Metacognition and its Association with Extrinsic Motivation and Learning Styles in Engineering Students

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Abstract
The present investigation analyzed statistical significance between Metacognition with extrinsic motivation and learning styles, in 1300 students of the engineering programs of the University of the Guajira between 2014 and 2017. The instrument used to measure metacognition was the "Learning Self-Regulation Inventory" designed by Lindner, Harris and Gordon. The extrinsic motivation was evaluated by CEVEAPEU, a questionnaire developed and validated by Gargallo et. al (2009) while the learning style was evaluated through the ILS (Inventory of learning styles) designed by Vermunt. The internal consistency of each instrument was evaluated using Cronbach alpha, which yielded values of 0.88, 0.91 and 0.89 respectively. The relationship analysis was obtained by crossing the independent variables: extrinsic motivation and learning styles, with the dependent variable (metacognition), thus constructing, the bar diagrams and contingency tables. The degree of statistical significance was obtained by the Chi-square test. The results indicate statistical significance (p <0.05) between metacognition and learning style (p = 0.035) with a confidence level of 95%. This allows to conclude that the learning style of the engineering student of the University of the Guajira allows him to perform adequately in the classroom and efficiently achieve their academic achievements.

Keywords: Metacognition, extrinsic motivation and learning styles

Introduction
For Flavell (1976), metacognition refers to knowledge that the student has about
cognitive processes or aspects related to it. That is, they are related to the active, consequent and organizational supervision of cognitive objects that allow them to reach specific academic goals. That is, metacognition is put into practice when one is fully aware of the inconvenient or difficulty one has in learning a particular subject. Also, when we consciously verify phenomena or processes before accepting them as true facts. As well as, when examining alternatives before selecting any [1]. According to Glaser (1994), metacognition is related to the consciousness and self-regulation that the student has about their own learning process [2]. The academic goals of university students are largely related to intrinsic and extrinsic motivation. For this reason, the student's behavior articulated with some type of external motivation determines the kind of cognitive resources that they use to face the academic processes in the classroom [3]. For Pekrun (1992), extrinsic motivation comes from the medium and leads the student to the execution of tasks and activities typical of their academic exercise in the classroom. In the same sense, the emotions related to the achievement of objectives also affect the extrinsic motivation [4]. Anaya et.al (2010) also considers that extrinsic positive motivation influences the total performance of the task and student motivation [5].

On the other hand, for Keefe (1988), Navarro (2008), the affective, psychological and cognitive aspects are constituted as fundamental elements in the learning style that the university student uses to understand, interact and perform in the educational environment [6, 7]. In the same way for Rodriguez (2002), the learning styles are articulated to the typical and stable modalities that the student uses in the specific act of learning [8]. For Valadez (2009), learning styles are related to properties of intelligence, as well as also with other elements of learning as the perception of achievement, performance, motivation and context [9]. In the same way for Alumran (2008), Cano (2000), Rojas et al. (2006), different learning styles are appreciated at different moments of the students' academic trajectory, that is, high prevalence of similar styles in initial semesters, as well as intermediate and advanced semesters [10, 11, 12].

In the present investigation, the association between metacognition, extrinsic motivation and learning styles in university students was evaluated.

Materials and Methods

Population and sample size: The study was carried out in a population of 1300 students of the engineering programs of the University of the Guajira between 2014 and 2017. The participants of the study were regular students of fourth and fifth semester of Civil Engineering, Systems, Environment, Industrial and Mechanics of the University of the Guajira. Of the total, 75% were male and 25% female. The ages of the students were between 17 and 21 years old. The size of the sample is calculated according to Fong et al (2017) [13] by equation (1):

$$n = \frac{\sigma^2 Npq}{e^2 (N - 1) + \sigma^2 pq}$$

(1)
n: Number of elements that the sample must have; N: Number of population elements;
e: Error allowed; \( \sigma \): Level of confidence or risk chosen; p: Probability that an element is selected (% estimated); q: Probability that an element is not selected (q = p (50%)).

**Variables, phases, instruments and reliability of the test:** The variables used in the investigation (independents and dependent) are described below:

b. Dependent variable: Metacognition

The research was carried out in three (3) phases: In the first one, the degree of metacognition of engineering students was identified by means of a survey. In the second phase, extrinsic motivation was measured. In phase 3, the independent variables are crossed with the dependent variable (metacognition), constructing the bar diagram of the relational analysis.

**Instruments:** Metacognition was measured using the instrument designed by Lindner et. al (1993) [14] called "Inventory of Self-Regulation of Learning", extrinsic motivation through the CEVEAPEU questionnaire (questionnaire for the evaluation of learning strategies of university students) developed and validated by Gargallo et. al (2009) [15] and for the learning style the ILS was used (Inventory of Learning Styles) of Vermunt (1994;1998) [16,17]. To determine the reliability of the test the internal consistency was determined using the Cronbach Alpha [18].

The dependent variable Metacognition was classified into two categories: a) Low Metacognition (LM) (LM < 65 points or less) and high metacognition (HM) (MA ≥ 65 points out of a total of 100 points). The independent variables were classified into three categories: a) Extrinsic motivation: Low extrinsic motivation (LEM) (LEM < 75 points or less) and high extrinsic motivation (HEM) (HEM ≥ 75 points out of 100 points). b) Learning Style: Low Learning Style LLS (LLS < 65 points out of 100 points) and High Learning Style (HLS) (HLS ≥ 65 points out of 100 points).

**Statistic Analysis**

The Chi-square test [19] between metacognition and the independent variables (extrinsic motivation and learning style) was used to find out which of these factors relate to each other in the engineering students of the University of the Guajira.

**Results and Discussion**

According to equation 1, with a confidence level of 95%, a sample size of 297 individuals is obtained. When applying the surveys, a total of 10 students per academic period and per program (5 programs, 6 academic periods) were made
homogeneously for a total of 300 respondents. The reliability of each instrument (Cronbach's alpha) yielded the following values: For the inventory of self-regulation of learning ($\alpha = 0.88$); for the CEVEAPEU questionnaire ($\alpha = 0.91$) and for the Inventory of Learning Styles ($\alpha = 0.89$).

Table 1 additionally indicates the values of p (statistical significance) where it is observed that there is a relationship of high statistical significance between Metacognition and extrinsic motivation and learning style ($p < 0.05$).

Table 1 Chi-Square Test for Metacognition

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chi-square</th>
<th>GL</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrinsic motivation</td>
<td>2.03</td>
<td>1</td>
<td>0.1544</td>
</tr>
<tr>
<td>Learning style</td>
<td>4.45</td>
<td>1</td>
<td>0.035</td>
</tr>
</tbody>
</table>

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

Figure 1 shows the bar graph between Metacognition and the learning style of engineering students.

According to Figure 1, 38.4% (83 cases) of students who develop a high metacognition is because they have their own and well-defined learning style. In addition, using high learning styles, allows them to achieve their academic goals efficiently and in a short time. That is, this type of students understand their cognitive process related to their academic exercise and develop active supervision of their processes, in a consequent and organizational manner. In addition, he is fully aware of the difficulties he faces in a certain subject and is able to propose
strategies to overcome them according to the precepts of Flavell (1976) [1]. 13.4% (29 cases) developed low metacognitive processes based on low learning styles, that is, in this group of students it was also possible to verify the statistical significance between these two factors according to Glaser (1994) [2] since it was possible to verify that metacognition is related to the consciousness that students have of their academic exercise and the self-regulation that they develop to achieve this type of processes in their cognitive structure. 5.6% (12 cases) of the students in the study reached high metacognitive processes despite developing low learning styles, that is, it is possible that affective aspects affect this group of students positively and psychological related to personal fulfillment, the organization and planning of the learning process as poses it Keefe (1988), Navarro (2008) [6,7] and Valadez (2009) [9] where the perception of performance and academic achievement are fundamental.

42.6% (92 cases) developed low metacognitive processes despite having high learning styles, that is, this is very possibly due to aspects related to intelligence, the perception of achievement, performance in the classroom, the motivation and context in which the academic process develops since they do not have the consciousness to understand their own cognitive structure. In the same way, it is probable that this type of students are accepting certain facts as true without previously verifying them according to Flavell (1976) [1], Valadez (2009) [9] despite having typical modalities and stable of learning styles as proposed by Rodriguez (2002) [8]. In the same way, this can also be a consequence of the same student as it has the same learning style in initial semesters, intermediate and advanced without doing an assessment and feedback of the same according to proposed by Alumran (2008), Cano (2000), Rojas et al.(2006) [10,11,12].

No statistical significance could be verified between the extrinsic motivation and the metacognitive processes in the students of the faculty of engineering of the University of the Guajira.

**Conclusion**

Based on the analysis as above, it is concluded as follow: There is a statistically significant relationship at a 95% confidence level between metacognition and the learning style used by the engineering student at the University of the Guajira. This is due to the active and organizational supervision that the student makes of the cognitive objects (learning processes and academic activities) and that allow him to reach his academic achievements. There is no statistical significance at a 95% level of confidence between the metacognition and the extrinsic motivation in engineering students of the University of the Guajira. That is to say, although extrinsic motivation develops with quality, It is not determinant so that students become aware of their own cognitive processes.
References


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