Metacognition and its Association with Intrinsic Motivation and Student Attitude in Engineering Students

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Abstract

The statistical association between metacognition, intrinsic motivation and student attitude in students of the Engineering Faculty of the University of Guajira was investigated. The instrument for measuring metacognition and intrinsic motivation was the "Learning Self-Regulation Inventory" designed by Lindner, Harris and Gordon (1993), which was modified for the research requirements and validated by Cronbach's Alpha. To do the relationship analysis, the contingency tables were made and the bar diagrams were constructed. The statistical significance between the variables was made by the Chi-square test. The values of 0.90 and 0.88 for the Cronbach's Alpha allowed to validate the instruments used. The results showed that there is statistical significance (p <0.05) between metacognition with intrinsic motivation (p = 0.036) and student attitude (p = 0.034) with a confidence level of 95%. This allowed us to conclude that by increasing or decreasing the intrinsic motivation and student attitude, metacognition does so in the same proportion.

Keywords: Metacognition, intrinsic motivation, Student Attitude

Introduction

Flavell (1992) considers metacognition as the ability of the student to reflect on their own processes of cognition. This allows the deliberate, conscious and continuous
control of their activities and intellectual processes [1]. For Brown (1978), metacognitive knowledge is the result of successive observations of the student's external world and of himself. These observations may or may not correspond to reality [2]. According to Ryan & Deci (2000) intrinsic motivation corresponds to the student's inherent tendency to seek exploration, innovation, novelty, challenge, learning, extension and exercise of their own abilities. This encourages the high positive potential of human nature [3].

Motivation, on the other hand, can occur intrinsically and extrinsically. That is, when a student is motivated by the interest generated by the subject and the same experience of the educational process is considered to have intrinsic motivation. In this sense, self-determination, independence and cognitive self-regulation become key pieces for the academic success of the subject according to the postulates of Polanco (2005) [4]. At present the attitude and student perception related to the level of difficulty and self-efficacy that the student develops in academic processes is largely related to the success and goals proposed in accordance with the statements of Meece & Courtney (1992) [5].

On the other hand, the student's attitude requires a personal commitment that allows him to achieve achievements and react to different situations of academic life such as: tolerance, respect, honesty, trust, prudence, intolerance, criticism, distrust, dishonesty, imprudence between others. That is, the student attitude is related to different conceptions of human nature, moral components and values as expressed by Martinez (2004) [6]. Also for Festinger (1957), the attitude can be destabilized by situations alien to the student and that generate imbalance or dissonance. This, would generate disturbance in those coherent and balanced attitudinal processes that the student may have in his diverse academic activities in the university [7].

In this project the association between the intrinsic motivation, student attitude and metacognition of the engineering student of the University of Guajira was evaluated.

**Materials and Methods**

**Population and sample size:** The participants were 450 students of the Faculty of Engineering of the University of Guajira.

To estimate the size of the sample when it comes to a finite population of less than 100,000 individuals is calculated according to Fong et al. (2017) [8] by equation (1):

\[ n = \frac{\sigma^2 npq}{e^2 (N - 1) + \sigma^2 pq} \]  

(1)

Donde: N: Number of population elements; n: Number of elements of the sample; \( \sigma \): Level of confidence; e: Error allowed; p: Probability that an element is selected.
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\( \% \); \( q \): Probability that an element is not selected \( (p = q) \).

**Variables, instruments, phases and reliability of the test:** The variables used in the investigation were:

a. Independent variables: Intrinsic Motivation and student attitude
b. Dependent variable: Metacognition

**Instruments**

Metacognition and intrinsic motivation was evaluated using the instrument designed by Lindner et al. (1993) [9,10] called "Inventory of Self-Regulation of Learning" which is a questionnaire of 80 questions weighted from 1 to 5 on the Likert scale. The student attitude was evaluated by means of a survey incorporating elements of Boza & de la O Toscano (2012) [11].

The research was carried out in three (3) phases: In the first one, the instrument made up of the Self-Regulation Inventory for Learning (SRLI) described above was applied to the student population under study. In the second phase, the attitude of the engineering students was identified through a survey. In phase 3 the independent variables were crossed with the dependent variable (metacognition) to construct the bar diagrams of the relationship analysis. To determine the reliability of the test, internal consistency was evaluated using Cronbach's Alpha [12].

The dependent variable Metacognition was classified into two categories: a) Low metacognition \( (LM < 65 \text{ points or less}) \) and high metacognition \( (MA \geq 65 \text{ points out of a total of 100 points}) \). The independent variables were classified in two categories: a) Intrinsic motivation: Low intrinsic motivation \( (LIM < 75 \text{ points or less}) \) and high intrinsic motivation \( (HIM \geq 75 \text{ points out of 100 points}) \) b) Student attitude: low student attitude \( (LSA < 171 \text{ points or less}) \) and high student attitude \( (HSA \geq 171 \text{ points out of 300 points}) \).

**Statistic analysis**

The chi-square test [13] between the Metacognition and the independent variables intrinsic motivation and student attitude, was used to know which of these factors are related to each other statistically.

**Results and Discussion**

When using equation 1 to a total number of 450 Engineering students between 2014 and 2016 at a confidence level of 95%, a value of 207 was obtained. This means that the surveys to be applied must be equal to this number or higher. In the case that concerns us, they were applied on a total of 216 fourth-semester students of the faculty. The Alpha of Cronbach [12] for the "Inventory of Self-regulation of Learning"
and for the questionnaire of student attitude with elements of Boza & de la O Toscano (2012) yielded values of 0.90 and 0.88 respectively, which indicates a high degree of consistency internal of the test.

The Chi-Square test was evaluated for the analysis of the relationship between Metacognition as a dependent variable and the independent variables: intrinsic motivation and student attitude. Table 1 also indicates the values of p (statistical significance), where it is also observed that there is a relationship of high statistical significance between the metacognition and the Intrinsic Motivation ($p < 0.05$) as well as between the Metacognition and student attitude ($p < 0.05$).

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>Intrinsic Motivation</td>
<td>4.38</td>
<td>1</td>
<td>0.036</td>
</tr>
<tr>
<td>Student Attitude</td>
<td>4.51</td>
<td>1</td>
<td>0.034</td>
</tr>
</tbody>
</table>

** Statistical significance at a 95% confidence level

Figure 1 shows the bar graph between metacognition and the intrinsic motivation of engineering students.

The 11.6% (25 cases) of the population have a low metacognition and intrinsic motivation, that is, this population is not able to reflect on their own processes of cognition and they do not have control of their intellectual processes according to Flavell. (1992) [1]. In addition, they do not possess a clear metacognitive knowledge according to what was posed by Brown (1978) [2]. 37% (80 cases) have low metacognition and high intrinsic motivation. This means that the student is motivated but does not have control of their cognition processes, that is, this group of students despite interacting with the outside world and of knowing itself, it is not capable of reflect on its academic reality according to the approaches of Brown (1978)
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[2]. On the other hand, these students, besides being interested in the subjects of their career, are able to explore, innovate, approach novel processes, pose challenges, exercise their intellectual capacities, are independent and have self-determination, confirming the approaches Ryan & Deci (2000) [3] and Polanco (2005) [4].

19% (41 cases) of the students present a high metacognition and low intrinsic motivation. This means that there is a student population with self-determination and independence that, even though it does not possess a high intrinsic motivation, develops high cognitive reflection processes according to what proposed Flavell (1992) [1], Brown (1978) [2] and Polanco (2005) [4].

Likewise, a third of the studied population (32.4%) have a correspondence between high metacognitive levels and high levels of intrinsic motivation, that is, they have a direct dependence where the statements of Flavell (1992) [1], Brown (1978) [2], Ryan & Deci (2000) [3] and Polanco (2005) [4] are fully met.

The statistical significance between metacognition and student attitude is evidenced in figure 2, where the third part of the studied population (32.4%) that presents a high attitude towards the study also develops high metacognitive processes, fulfilling the postulates of: Meece & Courtney (1992) [5], and Martinez (2004) [6]. In the same way, a fifth of the studied population (18.5%) has low attitude and metacognition which means that they have destabilized processes originated by situations external to the student such as family or social problems as proposed by Festinger (1957) [7].

In the same way, 42.1% (91 cases) despite having high attitudinal processes towards learning develop low metacognition processes, that is, they are not able to reflect and deliberate about their cognitive processes, not being fulfilled for this population what is posed by Flavell (1992) [1], Brown (1978) [2], and Festinger (1957) [7]. On
the contrary, the statements of Martínez (2004) [6] are fulfilled since it was possible to verify that this population reacts to diverse academic situations, practice respect, tolerance, prudence and other values of the conception of human nature.

Finally, 7% (15 cases) have a low attitude towards learning with high metacognitive processes, that is, in spite of the fact that their attitudinal processes are in disequilibrium as proposed by Festinger (1957) [7], neither do they acquire a personal commitment that allows them to achieve their academic goals and achievements. In addition, it is a very volatile group regarding values such as tolerance, respect, honesty, prudence among others, as stated by Martínez (2004) [6].

**Conclusion**

Based on the analysis as above, it is concluded as follow: There is a statistically significant relationship at 95% of the level of confidence between metacognition and intrinsic motivation in engineering students at the University of Guajira. This means that the engineering student reflects on his or her own cognition process. That is, he has conscious, continuous and deliberate control of his intellectual processes due to the intrinsic motivation he has in his formative process where he explores, overcomes challenges, develops competencies and even proposes initiative for innovation processes. There is a statistically significant relationship at 95% of the level of confidence between metacognition and student attitude. This means that the attitude towards the academic processes of the engineering student is developed by the personal commitment and self-efficacy of the same student that involves different types of values and moral components.

**References**


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