the items contained in the adapted instruments for the present research.

Table 2
The self-report instruments: planning and revising writing

Planning writing	
N° of item	**Statement**
PLAN.1	I know how to select the main ideas that I will develop in the written text
PLAN.2	I know what are the advantages of my writing strategies depending on the kind of writing task that I have to achieve.
PLAN.3	I know how to find ideas to write
PLAN.4	Before writing, I know what are the formal characteristics of the text that I have to construct
PLAN.5	I know what are the writing strategies to employ depending on the kind of writing assignment
PLAN.6	I ask someone to read the plan of my text in order to make sure that it is clear
PLAN.7	I use a text plan that someone recommended to me
PLAN.8	I discuss with my peers in order to identify the ideas that I will write
PLAN.9	I repeat in my head the ideas to write when I am reflecting about the organization of my text
PLAN.10	I know how to adapt my writing strategies to the requirements of the writing task
PLAN.11	I know how to decide if it is necessary to change my writing strategies according to the task demands
PLAN.12	I ask questions to the proof-reader of my text for better knowing his/her expectations
PLAN.13	I connect my ideas with some key words that flow in my head before writing
PLAN.14	I make a checklist of all my ideas in my head before writing
PLAN.15	I let flow my knowledge about the topic before writing
PLAN.16	Before writing, I know clearly what are the sections that I will develop in my text
PLAN.17	I show my proofreader a draft of my text with a view to knowing his/her advice

Continuation table 2.

	Revising writing
REV.18	I know what are the characteristics of a good text
REV.19	I ask a colleague of pair for reading my text and knowing their point of view
REV.20	I plan the time that I will spent for writing
REV.21	I decide what are the main point to examine during I reread my text
REV.22	I elaborate a list of evaluation's criteria and I hierarchize these before to start writing
REV.23	I mark on my list of evaluation's criteria the aspects that I examine progressively
REV.24	I examine alone my text
REV.25	I know a method to correct simultaneously the content and formal aspects of may text
REV.26	I use systematically a list of evaluation's criteria when I finish my text.
REV.27	I know a particular method to evaluate my text
REV.28	I know how to evaluate the quality of my text
REV.29	I know in advance the criteria that my teachers will use to evaluate my text
REV.30	I imagine in my head the evaluation's criteria during all my written production
REV.31	I take into account other different evaluation's criteria than those of my teacher
REV.32	I examine kindly that my text respect all the evaluation's criteria that I know
REV.33	I ask an expert in orthography and grammar domain for helping to examine my text
REV.34	I ask someone to read all or a part my text when I am not sure of something
REV.35	I know in advance what criteria will be priority and less important when I examine my text
REV.36	I impose myself a delay to finish my text
REV.37	I try to manage the time that I have left when writing
REV.38	I read just my time planning during writing
REV.39	I prefer that nobody read my text before to submit this to my teacher
REV.40	I remember other texts that I have wrote before in order to elaborate a list of evaluation's criteria
REV.41	I use my personal list of criteria as I examine my text
REV.42	I know precisely what are my aims when I examine my text
REV.43	I know an efficient method to correct simultaneously the content and the formal aspects of my text
REV.44	I know in a general manner the evaluation's criterion of my teacher
REV.45	I know precisely if all criteria will have the same importance in determinining the quality of my text
REV.46	Before finishing, I verify how much of time do I have left
REV.47	I repeat in my head what aspect I have to take into account while I examine the quality of my text. I mentally repeat the aspects I must consider while evaluating the quality of my text.

The instruments were constructed to be completed in face-to-face environments. The individuals were required to indicate to what extent each statement reflected their methods of planning and revising in writing academic texts. The participants rated the

frequency of use for each strategy on a seven-point Likert scale (never, almost never, few times, occasionally, frequently, very frequently, always).

After the items were formulated, an exploratory analysis of each instrument was conducted, using SPSS 22. The aim of this phase was to determine the reliability and validity of the self-report questionnaires by examining the interactions between the items and then by identifying clusters of similar items that measure common dimensions or factors. No specific number of factors were anticipated during extraction. An oblique rotation method was used because we assumed a strong interrelationship among the dimensions measured. The internal consistency of the factors found were calculated using the Pearson coefficient. We used alpha calculation to determine whether the groups of items were unidimensional. Some items were removed from the analysis after they showed an ambiguous relationship with the dimensions to which they belonged.

Using the reduced version of the instruments, scores were calculated by adding the results for each factor. The exploratory factor analysis revealed good KMO coefficients for both the planning (.77) and revising (.94) instruments, showing good sampling adequacy, and Bartlett's test of sphericity gave significant results for both (p = 0.00), meaning that all variables were completely independent. The variances were 68% for planning and 63% for revising.

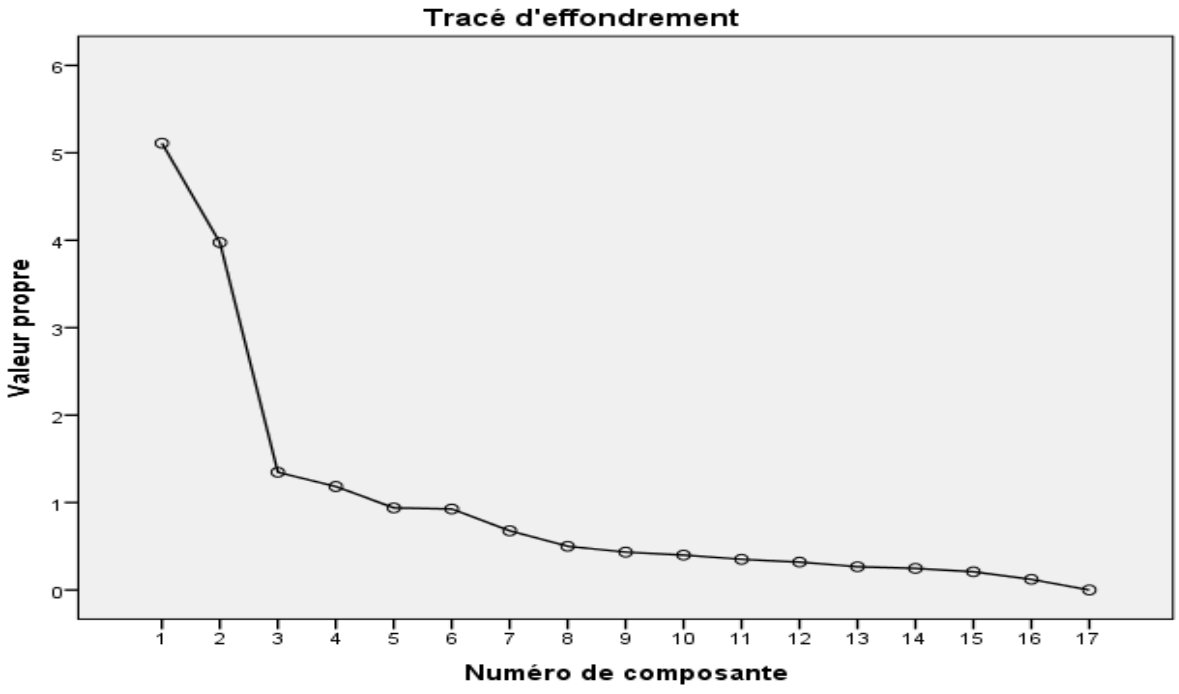

Figure 1
Scree plot from the AFE of planning scale

Table 3 gives the communalities for the planning items, which ranged from .57 to .89. The first solution consisted of four factors, but scrutiny of the scree plot (Figure 1) indicated that only a two-factor explanation was adequate because there were two data points before the break, without taking into consideration the point at which the break

occurs, Costello and Osborne (2005) suggest. Consequently, the planning scale was reduced to two factors, whose communalities corresponded to common magnitudes in the social sciences and were higher than .70. No item was cross-loaded on two or more factors. Five items were removed given the factorial structure found. The two factors ultimately used (that was the Factors 1 and 2 presented in the Table 3) represent knowledge and strategies participating in the self-regulation of two distinct processes of planning: generating and selecting ideas, which we termed self-regulated generation (plan.17, plan.16, plan.10, plan.15, plan.11, and plan.14) and self-regulated selection (plan.8, plan.9, plan.6, plan.1, plan.2, and plan.7). The alpha coefficients were .92 (self-regulated generation) and .85 (self-regulated selection), indicating good internal coherence for each dimension. Finally, the planning scale integrated 12 items.

Table 3
Pattern matrices of the planning scale – first factor solution

	Factors			
Items	**1**	**2**	**3**	**4**
PLAN.17	,894			
PLAN.16	,871			
PLAN.10	,865			
PLAN.15	,828			
PLAN.11	,818			
PLAN.14	,806			
PLAN.8		,839		
PLAN.9		,836		
PLAN.6		,828		
PLAN.1		,828		
PLAN.2		,821		
PLAN.7		,705		
PLAN.12*			,951	
PLAN.13*			,951	
PLAN.4*				,636
PLAN.5*				,603
PLAN.3*				,572
Eigenvalues	5,1	3,9	1,3	1,1
% var	30%	23,3%	7,9%	6,9%

Note. *Items removed after the exploratory factor analysis

Table 4 presents the communalities for the revising scale, which ranged from .35 to .87. Four factors were extracted from the first solution. Analysis of the communalities showed that three items had low interaction with their dimension, and they were cross-loaded with two factors. The scree plot (Figure 2) indicates that a three-factor-explanation seems adequate. Because of this, the structure of the revising scale was reduced to three factors, and some items were suppressed. The three factors used integrate knowledge and strategies for self-regulating in the processes that take place in revising. The first set of items was about the selection and utilization of evaluation criteria, based primarily on personal experience, which we termed personal approach to self-regulating revision (PASR) that integrates the items of the Factor 1 presented in the Table 4 (rev.37, rev.35, rev.44, rev.47; rev.46, rev.38, rev.33, rev.32, rev.42, rev.40, rev.36, rev.41, rev.45, and rev.31). Another set of items indicated a more social perspective during revision, incorporating items on seeking aid by inquiring of peers or teachers to improve a text: context-based approach to self-regulating revision (CASR), presented in the Table 4 (items from Factor 2: rev.22, rev.25, rev.23, rev.26, rev.20, rev.18, rev.21, and rev.24). Last, we found items related to knowledge of methods and tasks for revision, which we called conditional metacognitive knowledge (CMK) which contains the items from Factor 3, Table 4 (rev.25, rev.29, rev.30, and rev.27). The alpha coefficients were good (CASR = .85 and PASR = .90) and excellent (CMK = .95). Finally, 26 items composed the revising scale.

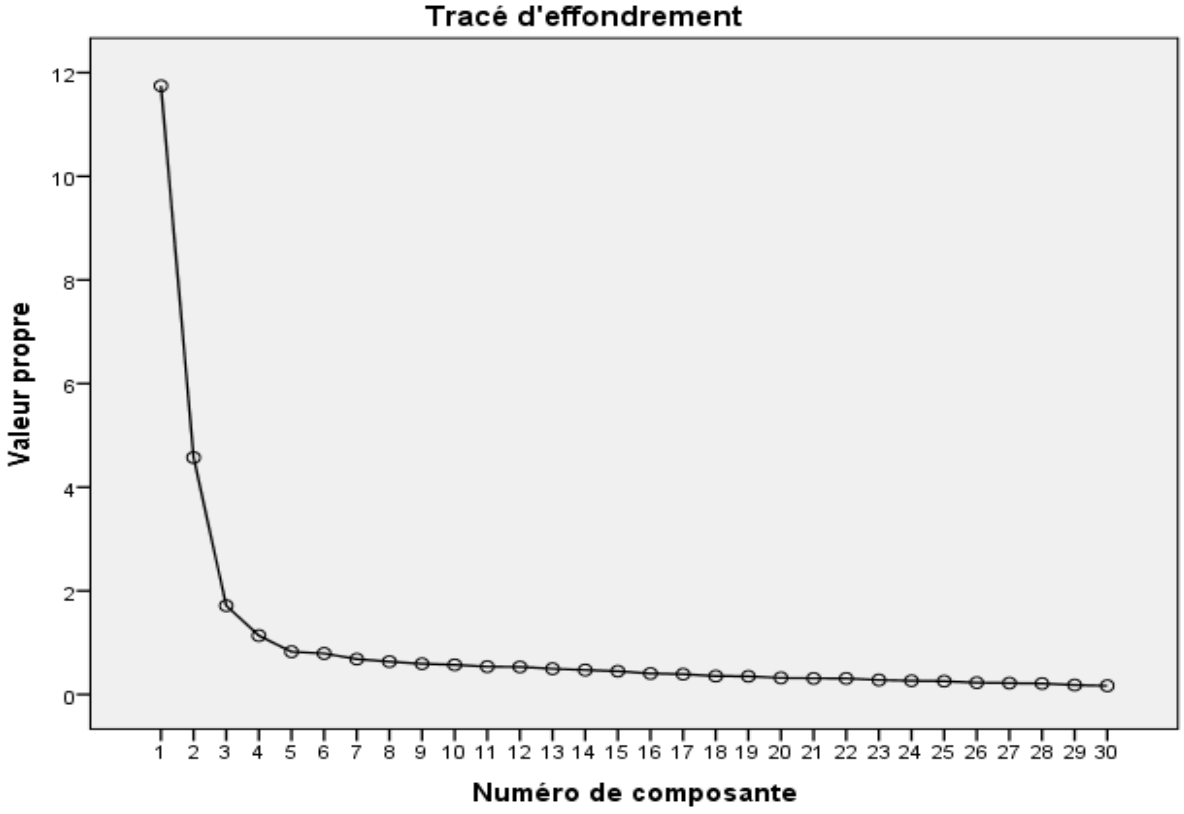

Figure 2
Scree plot from the AFE of revising scale

Table 4
Pattern matrices of the revising scale – first factor solution

	Factors			
Items	**1**	**2**	**3**	**4**
REV.34*	,879			-,390
REV.37	,845			
REV.35	,827			
REV.44	,802			
REV.47	,797			
REV.46	,786			
REV.38	,775			
REV.33	,773			
REV.32	,765			
REV.42	,764			
REV.40	,756			
REV.36	,741			
REV.41	,718			
REV.45	,711			
REV.31	,670			
REV.43*	,656			,342
REV.22		,843		
REV.25		,815		
REV.23		,796		
REV.26		,786		
REV.20		,753		
REV.18		,728		
REV.21		,705		
REV.19*		,665		-,350
REV.24		,623		
REV.28			,845	
REV.29			,837	
REV.30			,830	
REV.27			,795	
REV.39*				,733
Eigenvalues	11,7	4,5	1,7	1,1
% var	39,1%	15,2%	5,7%	3,7%

Note. *Items removed after the exploratory factor analysis.

The descriptive statistics for each item in the planning and revising scales (Tables 5 and 6) showed a normal distribution for the data in terms of skewness and kurtosis. We followed the recommendations of George and Mallery (2010) and took skewness and kurtosis values between -2 and +2 as acceptable.

Table 5
Descriptive statistics for the 12- items planning scale

	Mean	SD	Skewness	Kurtosis
Self-regulate generating (SG)				
PLAN.17	5,09	1,572	-,849	,225
PLAN.16	5,02	1,525	-,739	,029
PLAN.10	4,81	1,538	-,666	,126
PLAN.15	4,94	1,614	-,767	-,061
PLAN.11	4,90	1,568	-,652	-,065
PLAN.14	4,77	1,660	-,575	-,264
Self-regulate selecting (SS)				
PLAN.8	4,75	1,718	-,556	-,447
PLAN.9	4,97	1,713	-,785	-,134
PLAN.6	4,57	1,779	-,556	-,639
PLAN.1	4,96	1,641	-,852	,183
PLAN.2	4,78	1,579	-,692	-,018
PLAN.7	4,22	1,698	-,295	-,738

Table 6
Descriptive statistics for the 27- items planning scale

	Mean	SD	Skewness	Kurtosis
Personal approach to self-regulating revision (PASR)				
REV.34	4,89	1,715	-,793	-,217
REV.37	4,92	1,674	-,846	,038
REV.35	5,04	1,608	-1,027	,486
REV.44	4,98	1,617	-,911	,233
REV.47	5,03	1,783	-,807	-,232
REV.46	4,90	1,716	-,767	-,215
REV.38	5,02	1,614	-,857	,260
REV.33	4,88	1,767	-,851	-,127
REV.32	4,99	1,697	-,839	-,097
REV.42	5,07	1,605	-,984	,497
REV.40	4,88	1,670	-,809	-,130
REV.36	4,82	1,667	-,850	-,054
REV.41	4,69	1,708	-,659	-,437
REV.45	4,89	1,678	-,780	-,168
REV.31	4,80	1,652	-,821	-,091

Continuation table 6.

Context-based approach to self-regulating revision (CASR)				
REV.22	4,45	1,732	-,558	-,703
REV.25	5,01	1,655	-,883	,011
REV.23	4,63	1,655	-,583	-,459
REV.26	4,56	1,832	-,373	-,962
REV.20	4,87	1,646	-,780	-,223
REV.18	5,15	1,637	-,894	,064
REV.21	4,93	1,644	-,989	,302
REV.24	4,79	1,675	-,703	-,253
Conditional metacognitive knowledge (CMK)				
REV.28	4,76	1,583	-,761	-,021
REV.29	4,98	1,609	-,890	,278
REV.30	5,00	1,543	-,864	,251
REV.27	4,53	1,643	-,584	-,447

Results

After having determined reliability and validity for our instruments, we analyzed the data in two phases. First, we deployed descriptive statistics to a) identify socio-demographic and education characteristics and b) observe the differences in each metacognitive dimension in relation to those characteristics. Second, we ran an analysis of variance (ANOVA) to detect the variables that determined the differences among the students relative to the metacognitive components of planning and revising writing.

Table 7 shows the general descriptive statistics for respondents' self-reported metacognition. It should be noted that the mean CASR score was higher than the all-components scores and the PASR score was the lowest. However, CASR component integrated the most quantity of items. Consequently, the scores obtained relative to this component were the highest.

Table 7
General descriptive statistics for respondents' self-reported metacognition

Metacognitive components	***M***	***SD***	**Range**
Self-regulate selecting (SS)	28,24	8.2	6-42
Self-regulate generating (SG)	29,53	8.1	6-42
Context-based approach to self-regulating revision (CASR)	50,87	28.4	0-105
Conditional metacognitive knowledge (CMK)	27,02	13.8	0-56
Personal approach to self-regulating revision (PASR)	12,74	8.1	0-28

Table 8 presents the mean metacognition scores for the education variables and sociodemographic factors. We found that women's self-reported scores were higher than the men's for ESR, CMK, and PASR, but the men self-reported the highest scores for self-regulated generation and self-regulated selection. A paired-sample t test revealed that this difference was significant for two specifics variables: self-regulated generating t (-1, 48) = 4.29, p = 0.03 and CASR t (-.289) = 7.31, p = 0.00.

Table 8
Mean metacognition scores for the education variables and sociodemographic factors

	SG		SS		CARS		CMK		PASR	
	M	SD	M	M	M	SD	SD	SD	M	SD
Sex										
Male	30.28	6.94	29.38	8.47	51.52	31.16	12.01	8.34	26.19	13.83
Female	29.25	8.44	27.90	8.10	50.68	27.66	12.95	8.11	27.27	13.94
High school diploma track										
Commercial	30.34	7.01	28.23	7.76	47.37	27.30	12.55	8.21	28.34	13.62
Technical	30.87	7.80	30.55	6.01	45.45	25.17	12.81	7.25	27.45	13.98
General	29.30	8.33	28.08	8.40	51.83	28.54	12.76	8.24	26.77	13.54
Area of study										
Bacteriology	30.80	9.46	28.00	11.10	57.65	30.23	13.80	8.48	27.60	15.72
Infirmary	29.77	8.30	28.33	8.33	50.79	26.96	13.86	7.58	27.12	11.14
Medicine	30.23	7.88	27.84	8.76	50.14	27.43	13.40	8.18	27.21	13.46
Nutrition science	27.72	9.40	27.30	7.24	52.30	27.76	12.32	7.90	30.48	13.71
Odontology	28.90	6.37	28.00	8.05	54.45	28.18	11.60	8.13	23.21	14.02
Optometry	28.38	8.05	29.81	8.42	45.75	29.98	13.72	8.08	29.06	15.22
Physiotherapy	29.52	8.89	28.38	7.05	48.64	30.96	11.10	8.56	26.95	14.66
Speech language	28.80	8.49	30.12	5.17	51.22	33.00	10.26	8.08	25.46	15.31
Level of study										
Semester 1	29.11	8.04	27.91	8.13	48.51	28.14	12.92	8.34	26.35	14.20
Semester 2	30.06	8.28	28.76	8.20	53.77	28.62	12.55	7.94	27.77	13.18
Semester 4	34.00	2.82	19.50	19.02	88.50	6.36	5.00	4.24	45.00	8.48

Students who followed a technical track scored the highest in the dimensions of self-regulated generation, self-regulated selection, CMK, and PASR, and the students with a general diploma had the lowest self-reported scores for self-regulated generation, self-regulated selection, and PASR. However, these differences were not significant.

The students enrolled in Bacteriology had the highest scores for self-regulated generation, CMK, and CASR; optometry students had the highest selection scores, and

students in nutritional science had the highest PASR scores. However, nutritional science students had the lowest scores for self-regulated generation and self-regulated selection, optometry students had the lowest CASR, physiotherapy students had the lowest CMK, and odontology students had the lowest PASR. One-way ANOVA, conducted to compare areas of study for the metacognitive dimensions, found no significant differences.

Finally, we considered the term of study (semester) in relation to the metacognitive variables. We noted that the students in the fourth semester self-reported the highest scores for self-regulated generation, CASR, and PASR, but it was students in their second semester who obtained the highest scores for self-regulated selection and CASR. For all variables, first-semester students had the lowest scores. One-way ANOVA indicated that this difference was significant only for ES, $F(2, 547) = 4.06$, $p = 0.01$.

Analysis of variance

We performed four univariate ANOVAs for the entire sample (N = 548), with the metacognitive dimensions as the dependent variable and the education and sociodemographic factors as independent variables.

For self-regulated generation, this analysis showed a main effect for age, $F(33, 547) = 2.18$, $p = 0.00$, with the oldest students obtaining the highest values. Another main effect appeared relative to gender, $F(33, 547) = 1.75$, $p = 0.07$.

For self-regulated selection, the analysis indicated several significant results. First, a main effect was found for age, $F(34, 547) = 2.52$, $p = 0.00$. Study discipline also had a significant effect, $F(34, 547) = 1.59$, $p = 0.01$ where speech and optometry students had the highest scores, and nutrition science students had the lowest scores for selection. Another main effect was found for gender, $F(34, 547) = 1.78$, $p = 0.05$, with males having the highest self-reported scores. Likewise, the semester had a main effect, $F(34, 547) = 1.45$, $p = 0.04$, with students in their second semester providing the highest scores.

No effects for the education and sociodemographic variables were found for CASR or CMK. By contrast, we noted several main effects relative to PASR. Age and gender had significant effects: for age, $F(2\ 547) = 1.90$, $p = 0.00$, such that the oldest students had higher scores for PASR, and female students' PASR scores were higher than males' ($F(52, 547) = 1.64$, $p = 0.01$). Educational variables also showed main effects. Semester was significant, $F(52, 547) = 1.52$, $p = 0.01$, with first semester students with the highest PASR score; likewise, discipline was significant as well, $F(52, 547) = 3.01$, $p = 0.00$.

Discussion and conclusions

This study profiled two metacognitive components of academic writing; planning (idea generation and selection) and revision (covert self-regulation), among 548 Colombian health sciences students. It found significant differences based on gender, age, academic discipline, and semester, contributing novel insights into how these factors influence metacognitive writing strategies in a Latin American context.

First, gender and age differences in idea generation echo findings by Ávila-Reyes et al. (2020), who documented how diverse student trajectories affect metacognitive

awareness in university writing in Chilean universities. These age-related trends also mirror those reported by Ávila-Reyes and Navarro (2021), who observed that younger and less experienced writers struggle with systematic planning strategies, particularly in newly expanded higher education systems. In Colombia, this suggests that socio-educational gaps stemming from secondary-to-tertiary transitions, as noted by the Ministry of National Education (MEN, 2022), may hinder early development of planning skills.

Secondly, lower selection scores among nutrition students align with evidence showing that disciplines with less writing-intensive curricula offer fewer opportunities for strategic idea organization (Escorcia and Moreno, 2019; Ramos-Huacho et al., 2025). This is particularly relevant in Colombian health programs, where curricular emphasis varies significantly between clinical and complementary disciplines.

In terms of revision, our findings that older students and women employ more quality criteria during review align with patterns of higher reflective awareness and self-regulation among female university students documented in Iran and other contexts using metacognitive interventions in writing instruction (Khosravi et al., 2023). Pozzo and Rosso's (2023) analysis of writing practices in Colombian Communication Studies further supports this by showing how curriculum-integrated writing promotes reflective engagement with text quality. The intervention program they analyzed embedded writing processes: planning, drafting, and revision within disciplinary courses, providing students with structured opportunities to engage in metacognitive regulation through feedback and iterative refinement of their texts.

The association of fourth-semester status with more developed revision strategies emphasizes the cumulative benefit of repeated writing experiences across the curriculum. Yet, as Ávila-Reyes et al. (2021) argue, absent a deliberate, progressive writing pedagogy, gains may plateau, highlighting the need for structured literacy development practices at the institutional level.

Finally, while this study benefits from a large, diverse sample, it relies on self-report instruments and a convenience sample, which could introduce bias. The sample was also not homogeneous in terms of gender balance or representation across academic programs, potentially affecting comparisons between subgroups. Future research should incorporate stratified-random sampling and psychometric validation methods, such as confirmatory factor analysis and concurrent validity assessments, to enhance generalizability and instrument robustness (Teng et al., 2021).

In conclusion, this research demonstrates that metacognitive writing strategies in planning and revision vary significantly across gender, age, discipline, and academic progress among Colombian health sciences students. These findings underscore the importance of designing contextually aware, discipline-sensitive, and inclusive writing instruction models that acknowledge the heterogeneous experiences students bring to university.

Educationally, the evidence supports embedding explicit and progressive writing instruction within the curriculum from the first semester onward. Studies such as Teng et al. (2021) and Khosravi et al. (2023) advocate for structured, strategy-based interventions

like writing workshops, reflective practices, and flipped-classroom formats that have empirically improved both metacognition and writing outcomes. In Colombia, programs like that analyzed by Pozzo and Rosso (2023) serve as models for integrating writing instruction directly into disciplinary courses.

Teacher training is also critical: educators need sustained support to implement metacognitive pedagogy effectively (Karlen et al., 2023), particularly in virtual and hybrid learning environments. Such initiatives are aligned with national educational priorities (MEN, 2022) and regional research (Ávila-Reyes et al., 2020), which emphasize the need to transform writing instruction in Latin American universities. In a recent study, Trigos-Carrillo (2024) explores the academic literacy practices of first-generation university students in Mexico, Colombia, and Costa Rica. These students whose parents did not attend university often face institutional barriers and develop their own reading and writing strategies outside the classroom as a form of resistance to exclusion. These findings highlight that academic literacy is not merely a cognitive skill, but a socially situated practice shaped by power relations, capable of enabling greater inclusion and transformation within higher education.

In this context, academic writing should be promoted as a transversal and cognitively scaffolded practice throughout university education. To achieve this, institutions must:

1. Implement explicit writing strategy instruction from the earliest stages of university life,
2. Adapt interventions to the specific demands of each disciplinary field,
3. Provide faculty development in metacognitive writing pedagogy, and
4. Embed writing practices across the entire curriculum, rather than confining them to isolated courses.

    - These combined efforts are essential to creating more equitable and context-sensitive pedagogical environments. Recognizing and supporting students' authentic literacy practices, both within and beyond the classroom whichwill strengthen academic literacy, foster student motivation (Teng and Yang, 2022) and contribute to reducing educational inequalities in higher education.

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