Metacognition and its Association with Teacher Quality and Student Attitude in Engineering Students

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Abstract

The association between metacognition, teaching quality and student attitude in 950 students of the engineering programs of the University of Cartagena between 2014 and 2016 was analyzed. 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. Teaching quality was evaluated by means of a survey and the student attitude was evaluated by means of a survey incorporating elements of Boza & de la O Toscano into the questionnaire. Each instrument was validated by the Cronbach's Alpha which yielded the values of 0.90, 0.85 and 0.88 for each of the instruments mentioned previously in their order. For the relationship analysis, the variables were crossed and the bar diagrams and the 2x2 contingency tables were constructed, applying the Chi-Square independence test. The results indicate that there is a significant degree of statistical significance (p <0.05) between metacognition and student attitude (p = 0.047) at a confidence level of 95%. This means that metacognitive processes are associated with attitudinal processes causing academic success in the engineering student at the University of Cartagena. It was not possible to verify statistical significance between metacognition and teaching quality.

Keywords: Metacognition, teacher quality, student attitude
Introduction

For Klimenko (2009), Klimenko and Alvarez (2009) and Pozo (2006), metacognition corresponds to two aspects. The first is related to the cognitive activity that the student develops during their academic activity: execution of tasks, capacities, abilities, experiences and strategies that you can use to solve specific tasks. The second is related to the control exercised by the student over their own cognitive activity which involves planning to achieve objectives, supervision during execution and evaluation of the results obtained [1, 2, 3, 4]. For Okagaki & Sternberg (1993), metacognition accompanied by motivation can generate in the student the development of autonomous learning activities. That is, the cognitive process may be conditioned to metacognition and motivational aspects [5].

On the other hand, for Mellado (2009) it is important to train and stimulate in the teachers the change of pedagogical conceptions that allow curricular reforms and educational innovation to materialize since they are responsible for the success or failure of any educational process in the classroom [6]. For Nathan and Petrosino (2003), teachers' mastery of general and specific pedagogical aspects will allow students to better understand and assimilate disciplinary concepts generating in them the general and specific competences for their professional performance. In this sense, the knowledge to teach is related to the pedagogical domain of the teacher and in which you must work continuously since it is the one that receives the least attention in the universities [7].

For Gallardo et. al (2007) school failure rates are related to processes involved in learning where the student attitude is determinant and greatly affects academic performance [8]. For Meier and Lemmer (2001) future teachers must learn to develop in students positive attitudes towards learning processes. For this, this aspect takes on special relevance in the training processes of any teacher in any university in the world [9].

In the present investigation, the association between metacognition, teaching quality and student attitude was evaluated.

Materials and Methods

Population and sample size: The study participants were regular students of the fourth semester of the programs of Civil Engineering, Food, Systems and Chemistry of the University of Cartagena. Of the total, 75% were male and 25% female. The ages of the students were between 17 and 21 years old. 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. (2018) [10] by equation (1):

\[ n = \frac{\sigma^2 Npq}{e^2(N - 1) + \sigma^2 pq} \] (1)
N: Number of population elements; n: Number of elements that the sample must have; σ: Level of confidence or risk chosen; q: Probability that an element is not selected (q = p); p: Probability that an element is selected (% estimated); e: Error allowed.

**Variables, phases, instruments and reliability of the test:** The variables used in the research were classified into two (2) categories (independent and dependent):

a. Independent variables: Teacher quality and student attitude.

b. Dependent variable: Metacognition

The research was carried out in three (3) phases: In the first one, were identified by means of a survey, the degree of metacognition of engineering students. In the second phase, the teaching quality and attitude of the student of the University of Cartagena were 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 evaluated using the instrument designed by Lindner et. al (1993,1998) [11,12] called "Inventory of Self-Regulation of Learning". Teaching quality was evaluated by means of a survey and the student attitude was evaluated by means of a survey incorporating elements from Boza & de la O Toscano (2012) into the questionnaire [13]. To determine the reliability of the test the internal consistency was determined using the Cronbach Alpha [14].

The reliability of each instrument yielded the following values: For the inventory of self-regulation of learning (α = 0.90); for the student attitude questionnaire with elements of Boza & de la O Toscano (2012) (α = 0.88) and for Teaching quality was evaluated by means of a survey (α = 0.85).

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 two categories: a) Low teaching quality (LTQ) (score lower than 20, LTQ <20 points) and high teaching quality (HTQ) (score equal to or greater than 20 points out of a total of 30) HTQ≥20) b) Student attitude: low student attitude (LSA) (LSA <171 points or less) and High student attitude (HSA) (HSA≥ 171 points out of 300 points).

**Statistic analysis:** The test Chi-Square [15] between the Metacognition and the independent variables (teaching quality and student attitude) 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

According to equation 1, with a confidence level of 95%, a sample size of 274 individuals is obtained. When applying the surveys, a total of 12 students per academic period and per program (4 programs, 6 academic periods) were made homogeneously for a total of 288 respondents.

Cronbach’s Alpha [14] for the instruments: Inventory of Self-regulation of Learning, teaching quality and student attitude with elements of Boza & de la O Toscano (2012) yielded the values of 0.90, 0.85 and 0.88 respectively, which indicates a high degree of consistency internal of each of the tests.

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 student attitude (p <0.05).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chi-square</th>
<th>GL</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher quality</td>
<td>0.028</td>
<td>1</td>
<td>0.867</td>
</tr>
<tr>
<td>Student attitude</td>
<td>8.24</td>
<td>1</td>
<td>0.0041**</td>
</tr>
</tbody>
</table>

** Statistical significance at a confidence level of 95%

Figure 1 shows the bar graph between metacognition and student attitude.

![Figure 1. Bar graph: metacognition-student attitude.](image)

The 36.5% (79 cases) of the study students presented a high metacognition, significantly associated with a high student attitude. This is due to the fact that students of the faculty of engineering have the two aspects related to metacognition,
such as cognitive activity processes and control processes according to the approaches of Klimenko (2009), Klimenko and Alvarez (2009) and Pozo (2006) [1, 2, 3, 4]. Likewise, student motivation and attitude are articulated with the cognitive and metacognitive processes of the student as proposed by Okagaki & Sternberg (1993) [5] and Gallardo et. al (2007) [8].

The 16.7% (36 cases) of the students developed a low metacognition based on their low attitude toward learning processes. This is due to aspects related to the student's disposition to assume their academic responsibilities, that is, this population does not have control of their own cognitive activity nor of the planning of tasks, workshops and learning cards. This affects their metacognitive process according to the postulates of Okagaki & Sternberg (1993) [5] and Gallardo et. al (2007) [8].

5.1% (11 cases) of the students developed a high metacognition associated with a low student attitude. This means that this population of students are fully aware of how to learn and are able to develop planned learning processes by continually feeding back from their academic exercise despite the fact that those processes involved in learning do not allow them to encourage or awaken the best desire to learn, as proposed by Gallardo et. al (2007) [8].

41.7% (90 cases) of the students had a low metacognition despite having high student motivation. This is because the vast majority of students are related to processes involved in learning that stimulate and encourage the willingness to learn but are students who have not reached intellectual maturity. This does not allow them to understand the role they must acquire during the academic year in each of the subjects they attend in the engineering faculty, according to the approaches of Klimenko (2009), Klimenko and Alvarez (2009) and Pozo (2006), Okagaki & Sternberg (1993) and Gallardo et. al (2007) [1, 2, 3, 4, 5, 8].

It was not possible to determine statistical significance between metacognition and teaching quality in the engineering faculty of the University of Cartagena.

**Conclusion**

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

It was possible to verify a high statistical significance at a 95% confidence level between the metacognition and the attitude towards the academic processes of the engineering student at the University of Cartagena. This is because metacognition processes are accompanied by motivational and attitudinal processes where academic success characterizes the engineering student who controls their cognitive activity.

No statistical significance could be verified at a 95% level of confidence between metacognition and the quality of the engineering professor at the University of Cartagena.
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