

Metacognition and its Association with Self-efficacy and School of Origin in Engineering Students

Nicolás Amaya López¹, Rebeca Curiel Gómez¹ and Waldyr Fong Silva²

¹ University of the Guajira, TAMASKAL Research Group, Riohacha-Colombia

² University of Cartagena, GIMIFEC Research Group, Cartagena-Colombia

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Abstract

The association between metacognition, self-efficacy and school of origin was analyzed in 950 students of the engineering programs of the University of Cartagena between 2014 and 2016. The instrument for measuring metacognition was the "Learning Self-Regulation Inventory" designed by Lindner, Harris and Gordon (1993), which was modified for the requirements of the research. Self-efficacy was measured with the Self-Efficacy Inventory for Learning (SELF) and the school of origin was identified by survey. The values of 0.90 and 0.94 for the Cronbach's Alpha enabled the validation of the Learning Self-Regulation Inventory and the self-efficacy inventory for learning respectively. For the relationship analysis, the variables were crossed and the bar diagrams and the 2x2 contingency tables were constructed by applying the Chi-Square independence test, which showed statistical significance between the metacognition and self-efficacy variables. The results indicate that there is a significant degree of statistical significance ($p < 0.05$) between metacognition and self-efficacy ($p = 0.047$) at a confidence level of 95%. This allowed us to identify that the engineering student at the University of Cartagena understands his own cognition process and is able to select learning strategies that allow him to achieve his academic achievements.

Keywords: Metacognition, Self-efficacy, School of origin

Introduction

For Flavell (1971) [1], metacognition can be understood as the "cognition of cognition". According to the dictionary of the Spanish Royal Academy, cognition can be understood as the action and effect of knowing (DRAE, 1992) [2]. Being defined- as does Jakobson (1981) when speaking of Metalinguistics [3]- as a process which results in a product, that is, to know that we know something, we recognize it, to know that we know strategies to remember, plan, study and those strategies to keep the attention on particular things or when you learn something of what it is read or you listen. In the same sense Flavell (1987), Palincsar and Brown (1987) consider metacognition as the ability of the individual to reflect on their cognitive processes and be aware of the results that could be obtained from skills such as monitoring, regulation and control of their knowledge. Aspects that affect the choice and selection of cognitive strategies [4, 5].

For Colom (2012) expectations of self-efficacy in students is an essential factor of the activity that will be chosen to reach it as well as determine the time and effort that will invest in it to manage their academic behavior and your effort as long as you have the best skills and the right incentives to achieve it [6]. On the other hand, for Chemers, Hu & García (2001), when academic demands are valued as a threat that generates academic stress, it produces negative levels in the processes of self-efficacy and control, especially if the abilities that the student has are not necessary or sufficient to face them [7].

Authors such as Hackett (1995) consider that choice of the career has a decisive impact on student self-efficacy processes since they influence their motivational processes, performance and academic self-regulation [8]. For Pajares & Schunk (2001), self-efficacy and self-regulation are linked to performance and academic efficiency since students with high self-efficacy achieved better grades and have shown greater persistence and achievements in science and engineering courses [9]. For Baez (2014), the transition from secondary education to higher education is understood as a set of processes and phases in which students receive, they process information and build their humanistic, scientific knowledge or professional technician in the university for which the first year of studies in higher education is decisive [10]. Authors such as Carrión (2002), managed to determine in university students in Cuba that the origin of the student is a determinant predictor of academic performance [11].

In the present investigation, the association between metacognition, self-efficacy and school of origin was evaluated. Metacognition was measured using the instrument designed by Lindner et. al (1993) [12,13] called "Inventory of Self-Regulation of Learning", self-efficacy was measured with the inventory of self-efficacy for learning (Self-Efficacy for Learning Form) (SELF) [14], while the school of origin (private or public) was evaluated by means of a survey.

Materials and Methods

Population and sample size: The study was carried out in fourth-semester students of the Civil Engineering, Food, Systems and Chemistry programs of the University of Cartagena. Of the total, 80% were men and 20% women. The students were between 17 and 21 years old. To estimate the size of the sample, equation (1) was used according to Fong et al. (2017) [15]:

$$n = \frac{\sigma^2 N p q}{e^2 (N - 1) + \sigma^2 p q} \quad (1)$$

N: Number of population elements; n: Number of elements that the sample must have; σ : Level of risk chosen; p: Probability that an element is selected (% estimated); q: Probability that an element is not selected ($q = p$); e: Error allowed.

Variables, phases and reliability of the test: The variables used are of two types (independent and dependent):

- a. Independent variables: Self-efficacy and school of origin.
- b. Dependent variable: Metacognition

The investigation was carried out in three (3) stages: In the first, the degree of metacognition possessed by engineering students was identified through a survey. In the second stage, the level of self-efficacy of the students was measured and the school of origin was determined. In stage 3, the independent variables are crossed with the dependent variable metacognition constructing the bar diagram of the relational analysis.

The internal consistency of the test was determined using Cronbach's Alpha [16]. The dependent variable Metacognition was classified into two categories: a) Low metacognition (LM) ($LM < 65$ points or less) and high metacognition (HM) ($MA \geq 65$ points out of a total of 100 points). The independent variables were classified in two categories: a) Low self-efficacy (LSE) (percentages less than 70%, $PCB < 70\%$) and High self-efficacy (HSE) (percentage equal to or greater than 70%, $PCA \geq 70\%$) b) School of origin: Private (PR) and public (P).

Statistic analysis: The Chi-Square [17] test between the Metacognition and the independent variables (self-efficacy and School of origin) was used to know which of these factors are related to each other in the engineering students of the University of Cartagena.

Results and Discussion

By means of equation 1, a sample size of 274 individuals with a confidence level of 95% is obtained. The surveys were applied for a total of 12 students per academic period and per program (4 programs, 6 academic periods) for a total of 288 respondents.

Cronbach's Alpha [12] for the instruments: Inventory of Self-regulation of Learning and inventory of self-efficacy for learning (SELF) yielded the values of 0.90 and 0.94 respectively, which indicates a high degree of internal consistency of the test. The Chi-square test was evaluated for the analysis of the relationship between the dependent variable (metacognition) and the independent variables (self-efficacy for learning and school of origin).

Table 1 also indicates the values of p (statistical significance), which also shows that there is a relationship of high statistical significance between Metacognition and self-efficacy for learning ($p < 0.05$).

Table 1 Chi-Square Test for Metacognition

Variable	Chi-square	GL	P-Value
Self-efficacy	3.93	1	0.047**
School of origin	0.59	1	0.443

** Relationship with high statistical significance at a confidence level of 95%

Figure 1 shows the bar graph between metacognition and self-efficacy for the learning of engineering students.

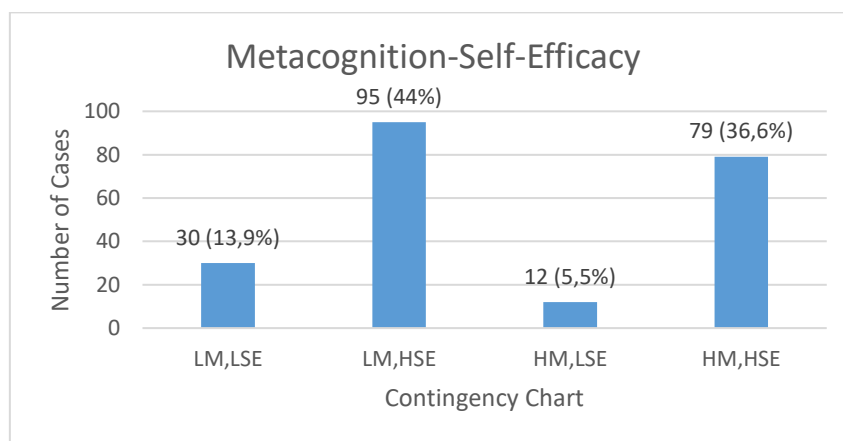


Figure 1. Bar graph: Metacognition-self-efficacy for learning

36.6% (79 cases) of the students developed high metacognition processes when presenting high levels of self-efficacy. This correspondence is due to the academic behavior, effort and skills they have to achieve their academic goals Depending on the action of learn and meet. This as a result of the academic product coming from the strategies of planning, study, memory and attention employed during the learning process according to the postulates of Flavell (1971) [1], (DRAE,1992) [2], Jakobson (1981) [3], Colom (2012) [6].

The 13.9% (30 cases) of the studied population developed low metacognitive processes by presenting low self-efficacy in their learning processes, that is, this correspondence allows us to verify the statistical significance between these two factors. In the same way, to the extent that the student stops reflecting on their own cognitive process (metacognition) and taking awareness of itself, the results obtained will be reflected in their processes of self-efficacy and academic performance according to the postulates of Flavell (1987), Palincsar and Brown (1987) [4,5], Pajares & Schunk (2001) [9].

5.5% (12 cases) developed high metacognition processes despite having low levels of academic self-efficacy. This is because these types of students are able to understand their cognition process and employ planning and feedback strategies of their academic work independent of incentives and self-efficacy processes according to the postulates of Flavell (1971) [1] and Colom (2012) [6]. In the same sense, it is likely that the academic demands on these students are valued as a threat generating academic stress which negatively impacts in the levels of self-efficacy and control as it is proposed by Chemers, Hu & García (2001) [7].

44% (95 cases) developed low metacognition processes despite having high levels of academic self-efficacy. This is probably due to the fact that these students are aware of their processes of academic self-efficacy, employing learning strategies related to the organization, planning and research neglecting their academic behaviors related to the process of understanding how to learn according to the approaches of Flavell (1971) [1], Jakobson (1981) [3], Palincsar and Brown (1987) [4, 5] and Colom (2012) [6].

It was not possible to verify statistical association between the metacognition and the school of origin for the group of students under study of the engineering faculty of the University of Cartagena.

Conclusion

Based on the analysis as above, it is concluded as follow:

The present investigation was able to verify the statistical significance that exists between metacognition and self-efficacy at a 95% confidence level. This is because the engineering student understands his own cognition process so he uses strategies such as memory, Planning and organization to achieve your academic goals. In addition, he reflects on his own learning process taking full awareness of the results achieved through monitoring, regulation and control of strategies.

In this study, it was not possible to determine a statistical association at 95% of the level of confidence between metacognition and the school of origin of the engineering student at the University of Cartagena.

References

- [1] John Flavell, First discussant's comments: what is memory development the development of?. *Human Development*, **14** (1971), 272-278.
<https://doi.org/10.1159/000271221>
- [2] Dictionary of the Royal Spanish Academy, (1992).
- [3] Roman Jakobson, *Linguistics and Poetics*, Editorial Cátedra, Madrid, 1981.
- [4] J. H. Flavell, *Speculations about the Nature and Development of Metacognition*, In *Metacognition, Motivation and Understanding*, Hillsdale, NJ: Erlbaum, 1987.
- [5] A. S. Palincsar and D.A. Brown, Enhancing instructional time through attention to metacognition, *Journal of Learning Disabilities*, **20** (1987), no 2, 66-75. <https://doi.org/10.1177/002221948702000201>
- [6] R. Colom, *Psychology of Individual Differences: Theory and Practice*, Editorial Pirámide. Madrid, 2012.
- [7] M. Chemers, L. Hu and B. García, Academic self-efficacy and first year college student performance and adjustment, *Journal of Educational Psychology*, **93** (2001), no. 1, 55-64.
<https://doi.org/10.1037//0022-0663.93.1.55>
- [8] G. Hackett, Self-efficacy in career choice and development, In *Self-Efficacy in Changing Societies*, En Bandura A., (Eds.), Cambridge: University Press, 1995, 232-259. <https://doi.org/10.1017/cbo9780511527692.010>
- [9] F. Pajares and D. Schunk, Self-beliefs and school success: Self-efficacy, self-concept and academic achievement, *Self-Perception*, **2** (2001), 239-265.
- [10] M. Baez, *Pedagogy in Differential Education*. Universidad of Tarapacá. Chile, 2014.
- [11] Evangelina Carrión Pérez, Validation of income characteristics as predictors of academic performance in the medical career, *Cuban Journal of Higher Medical Education*, **1** (2002), no. 16, Artículo 1. Retrieved from <http://scielo.sld.cu>
- [12] R. Lindner, B. Harris and W. Gordon, Teaching self-regulated learning strategies, *Annual Conference of the Association for Educational Communications and Technology*, New Orleans, LA, (1993).

- [13] R. Lindner and B. Harris, Self-Regulated learning in Education Majors, *The Journal of General Education*, **47** (1998), 62-78.
- [14] B. J. Zimmerman, A. Kitsantas, Reliability and validity of Self-efficacy for Learning Form (SELF) scores of college students, *Zeitschrift für Psychologie/Journal of Psychology*, **215** (2007), no. 3, 157-163.
<https://doi.org/10.1027/0044-3409.215.3.157>
- [15] Waldyr Fong Silva, J. Chiquillo-Rodelo and C. J. Brito-Carrillo, Extrinsic Factors and their Association with the Motivation and Self-Regulation of Learning in Engineering Students, *Contemporary Engineering Sciences*, **11** (2018), no. 20, 951 – 958. <https://doi.org/10.12988/ces.2018.8383>
- [16] L.J. Cronbach, Coefficient alpha and the internal structure of tests, *Psychometrika*, **16** (1951), no. 3, 297-334.
<https://doi.org/10.1007/bf02310555>
- [17] W.J. Stevenson, *Statistics for Administration and Economy: Concepts and Applications*, México: Harla, 1981.

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