Metacognitive skills of undergraduate university students: study based on three colombian institutions

Habilidades metacognitivas de estudiantes universitarios de pregrado: estudio en tres instituciones colombianas

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Abstract

Objective: The objective of this study was to determine the level of development of metacognitive skills of undergraduate students in Colombia and to establish whether there are differences by institution of origin, or by gender or by semester.

Method: A quantitative study and a non-probabilistic sampling was conducted. A total of 1.199 students from three universities participated, one public and distance modality; and the other two private and face-to-face modality. The Metacognitive Awareness Inventory (MAI) was used to determine metacognitive skills.

Results: At a general level, Colombian university students present a high level of development of their metacognitive skills with an average of 3,86 on a 5-point scale. When analyzing the abilities of the students according to the university of origin, the Kruskal-Wallis test shows that there are significant differences (p<0,05) in favor of the students in the distance modality. The Mann-Whitney U test allowed us to conclude that there are no significant differences by gender, although women have higher means (M = 3,88) than men (M = 3,83). It was possible to establish through the Spearman correlation that there are significant and negative differences in the level of metacognitive skills according to the semester of the students, as their skills decrease as they progress.

Conclusions: Although students have a good level of development of their metacognitive skills it is required to strengthen especially evaluation processes. Students trained in virtual distance learning methodology showed a higher degree of development of metacognitive skills than those in face-to-face mode, which could be explained by a greater development of self-regulation as an indicator of maturity for learning.

Keywords: metacognitive skills, higher education, cognition, MAI, gender, evaluation.

Resumen

Objetivo: El objetivo de este estudio fue determinar el nivel de desarrollo de las habilidades metacognitivas de estudiantes de pregrado en Colombia y establecer si existen diferencias por institución de procedencia, o por género o por semestre.

Método: Se realizó un estudio cuantitativo y un muestreo no probabilístico. Participaron 1199 estudiantes de tres universidades, una de carácter público y modalidad distancia; y las otras dos privadas y modalidad presencial. Se utilizó el Metacognitive Awareness Inventory (MAI) para determinar las habilidades metacognitivas.

Resultados: A nivel general los estudiantes universitarios colombianos presentan un alto nivel de desarrollo de sus habilidades metacognitivas con una media de 3,86 en una escala de 5 puntos. Al analizar las habilidades de los estudiantes según la universidad de procedencia, la prueba de Kruskal-Wallis muestra que existen diferencias significativas (p<0,05) a favor de los alumnos en la modalidad a

distancia. La prueba U de Mann-Whitney permitió concluir que no hay diferencias significativas por género, aunque las mujeres tienen medias más altas (M = 3,88) que los hombres (M=3,83). Se pudo establecer a través de la correlación de Spearman que existen diferencias significativas y negativas en el nivel de habilidades metacognitivas según el semestre de los estudiantes, a medida que avanzan sus habilidades disminuyen.

Conclusiones: Aunque los estudiantes tienen un buen nivel de desarrollo de sus habilidades metacognitivas se requiere fortalecer especialmente procesos de evaluación. Los estudiantes que se forman en metodología a distancia virtual mostraron un mayor grado de desarrollo de las habilidades metacognitivas que los de modalidad presencial, lo que podría explicarse por un mayor desarrollo de la autonomía como indicador de madurez para el aprendizaje.

Palabras clave: habilidades metacognitivas, educación superior, cognición, MAI, género, evaluación

1. INTRODUCTION

Metacognition is a widely studied construct and different studies show its importance for success in learning (Flores and Pacheco, 2020; Harris and Graham 2017; Tobias and Everson, 2009; Embleton, 2023) and for the development of critical thinking (Bernal *et al.*, 2019; Lozano and Lozano, 2016; Suárez and González, 2021; Aguilar-Perez, *et al.*, 2022; Pérez, *et al.*, 2023). More recently, some research also shows its relationship with self-control conflicts and how to learn to resolve them successfully (Bürgler *et al.*, 2022), and with the use of social networks and disorders related to internet gaming (Cavalcante-Pimentel, *et al.*, 2022; Akbari *et al.*, 2023).

The origin of metacognition dates to the 1970s, when Flavell (1971), based on his research on cognitive development inspired by the work of Jean Piaget, introduced the concept of metamemory. Later Flavell (1976) defines metacognition as the knowledge that people have about their cognitive process and the way it regulates their learning. In this definition, two aspects of metacognition are appreciated: knowledge of cognition referred to the awareness of one's own knowledge, metacognitive regulation, or self-regulation of learning (Flavell, 1979; Brown, 1983; Cerezo, *et al.*, 2019).

Flavell (1979) emphasizes that the metacognitive experiences on which he refers can be short or extensive, of a cognitive or affective nature, based on continuous observation and reflection as strategies to assess the processes in relation to the cognitive objects on which they are based, to become aware and establish new goals, so that theoretical understanding involves metacognitive knowledge, metacognitive experiences, strategies and goals or objectives, in the interweaving of the metacognitive regulation process.

Flavell (1985) emphasizes in his model about the interaction and collaboration between internal cognitive factors and the environment for the construction of knowledge. He also points out that in the cognitive encounter with the

world, assimilation and accommodation are present with equal importance, which allows us to appreciate the relevance given to previous learning or prior knowledge, and to learning environments, as activating and detonating environments of new learning.

On the other hand, metacognitive regulation refers to the ability of students to use information about their thinking to direct or regulate their learning, it implies the ability to think strategically and solve problems (Aizpurua *et al.*, 2018; Solaz y Sanjosé, 2008; De Jesús, 2020; Ricardo-Fuentes *et al.*, 2023), plan, set goals, organize ideas, and evaluate what to know and not to know. For Flavell (1992), a large part of cognitive development is self-motivated, so metacognition implies the ability to teach others and make the thought process visible.

Brown (1983) describes three ways in which we direct our own learning. First, planning approaches to tasks, which involves identifying the problem, choosing strategies, organizing our thoughts, and predicting outcomes. Second, exercise supervision of activities during learning, this implies testing, reviewing, and evaluating the effectiveness of our strategies. And finally, check the results, which requires evaluating the results based on specific criteria of efficiency and effectiveness.

For Nelson and Narens (1990), monitoring and control are the primary processes of metacognition; in monitoring, strategies for the development of a task are established, and through control, the necessary adjustments and modifications are made. In this way, metacognition allows students to ask themselves about how to develop a task, carry out strategies, self-evaluate and based on the results make the necessary adjustments (Wilson and Bai, 2010; Kleitman and Narciss, 2019; Escalante, *et al.*, 2023), that is, it implies high self-regulation processes. Cerezo, *et al.* (2019) suggest that students self-regulate their learning when they adequately interpret tasks and the contexts, which allows them to activate a path to solving, thus making appropriate decisions, and selecting the required strategies. For Boekaerts *et al.* (2000) metacognition has three fundamental aspects, firstly, the subject's awareness of his weaknesses and strengths in the learning process; secondly, the cognitive resources he has for the development of his academic activities and, finally, the regulation of his processes, which implies that he evaluates his performance with the aim of obtaining better performance in his tasks.

During the last decades, metacognition has been studied by various authors from psychology, pedagogy, and neurosciences, consolidating these under-

standings and catapulting the ideas previously exposed. Carretero (2001) refers to metacognition as "the knowledge that people build regarding their own cognitive functioning" (p.191), for Díaz and Hernández (2010) metacognition consists of "that knowledge we develop about our own processes and knowledge products "(p.187) and for Frade (2011) metacognition" is the thinking ability that consists in evaluating the knowledge that one has, what is known, but also what is thought, felt, and even the movement itself that is carried out or not, so as to reflect on what is missing to know, do or feel "(p. II).

Complementing, the theory of Schraw (2002) that postulates the existence of a general metacognitive capacity that allows individuals to know and regulate their own learning process, regardless of the domain. Cognitive skills are necessary to perform a task while metacognition is necessary to understand how the task was performed. Initially, he considered metacognitive knowledge to be a specific domain or task and regulatory skills as those that allow selecting appropriate learning strategies (Barrero, 2001). On the other hand, Winne and Azevedo (2014) define procedural knowledge as a set of skills that students have on how to perform cognitive work to perform tasks effectively.

Furthermore, Ugartetxea (2001); Carvallo (2001) and Efklides (2009) refer that metacognition involves affect, knowledge, emotions, feelings and, attitudes and motivation, which are factors that contribute to long-term self-regulation, the motivation induced by metacognitive experiences activates existing cognitive knowledge and metacognitive skills, the control of feelings of difficulty and confidence regulate the efforts in the accomplishment and challenges that come with troublesome tasks and situations. Specifically, for Efklides (2011) metacognition is divided into two interdependent domains, the first refers to metacognitive knowledge understood as the explicit verbalizable beliefs that a subject has about how his or her mind works and the second is metacognitive experiences, which refer to the feelings that a person experiences when learning, remembering and thinking about his or her own learning. For Arango-Muñoz metacognitive experiences are inherently subjective, that is, they occur regardless of whether they are accurate or not.

Metacognitive control is said to be the ability to evaluate and make one's own thought processes conscious. Metacognitive control is what enables individuals to regulate their thoughts and interact with their environment according to their desired goals. From a competency perspective, from the

socioformative approach, metacognition is conceived as the process by which human beings reflect to become aware of our development in the face of different life activities and to self-regulate said performance in order to avoid mistakes and seek to have more clarity in what we do, beyond the cognitive field (knowing how to know) as it has traditionally been approached, but also in the socio-affective field (knowing how to be / to live together) and in the acting field (knowing how to do). For Arguelles and Nagles (2010) "metacognition in the perspective of competence development deals with aspects such as learning potential, cognitive processes, variables of cognitive activity, understanding of mental activity and self-regulation processes" (p.118).

Based on the postulates around the subject of metacognition, researchers around the world have developed studies from various perspectives to broaden their understanding. To start the characterization of metacognitive skills at undergraduate level is widely carried out around the world with the purpose of guiding students with respect to the responsibility of assuming the learning process as their own (Bortone & Sandoval, 2014; García et al., 2015). This awareness of metacognition involves knowledge, control, and regulation of learning, that is, knowledge about one's own activity of knowing or higher-order capacity, which allows directing and regulating cognitive, affective and motivational processes to achieve a specific objective. Therefore, there are as many metacognition modalities as there are cognitive processes (Brown, 1987; Otero, 1990; Pintrich et al. 1991; Ifenthaler, 2012; Hernández y Camargo, 2017).

Several studies have explored the metacognitive skills of undergraduate students and the metacognitive strategies they use in different contexts and activities. Maturano et al. (2002) researched on the cognitive and metacognitive strategies used by undergraduate students to understand an expository text, they worked with a sample of 59 students from different degrees, and concluded that they can take more literal information easily, that they establish relations between different ideas, that their comprehension of the text is limited and their vocabulary is poor. The researchers point out that these results are not those expected for undergraduate students and, therefore, teachers are required to actively engage so that students develop cognitive and metacognitive strategies.

Ceniceros and Gutiérrez (2009) undertook a study on metacognitive skills with the involvement of 218 undergraduate and graduate students from a Mexican university. They used a structured questionnaire to analyze two dimensions of metacognition: self-knowledge (10 items) and self-regu-

lation (10 items) with a Likert scale between 1 and 5. In the first category, the average in each item was greater than 4, which reflects a systematic use of strategies related to the knowledge of their own cognition, students in general are aware of the cognitive processes they use to learn. In the second, the average of each item was close to 4, which shows that students are aware of their self-regulation process.

There are, in turn, studies on metacognitive monitoring in educational settings that are grouped into three models, the first one that is based on the use of Gamma Statistic, evaluating the precision of the judgments about correct performance, and the specificity that measures the precision of judgments about incorrect performance (Schraw *et al.*, 2013). The second, makes a judgment of two performance factors, referring to correct and incorrect and the general monitoring model, which refers to two incident processes in the error and precision process (Gutiérrez *et al.*, 2016; Schraw *et al.*, 2013; Schraw *et al.*, 2014).

On the other hand, Bortone and Sandoval in 2014 carried out a study with the objective of characterizing the metacognitive profile of first-semester students from different engineering programs. They used the Metacognition Inventory of Sandoval and Franchi (2007) with a Likert scale between 1 and 5. The results showed that new students had a metacognitive profile between Moderate and High, which the authors consider as an adequate metacognitive ability to manage and control the knowledge they own.

Arias *et al.* (2014) as part of their study with 273 freshman-year psychology students from three Peruvian universities used Kolb's Inventory of Metacognitive Strategies and found that a high percentage of students were located at low levels of metacognition, self-knowledge, self-regulation and evaluation. In this study, it is concluded that those students who have established goals and achievement motivation are the ones who have better performance and greater academic success, regardless of their learning style.

Campo *et al.* (2016) in their study with 462 university students from France and Colombia identified, through a self-report questionnaire, that students use their metacognitive knowledge in text production processes and that planning strategies are used most often by French students. Some of the metacognitive strategies used were: information organization, goal setting, planning, seeking help with tutors, and self-reward. The results of the study also found that there is a positive correlation between the level of performance and metacognitive knowledge, for which the authors conclude that

metacognitive knowledge is a requirement for controlling what is produced, and that self-regulation strategies contribute to the planning, editing and revision of texts.

Arias and Aparicio (2020) analyzed the metacognitive awareness of 96 first-cycle university students at the beginning and end of the semester to determine if the training received at the university contributed to their development. They used the Schraw and Dennison (1994) metacognitive skills inventory adapted for use in Peru. The results show, in general, that participants are at an average level with significant differences in metacognitive awareness, and dimensions of planning and self-regulation, but not in evaluation, and that there are no significant differences by gender or correlation with academic achievement. The researchers suggest that the favorable change observed is due to the fact that teachers have provided students with opportunities for the appropriate use of metacognitive planning and self-regulation strategies related to setting goals, identifying the resources to be used, and supervising and monitoring during the development of the activities.

In a recent study, Gutiérrez & Montoya (2021) examined the generality / specificity of metacognitive skills (knowledge of cognition: declarative, procedural, and conditional; regulation of cognition: planning, information management, debugging, monitoring and evaluation), with a sample of 507 university students from the education, medicine and psychology programs. It was hypothesized that the existence of statistically significant differences between the domains is an indicator of the specificity of metacognitive skills to a domain, if on the contrary, they are general, that is, they are not a function of the domain of the task of learning, there will be no significant differences. It was found that there are significant differences between the domains for all skills, except for procedural knowledge and debugging. The authors expected metacognitive awareness to be different among medical and educational students, and among medical and psychology students. However, there was no significant difference.

Studies on the correlations between the metacognitive abilities of university students with academic performance, gender, the nature of the institution (public or private) and semester are still incipient, they are at the descriptive and exploratory levels. As an example, Andriani & Mbato (2021) in a study on academic reading from a gender perspective with a mixed method with open and closed questionnaires and a semi-structured interview. Through a t-test, it was established that only the use of the strategy of guessing the meaning during the planning phase is significantly different. However, the students

used the reading strategies differently, with the men using the guessing strategy more during the monitoring phase, while the women taking regular breaks and using other strategies, the women activating their prior knowledge more often. The authors indicate that the only significantly different strategy use was guessing the meaning, used more frequently by men.

On the other hand, Gutiérrez de Blume, *et al*. (2022), sought to establish the differences in metacognitive knowledge: declarative, procedural, and conditional, and regulation: planning, monitoring, and evaluation with a sample of 771 Colombian teachers based on the variables of gender and type of professional performance based on a Manova analysis, finding significant differences between teachers based on level of training and gender.

Finally, Gutiérrez de Blume and Montoya (2023) explored the relationship between objective and subjective measures of metacognition with a sample of 352 Colombian students. Based on descriptive statistics, zero-order bivariate correlations, simultaneous multiple regression, and multivariate analysis of covariance, conscientiousness and openness were found to be the personality traits that positively predicted metacognition. Objective and subjective measures of metacognition are weakly related, and subjective measures of metacognition are more strongly related to personality traits. Gender affected subjective and objective measures of metacognition.

The above shows the importance of knowing the metacognitive abilities of university students because the identification of strengths and needs allows the development of new learning strategies that contribute to the strengthening of knowledge and regulation of cognition, and this may impact other areas. Additionally, it is important to recognize the effect of variables such as gender, age and semester and the incidence of institutional methodologies in the development of students' cognitive abilities during the first university semesters, to forge awareness about the learning process and the strategies that are useful individually, contributing to educational practice.

This research analyzes the metacognitive skills of university students from three Colombian universities and establishes whether there are significant differences according to the university of origin, gender, or semester of the participants. More specifically, the following questions were posed:

- Q1. What is the level of development of the metacognitive skills of Colombian university students?

- Q2. Are there significant differences in the level of development of metacognitive skills of Colombian university students according to the University of origin?

- Q3. Are there significant differences in the level of development of metacognitive skills of Colombian university students according to their gender?

- Q4. Are there significant differences in the level of development of metacognitive skills of Colombian university students according to the semester they are studying?

2. METHOD

2.1. Research Design

In this study, it is quantitative, descriptive and correlational, descriptive and inferential statistics are combined.

2.2. Participants

The convenience sampling technique was used to select the study partici-pants, who had to be pursuing the first four terms of their academic programs. Informed consent was requested in accordance with the guidelines of the Colombian Data Protection Law of 2012, for the application of the instrument in three Colombian universities. A total of 1204 students responded to the instrument, however, when analyzing the data, 5 outliers were detected and excluded. Of the 1199 participants 40,6 % were men and 59,4 % were women, as shown in Table 1.

Table 1.
Participants

INSTITUTION	MEN	WOMEN	TOTAL
National Open and Distance University- UNAD	143	248	391
Universidad Antonio Nariño University- Bogotá Campus- UAN	175	221	396
Universidad Autónoma de Bucaramanga University- UNAB	169	243	412
Total	487	712	1199

Note: Own elaboration.

In relation to age, it stands out that 55 % of the participants were under 21 years of age, followed by 19 % between 21 and 25 years of age; approximately 10 % between 26 and 30 years, and the rest distributed in the other three age ranges established as shown in Table 2.

Table 2.

Age of participants

INSTITUTION	LESS THAN 21	GREATER THAN OR EQUAL TO 21 AND LESS THAN 26	GREATER THAN OR EQUAL TO 26 AND LESS THAN 31	GREATER THAN OR EQUAL TO 31 AND LESS THAN 36	GREATER THAN OR EQUAL TO 36 AND LESS THAN 40	GREATER THAN OR EQUAL TO 40	TOTAL
National Open and Distance University - UNAD	74	83	79	59	46	50	391
Universidad Antonio Nariño University - Bogotá Campus - UAN	317	60	13	6	0	0	396
Universidad Autóno-ma de Bucaramanga University- UNAB	279	86	22	10	7	8	412
TOTAL	**670**	**229**	**114**	**75**	**53**	**58**	**1199**

Note: Own elaboration.

UNAD is a Public University, UAN and UNAB are Private Universities, UNAD participants belonged to distance learning programs and the other participants to face-to-face learning programs. The modality in Colombia, in accordance with decree 1330 of July 25, 2019 of the Ministry of National Education, is the means used integrating a set of organizational and / or curricular options that seek to respond to specific requirements of the level of training and attend to conceptual characteristics that facilitate access to students, in different conditions of time and space.

2.3. Instrument

The Metacognitive Awareness Inventory (MAI) designed by Schraw & Dennison in 1994 and validated by Huertas *et al*. (2014) and Gutiérrez *et al*. (2021) in Colombia, was applied. This instrument has 52 items in total distributed in two categories: Knowledge of Cognition and Regulation of Cognition. Knowledge of Cognition refers to knowledge that subjects have about their own knowledge and comprises three subcategories: Declarative Knowledge (8 items), Procedural Knowledge (4 items) and Conditional Knowledge (5 items). The Regulation of Cognition comprises activities that help the subject control learning and is made up of five sub-processes: Planning (7 items), Organization (10 items), Monitoring (7 items), Debugging (5 items), and Evaluation (6 items). Each item includes a five-point Likert-type scale whose score ranges from 1 (completely disagree) to 5 (completely agree). The overall internal consistency reliability was α = 0,94.

2.4. Procedure

The students were contacted directly, and their participation was voluntary. In one of the universities, the students answered the instrument on paper, then the data was entered. In the other two universities, the instrument was designed as a Google form and was sent to students by institutional mail. Students responded anonymously, only age, gender, and semester were collected. Students had to be pursuing the first half of their study programs, that is, be in semesters 1 to 4.

2.5. Data analysis

Data processing was done with SPSS v25. For the analysis and presentation of the data, descriptive and inferential techniques are combined. For the descriptive part, for each participant a global value was determined by averaging the 52 items of the instrument that allows knowing the metacognitive level in general, and a value for each of the two components and eight subcomponents averaging respectively the items that comprise them, this in turn allows knowing the level in each one of these. Taking into account that these averages are on a scale of 1 to 5, the interpretation of Figueroa *et al*. (2012) to describe the results obtained

- From 1 to 1,8 (included): is considered a very low level
- Greater than 1,8 and less than 2,6 (included): is considered Low level
- Greater than 2,6 and less than 3,4 (included): is considered Neither high nor low
- Greater than 3,4 and less than 4,2 (included): is considered High level
- Greater than 4,2: is considered Very high level

This description was combined with inferential techniques. Since the data were not normal, nonparametric tests were used. To determine significant differences in the level of development of metacognitive skills of the students according to the institution of origin, a Kruskal Wallis test was performed. To determine if there were significant differences in the level of development of metacognitive skills of Colombian university students, considering only gender, a T-test was carried out. And to determine significant differences in the level of development of metacognitive skills of Colombian university students, considering only the semester studied, a Pearson correlation was made, the participants were between 1 and 4 semesters.

3. RESULTS

Within the framework of the research questions that guided this study, the results are divided into three parts. First, a description is made of the metacognitive abilities from all students at a general level and in each of the

components and subcomponents evaluated through the MAI, question 1. In a second moment, it is analyzed if there are significant differences when considering the university of origin, question 2. And finally, it is analyzed if there are differences based on gender or semesters, questions 3 and 4.

3.1. General analysis

University students Colombians have a high level of metacognition with an average of 3,86 (SD = 0,46), with better knowledge of their cognition than of their regulation with general averages of 3,95 (SD = 0,48) and 3,81 (SD = 0,48) respectively, as observed in Figure 1.

When analyzing the subcomponents of metacognition, it is evident that the aspect that should be strengthened the most is the evaluation with an average of 3,52 (SD = 0,64), that is, university students must improve the analysis they make on the effectiveness that have the strategies they use, verify that what has been done allows them to meet the objective of the activity and has allowed them to learn as much as possible. In contrast, they are stronger in debugging, with an average of 4,08 (SD = 0,57), that is, students identify weaknesses in their learning process and adjust improve their performance, for example, they ask for help, reread, or change strategy when they do not understand or when they are confused.
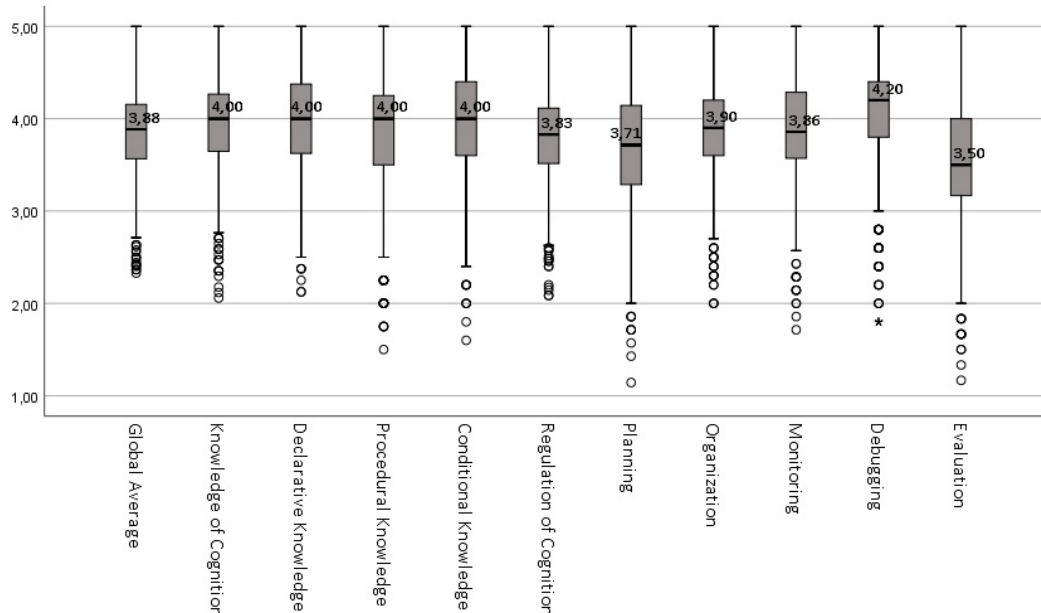

Figure 1. Average in Each Component and Subcomponent of Metacognition

Note: Own elaboration.

Most university students are at the High Level, only 21,4 % are at the Very High Level, at general level, 29 % in knowledge of cognition, and only 17,8 % in the regulation component of cognition. It should be noted that no student is at a very low level and only the 1,4 % is at a low level., as shown in Table 2.

Table 3.
Percentage of Students Placed in the Different Levels

FEATURE / LEVELS		VERY LOW	LOW	NEITHER HIGH NOR LOW	HIGH	VERY HIGH	TOTAL
Metacognition in general	# Students	0	13	163	766	257	1199
	Percentage	0	1,1	13,6	63,9	21,4	100,00
Knowledge of Cognition	# Students	0	14	124	713	348	1199
	Percentage	0	1,2	10,3	59,5	29	100,00
Regulation of Cognition	# Students	0	17	216	753	213	1199
	Percentage	0	1,4	18	62,8	17,8	100,00

Note: Own elaboration.

3.2. Analysis by Universities

When analyzing each institution, it is evident that in the three universities more than 70 % of students are located at a High or Very High Level both at a general level and in the two components of metacognition: knowledge and regulation of cognition, as shown in figure 2. It should be noted that at UNAD, more than 90 % of students are located at Higher Levels.
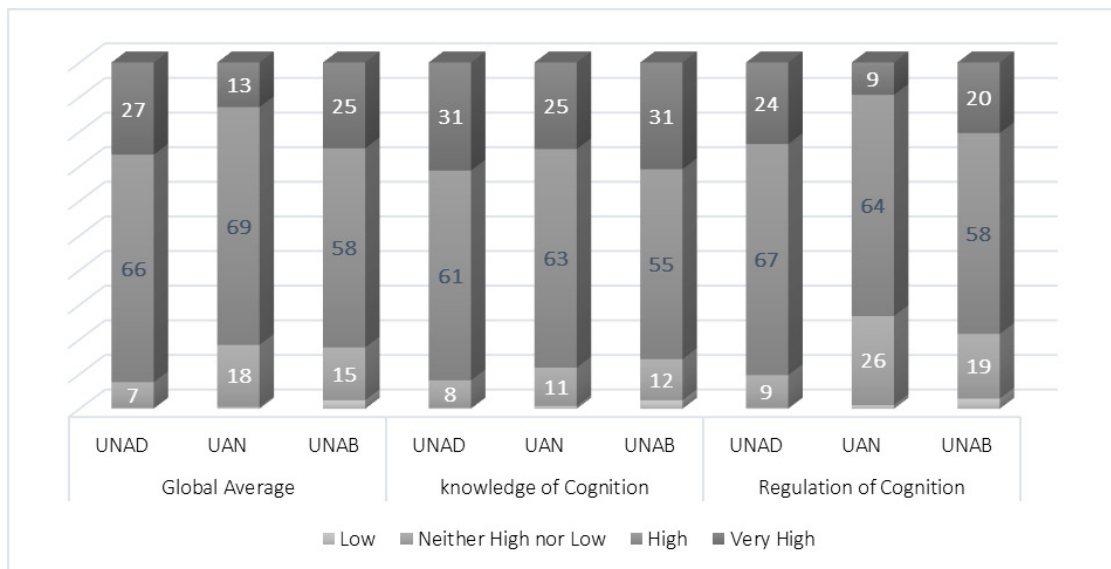

Figure 2. Percentage of Students in the Different Levels by University

Note: Own elaboration.

When doing a Kruskal Wallis analysis, it was possible to observe that there were significant differences in the level of metacognitive skills of the students according to the University of origin, as well as in each of the components and subcomponents, the p value was less than 0,05 in all cases. By doing a Post hoc analysis it was possible to establish that the differences are significant in favor of the results obtained by the students from UNAD, as shown in Table 3.

Table 4.

Prueba Post hoc (Games-Howell). Multiple comparisons

	(I) UNIVERSITY	(J) UNIVERSITY	DIFFERENCE OF AVERAGES (I-J)	DESV. ERROR	SIG.
Global Average	UNAD	UAN	0,21303*	0,02904	0,000
		UNAB	0,13630*	0,03313	0,000
	UAN	UNAD	-0,21303*	0,02904	0,000
		UNAB	-0,07673*	0,03233	0,047
	UNAB	UNAD	-0,13630*	0,03313	0,000
		UAN	0,07673*	0,03233	0,047
Knowledge of Cognition	UNAD	UAN	0,12902*	0,03176	0,000
		UNAB	0,07818	0,03528	0,069
	UAN	UNAD	-0,12902*	0,03176	0,000
		UNAB	-0,05084	0,03490	0,312
	UNAB	UNAD	-0,07818	0,03528	0,069
		UAN	0,05084	0,03490	0,312
Declarative Knowledge	UNAD	UAN	0,10510*	0,03410	0,006
		UNAB	0,03460	0,03613	0,604
	UAN	UNAD	-0,10510*	0,03410	0,006
		UNAB	-0,07050	0,03601	0,123
	UNAB	UNAD	-0,03460	0,03613	0,604
		UAN	0,07050	0,03601	0,123
Procedural Knowledge	UNAD	UAN	0,17674*	0,04244	0,000
		UNAB	0,09199	0,04559	0,109
	UAN	UNAD	-0,17674*	0,04244	0,000
		UNAB	-0,08475	0,04556	0,151
	UNAB	UNAD	-0,09199	0,04559	0,109
		UAN	0,08475	0,04556	0,151
Conditional Knowledge	UNAD	UAN	0,12912*	0,03709	0,002
		UNAB	0,13688*	0,04112	0,003
	UAN	UNAD	-0,12912*	0,03709	0,002
		UNAB	0,00776	0,04133	0,981
	UNAB	UNAD	-0,13688*	0,04112	0,003
		UAN	-0,00776	0,04133	0,981

Category					
Regulation of Cognition	UNAD	UAN	0,25468*	0,03019	0,000
		UNAB	0,14664*	0,03401	0,000
	UAN	UNAD	-0,25468*	0,03019	0,000
		UNAB	-0,10804*	0,03366	0,004
	UNAB	UNAD	-0,14664*	0,03401	0,000
		UAN	0,10804*	0,03366	0,004
Planning	UNAD	UAN	0,38121*	0,04138	0,000
		UNAB	0,25880*	0,04499	0,000
	UAN	UNAD	-0,38121*	0,04138	0,000
		UNAB	-0,12241*	0,04492	0,018
	UNAB	UNAD	-0,25880*	0,04499	0,000
		UAN	0,12241*	0,04492	0,018
Organization	UNAD	UAN	0,16396*	0,03320	0,000
		UNAB	0,06981	0,03535	0,119
	UAN	UNAD	-0,16396*	0,03320	0,000
		UNAB	-0,09415*	0,03642	0,027
	UNAB	UNAD	-0,06981	0,03535	0,119
		UAN	0,09415*	0,03642	0,027
Monitoring	UNAD	UAN	0,25644*	0,03511	0,000
		UNAB	0,13988*	0,03920	0,001
	UAN	UNAD	-0,25644*	0,03511	0,000
		UNAB	-0,11656*	0,03852	0,007
	UNAB	UNAD	-0,13988*	0,03920	0,001
		UAN	0,11656*	0,03852	0,007
Debugging	UNAD	UAN	0,19727*	0,03816	0,000
		UNAB	0,10305*	0,03875	0,022
	UAN	UNAD	-0,19727*	0,03816	0,000
		UNAB	-0,09422	0,04210	0,066
	UNAB	UNAD	-0,10305*	0,03875	0,022
		UAN	0,09422	0,04210	0,066
Evaluation	UNAD	UAN	0,30406*	0,04142	0,000
		UNAB	0,18804*	0,04473	0,000
	UAN	UNAD	-0,30406*	0,04142	0,000
		UNAB	-0,11602*	0,04596	0,032
	UNAB	UNAD	-0,18804*	0,04473	0,000
		UAN	0,11602*	0,04596	0,032

Note: Own elaboration.

UNAB students have higher metacognitive levels than UAN students both at a general level and in each one of the categories and subcategories; all these differences are significant. With respect to UNAB students, UNAD students also have higher metacognitive levels at a general level, in conditional knowledge, in the category regulation of cognition and all its subcate-

gories, except organization. There are also significant differences in favor of UNAB students, in the regulation of cognition and its planning, monitoring and evaluation subcategories, with respect to the results from UAN students.

The figure 3 shows that overall average of UNAD students is 0,21 higher than those from UAN, and 0,14 with respect to those from UNAB, these differences are significant. In the knowledge of cognition, although the average of UNAD students is 0,08 higher than those of UNAB, this difference is not significant, but it is compared to UAN students who are 0,13 below.
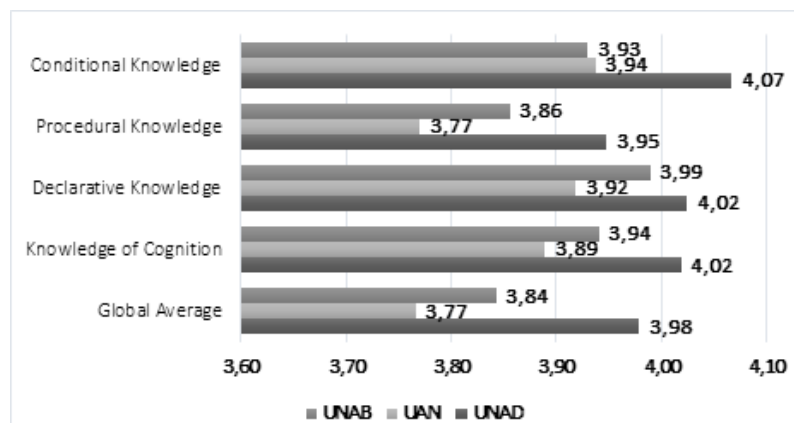

Figure 3. Average by University for Knowledge of cognition and its subcomponents

Note: Own elaboration.

It stands out that in the Conditional Knowledge subcomponent is where the greatest difference between UNAD and UAN and UNAB is, also in the only cognition subcomponent in which UAN students have a better average than UNAB students, with averages of 3,94 and 3,93 respectively, however this difference is not significant.

Regarding the Regulation of Cognition (figure 4), the students from UNAD have better averages than those from UAN and UNAB, both at the general level and in the subcomponents, and these differences are significant, except in organization, where the students from UNAD and UNAB have the same average. Students from the three universities have greater strength in Debugging, being Evaluation the one that should be strengthened the most.
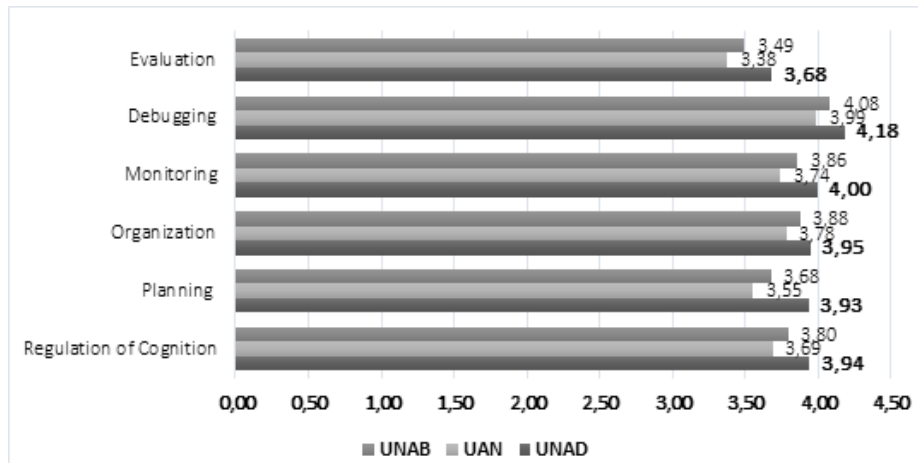
Figure 4. Average by university for regulation of cognition and its subcomponents

Note: Own elaboration.

3.3. Analysis by Gender and Semester

Women have better averages both at the general level and in each component and subcomponent (see Tables 4 and 5), however, when doing the U de Mann-Whitney test it was found that the differences are not significant (p> 0,05). It was also found that there are no differences by gender when considering the University.

Table 5.

Average Men and Women in Knowledge of Cognition and its Subcomponents

	GLOBAL AVERAGE	KNOWLEDGE COGNITION	DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	CONDITIONAL KNOWLEDGE
Men	3,83	3,94	3,97	3,86	3,95
Women	3,88	3,96	3,98	3,86	3,99

Note: Own elaboration.

Table 6.

Average Men and Women in the Regulation of Cognition and its subcomponents

	REGULATION OF COGNITION	PLANNING	STRATEGY	MONITORING	DEBUGGING	EVALUATION
Men	3,76	3,66	3,83	3,83	4,01	3,50
Women	3,84	3,76	3,89	3,89	4,13	3,53

Note: Own elaboration.

Using Spearman correlation coefficient, it was possible to establish that there are differences depending on the semester taken by the students (p< 0,05) in all categories and subcategories except procedural knowledge. And contrary to what would be expected, students have better metacognitive levels

when they start their studies and as they progress the average decreases as evidenced in Table 6.

Table 7.
Average for semester

Components /subcomponents	1	2	3	4	Components / subcomponents	1	2	3	4
	SEMESTER					SEMESTER			
Global Average	3,91	3,83	3,81	3,76	Regulation of Cognition	3,87	3,76	3,73	3,70
Knowledge of Cognition	3,97	3,96	3,93	3,86	Planning	3,80	3,65	3,65	3,55
Declarative Knowledge	3,99	3,98	3,99	3,91	Organization	3,90	3,87	3,77	3,79
Procedural Knowledge	3,90	3,84	3,85	3,73	Monitoring	3,93	3,82	3,80	3,73
Conditional Knowledge	4,00	4,01	3,90	3,88	Debugging	4,14	4,02	4,03	4,00

Note: Own elaboration.

4. DISCUSSION

This study aimed to describe the metacognitive skills in its components Knowledge of Cognition and Regulation of Cognition, and its subcomponents in a group of university students and to establish differences in relation to the university of origin, gender and term of the participants. It was determined that 63,6 % of students are at a High Level and 21,3 % are a Very High Level, that is, more than 80 % of young university students have a good level in the development of their metacognitive skills. These findings are similar to those reported by Arias and Aparicio (2020), where 75 % of students were placed at an Average Level, which would be equivalent to a High Level in this study, and 11,5 % at a very High Level, since those reported by Bortone and Sandoval (2014) and by Ceniceros and Gutierrez (2009) with averages close to 4 in both categories, which shows that students have a reflective and systematic process towards learning processes and the evaluation of results.

The results show that there were differences depending on the Participants' University of origin, the students from UNAD, a university that carries out all its learning programs based on Distance Modality, have better metacognitive skills, with significant differences in most of the subcomponents with respect to the other two universities. It is possible that this is explained because the distance modality requires autonomy as a capacity to respond independently to the responsibilities acquired in an educational process, additionally, it is an indicator of maturity for learning associated with the discipline to fulfill

the acquired commitments or to manage techniques, tasks and time. The construction of knowledge is generated independently, of a place, a time or a teacher (Peters, 2003; Preti, 2005; Moore and Kearsley, 2007; Gottardi, 2015).

Furthermore, although in this study an analysis of metacognitive skills by domain was not made, that is, in the three institutions the participants were from different academic programs but there is no information in this study by training area, the positive outcomes for students in distance modality could support the hypothesis of some researchers those metacognitive cognitive skills, especially in adulthood, are of general domain (Gutierrez et al., 2016; Schraw et al., 2013) and that other factors can explain it.

It was also found that there is difference by semester, which not grees with the study carried out by Cantillo et al. (2014) nor with the research of Hermosilla and Ossa (2022). These results also differ from the results presented by Martínez-Fernández (2007) which found that students who are finishing their degree have a greater use of metacognitive strategies with respect to students who are at the beginning or in the middle of their programs. The results in this study, at a general level, show that Colombian university students decrease their metacognitive levels as they progress in their programs, both at the level of cognition knowledge and its regulation.

Regarding gender, although women have higher averages, the differences are not statistically significant, which implies, as pointed out by Cantillo et al. (2014) that it is important to analyze other aspects that are decisive for the development or not of metacognitive skills. In contrast to the results reported by Gutiérrez de Blume et al. (2022), where it was found that women reported significantly higher regulation skills (monitoring and evaluation) compared to men. In subsequent studies, Gutiérrez de Blume et al. (2023) found, exploring the relationship between objective and subjective measures of metacognition with a sample of 352 Colombian students, that men obtain better results in monitoring, awareness of their knowledge, and regulation of cognition than women, and women reported overconfidence. Which suggests that it is necessary to deepen studies in this line because it is complex and dynamic.

LIMITATIONS AND RECOMMENDATIONS

The data from this study differ from others and therefore further investigation is required. It is recommended to design and implement strategies aimed at

strengthening the development of metacognitive skills in university students and that allow determining if they can be generalized in different learning domains. Authors such as Greene *et al.* (2015); Kleitman & Narciss (2019); Olaya *et al.* (2023) point out that general metacognition can be instructed simultaneously in different learning situations, thereby hopefully transferring to new learning situations, in contrast specific metacognition must be taught for each task or domain separately.

The leveling strategies, peer tutoring, time organization, establishing study habits and strategies, as well as the implementation of technological strategies, are part of the activities that promote the development of metacognitive skills (Castro, 2017), in this sense, other studies may focus on using these skills and testing new strategies in general or specific domains. In this sense, it is important to take into account the recommendation of Azevedo (2020) who points out that a process aimed at strengthening metacognitive skills must meet three conditions: 1) integrate metacognitive instruction into the content to ensure connectivity, 2) inform learners about the usefulness of metacognitive activities to make them exert the initial additional effort, and 3) prolong the training to ensure the smooth and sustained application of metacognitive activity.

5. CONCLUSIONS

This study allowed to know the metacognitive skills of Colombian university students, through the analysis in three universities that include public and private institutions and with the use of different teaching modalities. It is evident that although students have a high level in the development of their skills, they still need to be strengthened in an important way. The results show that it should not be taken for granted that university students are aware of their ways of learning and the strategies that work best for them. It was also possible to determine that the mere fact of advancing in the career does not have a significant impact on the strengthening of their metacognitive skills, and contrary to what would be expected their metacognitive skills are decreasing. In other words, there are significant differences in the level of skills of Colombian university students according to the semester in which they are located, but as they progress in their programs, their skills decrease. It is important to take into account that in this study only students from the first to the fourth semester were considered.

This shows the importance of working with students, from the first semesters and in an explicit manner, in becoming aware of their study habits and not

assuming that they already have these aspects developed, but rather that in any educational process they must continue to strengthen. It is necessary that students can assess the effectiveness of the strategies they implement to achieve their objectives and determine if they allow them to learn. It is necessary to work on this from the first semesters of University since it favors students to be aware of the learning process and what they require to make it meaningful, information that will also allow teachers to plan educational practice.

Although 70 % of university students in general, are located at high and very high levels in the two components of metacognition: knowledge and regulation of cognition. It stands out that more than 90 % of the students of the public university, who attend distance education programs, are located in the high levels of metacognition. It was established that there are significant differences between the level of development of the skills and the university of origin. It is possible that this can be explained by the educational models that the institutions have. The UNAB, which was the University where the students had the best levels, is a University that offers distance programs, for which the autonomy of the students in their learning process is worked from the beginning, this requires studying in greater depth.

On the other hand, it is determined that university women have better averages than men, at a general level as well as in each component and subcomponent of metacognition. However, the Mann-Whitney U test allowed us to determine that the differences are not significant.

It is important to delve into the correlational studies between the metacognitive abilities of university students and variables such as: academic performance, gender, nature of the institution (public or private) since the results do not show conclusive trends. It is necessary to combine subjective and objective measures of metacognition in research, together with the control of variables and the selection of samples to reduce bias and achieve greater clarity about predispositions.

Highlights (key points): This study was conducted only in three Colombian institutions, however, it provides a broad overview of the metacognitive skills of undergraduate university students. This study, through a large sample of students, provides information that allows analyzing and comparing the metacognitive abilities of university students, both in the knowledge of cognition and in the regulation of cognition at a general level without focusing on a specific domain. The data presented show differences by University of origin, as the semester progresses and that do not

exist by gender. It is a study that allows comparisons with other similar ones and that opens the doors to new investigations.

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