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Intrinsic Motivation and its Association with Cognitive, Actitudinal and Previous Knowledge Processes in Engineering Students

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Abstract

The present research allowed to make a study of the relationship between the intrinsic motivation and cognitive, attitudinal and previous knowledge processes in engineering students of the University of Cartagena. The sample was made up of nine hundred sixty (960) students between 2014 and 2016. The instrument for collecting the information was the Self-Regulation Inventory for Learning (SRLI) designed by Lindner, Harris and Gordon (1993). The relationship study was advanced by crossing the dependent variable intrinsic motivation with the independent ones: cognitive processes, attitudinal processes and previous knowledge which allowed to make the correlation bar diagram throwing statistical significance between the intrinsic motivation with the cognitive and attitudinal processes to a confidence level of 95% while with previous knowledge was not significant.

Keywords: Self-regulated learning inventory, intrinsic motivation, cognitive processes, attitudinal processes, processes and previous knowledge

Introduction

According to Maslow's (1968) criteria, intrinsic motivation is articulated with a hierarchy of needs scaled by levels according to a stepped pyramid where the basic needs found at the base must be met first, then meet family needs, health , friendship, intimacy, success, recognition and ending with the self-realization that is at the top of this pyramid. This indicates that as the different needs established in the pyramid are being met, so is the intrinsic motivation of each individual which increases in the measure that it ascends in the same until reaching its own realization [1]. For Santrock (2002), the concept of motivation is considered as "the set of reasons why people behave in the ways they do. Intrinsic motivated behavior is vigorous, directed and sustained"[2]. Within these reasons we can mention the attitude toward learning which, to a greater or lesser extent, is integrated with the students previous knowledge and cognitive processes reason for this research.

For Ausbel (1981), the reason for acquiring certain knowledge is associated with the person, that is, it is intrinsic and is mainly due to the need to know something, developing specific competences and meaningful learning [3]. Authors such as Zaccagnini (2011) consider that self-esteem is related in a determinant way to intrinsic factors of the person, from this perspective considers that a student with fears related to his intellectual capacity to overcome new challenges is because he has weak selfesteem. These intrinsic factors manifested as fears, slow their cognitive development, prevent it from progressing and affect it in decision making which will prevent the achievement of academic goals [4].

Other authors such as Huertas (1997) consider three basic characteristics that allow us to judge an intrinsic action: self-determination, competence and feelings. The first, considers that the control of the action depends on the person himself. The second is related to the individual's ability for face challenges and the third, related to the satisfaction of the person towards the task feeling pleased and at ease [5]. It is important for Barberà (1999) to "know what he knows" the university student, that is, to know what previous school knowledge he has acquired either inside or outside the university center since they do not process the information they do not consider relevant of transforming into knowledge. In this sense, the student is transforming and acquiring disciplinary skills by building new knowledge supported or based on previously acquired and the motivation that has. [6].

The constructivist pedagogical model considers the teaching-learning process as the result of a positive attitude of personal-collective construction of new knowledge from the pre-existing ones making use of the collaborative work with peers and supervised by the teachers of each particular area. which will allow students learning to be consolidated in the long-term memory in an effective and lasting way, improving students' cognition processes [7]. Other authors consider that previous knowledge represents a basis on which new information is supported for its processing and transformation into knowledge, however, it can also mean an obstacle

to re-meaning previously existing concepts in students. For this reason, the attitude, motivation and degree of intellectual maturity of the student are fundamental elements for the processing of information and construction of new meaningful knowledge [8].
The Cognitive processes are associated with multiple factors that allow the student to process information and transform into effective knowledge that will be used to develop specific and disciplinary skills [9]. However, intrinsic motivation, attitude and previous knowledge can play an important role in the student's metacognition, since they rely on basic elements such as attention, storage, data recovery and task execution that are evaluated in the present research with the instrument designed by Lindner, Harris and Gordon [10]. The cognitive processes for Calfee (1981) are carried out in two phases, in the first, it is associated to the information management, that is, to obtain it, to summarize it and to analyze it, whereas in the second, which is structural, it develops with the process of thought, which is organized in a complex way according to the higher mental abilities of the individual thus allowing the construction and assimilation of new knowledge [11]. At present, cognitive processes must allow students to choose, organize, plan, critique, produce and apply in a contextualized way the new knowledge in problem solving [12]. Currently the concept of attitude is considered as the tendency of the individual to assume a task which generates cognitive or behavioral responses with a certain degree of acceptance or rejection. This implies some intrinsic relation with cognitive and motivational aspects in the student [13, 14].

The attitudinal processes of the students are conceived as an intrinsic structure that guides the behavior in order to dynamize and regulate their daily actions, academic or otherwise, that is, in general terms can be considered as the global positive or negative orientation that students assume when they set a goal [15]. Others, however, argue that attitude is acquired and is the result of relationships with the environment, that is, the individual is not born with positive or negative predispositions towards a situation that is object of attitude but are generated from the interaction itself of the academic exercise for the case of university students [16, 17]. In this sense, it is here that the cognition and motivation could be associated with the previous knowledge that the student has before an object of attitude, that is, a subject, laboratory or subject in particular.
In the present research the association between the intrinsic motivation of the university students with the cognitive, attitudinal processes and previous knowledge was evaluated using the instrument designed by Lindner et al (1993) [10] called the Self-Regulation of Learning Inventory.

Materials and Methods

Population and sample size: The study participants were regular students of the fourth semester of the programs of Civil Engineering, Systems, Chemistry and Food 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. (2017) [1] by equation (1):

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

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

Variables, phases and reliability of the test: The variables used in the research were classified into two (2) categories (independent and dependent):
a. Independent variables: Cognitive processes, attitudinal processes and previous knowledge.
b. Dependent variable: Intrinsic motivation

Intrinsic motivation was assessed using the SRLI (Self-Regulation of Learning Inventory) which is a questionnaire designed by Lindner et al. (1993) [10] consisting of 80 weighted questions from 1 to 5 based on the Likert scale.

The research was carried out in three (3) phases: In the first one, the degree of previous knowledge of engineering students was identified by survey. In the second phase, the instrument made up of the Self-Regulation Inventory for Learning (SRLI) described above was applied to the student population under study. In phase 3 the independent variables are crossed with the dependent variable intrinsic motivation constructing the bar diagram of the relational analysis. The instrument was validated as reported by Reinhard and Bruce (1993) [10]. To determine the reliability of the test the internal consistency was determined using the Cronbach Alpha [18] according to equation (2):

$$\alpha = \frac{k}{k-1}\left(\frac{1 - \sum S_i^2}{S_{sum}^2}\right) \quad (2)$$

Where k is the number of test items, S_i^2 is the variance of the items (from 1 ... i) and S_{sum}^2 is the variance of the total test. The coefficient measures the reliability according to two terms: the number of items and the proportion of the total variance of the test due to the covariance between its parts (items). This means that reliability depends on the length of the test and the covariance between its items.

The dependent variable intrinsic motivation was classified into two categories: a) Low motivation (LM) (LM <75 points or less) and high motivation (HM) (HM≥ 75 points out of 100 points). The independent variables were classified into three categories: a) Low cognitive process (LCP) (score less than 70, LCP <70 points) and high cognitive process (HCP) (score equal to or greater than 70 points; PCA≥70)

b) Attitudinal processes: low attitudinal processes LAP (171< LAP≤ 213.75) and high attitude process (HAP) (213.75< HAP≤ 285. c) low previous knowledge (LPK) (LPK< 75 points) and high previous knowledge (HPK) (HPK≥ 75 points out of 100 points).

Statistic analysis: The Chi square test [19] between intrinsic motivation and the independent variables cognitive process, attitudinal process and previous knowledge was used to find out which of these factors relate 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 201 individuals is obtained. When applying the surveys, a total of 9 students per academic period and per program (4 programs, 6 academic periods) were made homogeneously for a total of 216 respondents. The Cronbach's alpha [18] yielded an average value of 0.90 indicating a high degree of internal consistency of the test.

The Chi-Square test was evaluated for the analysis of the relationship between intrinsic motivation and independent variables (cognitive process, attitudinal process and previous knowledge). The Table 1 shows the values of p (statistical significance) where it is also observed that there is a relation of high statistical significance between the intrinsic Motivation and the cognitive and attitudinal processes of the students ($p < 0.05$). The statistical significance between the intrinsic motivation and the cognitive and attitudinal processes allows to infer that the engineering student of the University of Cartagena is a student that reaches recognition, success and self-realization since he has surpassed some of the necessities established in the pyramid of Maslow 1968) [1]. In the same way, the results allow you to check the claims of Santrock (2002), as the correspondence between the attitude, cognitive processes and the motivation could be considered as the set of reasons why engineering students behave the way they do in the faculty, that is to say, by maintaining a self-regulate intrinsic motivated behavior, vigorous, targeted and sustained [2]. These results also corroborate the approaches of Ausubel (1981) because in the engineering students the reason for purchasing the disciplinary knowledge, is associated with itself, that is to say, it is intrinsic and is a consequence of the need to discover and know something significantly [3].

In addition, these results mean that intrinsic motivation and cognitive process correspond, that is to say, a intrinsically motivated student is a student who possesses self-esteem without fear, is self-regulated, has the capacity to overcome new challenges, facilitates your cognitive process, progresses making decisions that allow him to reach his academic goals as proposed by Zaccagnini (2011) [4]. In the same way, this relation allows us to infer that the intrinsically motivated student has self-determination (control of the action), competence (ability to face challenges) and feelings (satisfaction of the person in developing a task) that is to say, it is associated with the person developing generic and specific competences allowing significant learning according to what was proposed by Ausubel (1981) and Huertas (1997) [3, 5].

The results allowed to verify that two of the factors that are associated with the cognitive processes are the intrinsic motivation and the student attitude, which allows the students to efficiently process the disciplinary information besides to develop own competences in its area of knowledge according to as posed by Fong et al (2017) [9]. The intrinsic motivation does play a relevant role in the student's meta-cognition, since it is significantly associated with attitude rather than previous knowledge, that is, engineering students do employ basic elements such as attention, storage, retrieval of data and execution of the task in its formative process according to the proposed by Lindner et al. (1993) [10]. In addition, cognitive processes are organized in a complex way in the minds of the same according to the approaches of Calfee (1981) [11] and Ríos (1998) [12].

The results allow to infer that the own structure that guides the behavior of the students of engineering when tracing an academic goal is the intrinsic motivation that it possesses. In addition, the student of Engineering of the University of Cartagena has a positive trend at the time of assuming a task as it has a high cognitive potential. With this checked the approaches of Eagly et al. (1993), Fong *et al.* (2014) y Araya *et. al.*(2002) [13, 14, 15]. Finally, the statistical significance between the intrinsic motivation and attitude of students of Engineering of the University of Cartagena allows to infer that the predisposition to learning which possess the engineering students of the University of Cartagena is due in large measure to the daily interactions you have with the environment due to its academic activity thus checking the approaches of Cueto *et.al.* (2003) y Fong *et. al.* (2017) [16, 17].

On the other hand, the results show that there is no relation of statistical significance between intrinsic motivation and previous knowledge ($p > 0.05$). It can´t be verified that previous knowledge plays an important role in the student's metacognition when it interacts with an object of attitude as posed by Lindner et. to the. (1993) and Fong et.al. (2017) [16, 17].

Table 1 Chi-Square Test for Intrinsic Motivation

Variable	Chi Square	GL	p Value
Cognitive Process	7.15	1	0.008**
Attitude Process	19.8	1	0.00**
Previous Knowledge	0.015	1	0.903

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

Figure 1 shows the bar chart between the intrinsic motivation and the student´s attitudinal process.

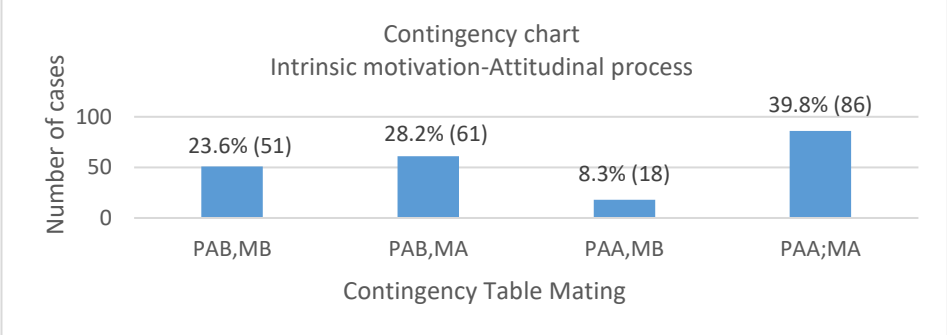

Figure 1. Bar chart intrinsic motivation - student attitudinal process.

According to Figure 1, it is very rare for students with high attitudinal processes (HAP) to have low intrinsic motivation (LM) as shown in Figure 1. Only 8.3% (18 cases) of the students in the sample showed this tendency, that is, they face their academic exercise in the best way but in the process, something is affecting their disposition towards learning because they lose or decrease their intrinsic motivation. The 39.8% represented in 86 cases have a high attitudinal process (HAP) and high intrinsic motivation (HM), that is, almost half of students in the research showed great self-determination, competence and feelings when advancing an academic exercise. The 28.2% (61 cases), which corresponds to almost a third of the sample, have a low attitudinal process (LAP) despite having high intrinsic motivation (HM), this may be due to some kind of economic, sentimental or family that impinges on their attitude but not on their motivation towards learning. The 23.6% (51 cases), which corresponds to almost a quarter of the sample, have a low intrinsic motivation (LM) and a low attitudinal process (LAP). This, in addition to corroborating the statistical significance between motivation and attitude, is probably due to the considerations of Maslow (1968) [1] where perhaps low self-esteem is the product of some unmet need that is affecting these students in a decisive way.

Figure 2 shows the bar chart between the intrinsic motivation and the cognitive process of the students.

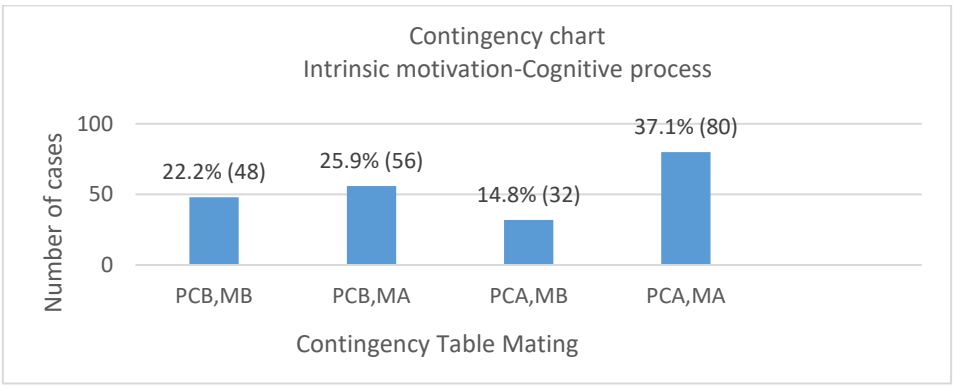

Figure 2. Bar chart intrinsic motivation - cognitive process.

The 37.1% (80 cases) in addition to corroborate the statistical significance between the intrinsic motivation and the student's cognitive process indicates that a student with high motivation (HM) toward your academic exercise, it is very likely that due to his perseverance and persistence scope to develop high cognitive processes (HCP). The 14.8% (32 cases) that corresponds to almost the sixth part of the sample develop a high cognitive process (HCP) despite having a low intrinsic motivation (LM), this may be due to an unmet need in Maslow's Pyramid (1968) [1] which in addition to worrying, affects his self-esteem but not his intellectual abilities. The 25.9% (56 cases), which represents a quarter of the sample develop low cognitive processes (LCP) despite having high intrinsic motivation (HM); this may be due to academic limitations or of interpretation on the student. Finally, the 22.2% (48 cases), which corresponded to almost one-fifth of the investigated, presented low cognitive processes (LCP) associated with low intrinsic motivation (LM); this validates the statistical significance between motivation and cognitive process in students. In addition, this correspondence may be due to a student with low self-esteem, unmet needs, family problems and perhaps financial problems affect the good cognitive development of students in facing a learning activity.

Conclusion

Based on the analysis as above, it is concluded as follow:
The processes of significant learning faced by students of Engineering of the University of Cartagena are based on the beliefs, allocation and orientation toward the goal that assumes the student associated with the needs met, established in the Maslow pyramid (1968) and who draw a north to reach the top of personal and professional self-realization through a positive attitude and intrinsic motivation that is built from their professional objective and goals. Teaching-learning processes for engineering students should be addressed by enhancing the motivational and attitudinal processes that allow them to develop without drawbacks complex and comprehensive cognitive processes without inconvenience. For this reason, it is necessary to design strategic university development plans that support attitudinal development activities, either through psychological techniques or social work, rather than through academic reinforcement workshops. The results allowed to verify a statistically significant relation to a level of confidence of 95%, between the intrinsic motivation and the attitudinal processes of the engineering students. This means that the individual's own factors have a significant impact on the cognitive and learning processes that allow him to develop specific and disciplinary competences in his area of professional performance.
According to the results of the study there is a statistically significant relationship at a 95% confidence level, between intrinsic motivation and cognitive processes. This means that the engineering student possesses an intrinsic motivation that possibly comes from his self-determination, competence, feelings, high self-esteem, love for his profession, fear of rejection, aptitude and positive attitude which allow him to reach goals and achievements of his personal self-realization in accordance with approaches Maslow's (1968) [1]. The results of the present study

showed that there is no statistically significant relationship between intrinsic motivation and knowledge previous to a 95% confidence level in engineering students. This means that the previous knowledge that the student arrives at his high school does not affect when planning and organizing his learning at the University. These results did not allow to verify the affirmations of Barbera (1999) [6].

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