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Learning strategies in higher education

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Abstract

This work presents a study carried out with students of the faculty of engineering in a university, in which there are identified the learning strategies used by them and the relation with the variables: academic performance, gender, social stratum, type of school and type of engineering studies. In this study, several statistical tools were used to analyze the information obtained through a survey, such as descriptive analysis, logistic regression and decision trees; the results obtained in each of the statistical analysis were compared among them; in addition, there are presented several proposals resulting from data analysis.

In the logistic regression, it was evaluated the relation between the students' academic performance and the other study variables, with a 61.3% prediction of correct cases; as for the results obtained with the decision tree, it was observed a coherence with what was shown by logistic regression.

Keywords: Learning strategy, academic performance, higher education, logistic regression, decision trees.

Introduction

The present research work is a study about the learning strategies used by the students of the Faculty of Engineering of a university, and their relationship with the variables: "gender", "type of engineering", "type of school", " social stratum" and "academic" performance;" in addition, there are analyzed the factors that can influence the academic performance of the students of the faculty.

Through different statistical analyzes, such as logistic regression and decision trees, the existing dependence between academic performance and the other study variables is deepened, the objective of this research was to identify the variables that may affect to a greater or lesser extent, the performance of students within their professional careers.

The descriptive statistical analysis made it possible to demonstrate the tendency of use of the different learning strategies, according to the gender of the students, the type of engineering, the type of school from which they come, the social stratum to which they belong, and their current academic performance.

A series of study techniques are proposed that can help students to improve their academic performance and level of knowledge apprehension, as well as suggestions for teachers to become more involved in the students' learning process, and to contribute to the strengthening of knowledge and competences of students.

Education and learning

The concept of education has been a widely used term for many centuries; Pythagoras said that education consisted in "tempering the soul for the difficulties of life;" while Plato said that "education is the process that allows humankind to become aware of the existence of another, fuller reality, to which they are called, from which they proceed, and towards which they are directed "(Verdugo 2007). The General Law of Education (Law 115 of 1994) defines it as a "process of permanent, personal, cultural and social formation that is based on a comprehensive conception of the human person, their dignity, their rights and their duties."

Education, as stated by Montanha (2013), is one of the most important social instruments to promote national development, which allows the individual transposition of marginality; without it, a productive country cannot be built, nor expand national consumption or be competitive; therefore, if it can be provided an education where everyone can understand the existing knowledge, then a better use of this will achieved.

Acevedo and others (2009) affirm that the students are all different, that they have different types of personality, and the learning strategies are, in turn, diverse; and it is learnt with different modalities. Fariñas (1995) adds that the character of people (each person) is unrepeatable, and each of the students has their own way of learning, a unique development potential, of an eminently motivational nature, in which personal preferences significantly influence. Likewise, Monroy and Pina (2014) mention that the motivation, the personality traits, the conceptions and teaching methods of the teachers, the amount and type of task influence the way of learning of the students.

Studying the different ways in which people understand, analyze and structure information to learn, involves many aspects that can contribute to the understanding of learning processes in humans (Bahamón and others 2013). Pozo and Postigo (1993) say that "the application of these strategies is not automatic but controlled, they require planning and control of execution and are related to metacognition or knowledge about one's own mental processes, they involve a selective use of one's resources and available skills, in order for students to be able to implement a strategy, they must have alternative resources, among which they decide to use, according to the demands of the task, those that deem most appropriate.

According to the above, it is not possible to use the same learning strategy for all the programs of the Faculty of Engineering; it may not even be possible to apply a single one for the same students of an engineering program, due to the differences that people present. However, it is not restricted that students from the same engineering or faculty program may present similarities in the techniques used to acquire their knowledge, since these are somehow part of what can characterize the learning techniques that have students from one program to another.

Learning strategies

Learning strategies have been a topic of interest for a long time, because as it was mentioned above, education is the way for the development of a country and the improvement of the quality of life of people. Knowing the basic theories of education is no longer enough, as Rianudo and González (2002) say, the world has evolved and therefore, people have had to adapt to these changes, where the use of technology is the common denominator.

All kinds of theories and educational models have been implemented in all educational institutions, with the aim of creating a clear vision of the world and the behavior that we have today. Learning is a complex variable that has been defined in different ways and in which different processes converge. They refer, in general, to an acquisition of knowledge or behavior, a change in cognitive structures (Del Valle and Urquijo 2015).

According to Porter (cited by Martínez and Rentería in 2006), the strategies refer to the creation of complex designs based on the analysis that provides a valuable and original position, articulated with a whole structure of actions and behaviors directed towards a specific objective. Learning also implies the creation of links between the mental, the socio-emotional, the sensorimotor and the neurological, which affects personal, relational, cognitive and symbolic factors linked to changes, or reorganizations. In this perspective, learning is a process that allows knowledge and is based on continuous processes of cognitive balances, in which successive elaborations of structures are made. Traditionally, learning strategies have been conceptualized as a combination of cognitive and metacognitive processes (Peculea and Bocos 2015). The new theories of learning suggest to offer students the necessary tools, so that the master classes be reduced to scenarios where ideas be exposed, and there be materialized concepts directed to self-training, through the experience gained and the use of the necessary means to achieve this experience (Ríos and others 2012).

Gonzalez and Diaz (2006), add that the entrance to the university represents for students a greater academic demand, for facing a great content of materials to learn. The high degree of difficulty and rigor in its structure makes it necessary to resort to certain strategies that facilitate its acquisition, and therefore, its learning. Reports from some investigations have found that for students, learning is often rote, that they are not strategic, and therefore their academic performance is poor

According to Beltrán (2003), a determining factor for good learning and optimal academic development is the use of learning strategies. When this happens, students can appropriate an elaborated, orderly and meaningful form of the curricular contents. Evaluating its use in university students is fundamental, finding that these are directly related to the quality of learning, allowing to identify and diagnose the causes of high and low academic performance.

Characteristics of learning strategies

Lima (2009) mentions a series of characteristics of learning strategies, which are:

They promote effective learning.

They allow to sequence, order and work with accuracy the contents for a better use.

They avoid improvisation.

They give security to the actors (learner, teacher).

They favor self-confidence.

They encourage cooperative work.

They make dynamic the teaching-learning process.

They favor participation and socialization.

They avoid rote memorization of the teaching material.

Students stops being receivers to become actors of their own learning, managers of their own knowledge.

Classification of learning strategies

There is no universal classification regarding learning strategies; however, some authors agree on this classification. For the study to be carried out, it will be taken as a classification of the learning strategies considering how information is processed in the brain according to Román and Gallego (1994), so the learning strategies are divided into:

· Information acquisition strategies

· Information coding strategies

· Information retrieval strategies

· Support strategies for information processing

The first three strategies are cognitive processes responsible for selecting, transporting and transforming information from the sensory environment and short and long term memory; the fourth last strategy is a metacognitive process that serves as a collaboration to the other strategies to achieve good results. (Pizano, 2004).

Materials and methods

According to the level of analysis to cover the proposed objective, a descriptive study was carried out, since the aim was only to examine the situation of students in relation to the learning strategies that they used. The population was constituted by the totality of students enrolled in the Faculty of Engineering of the University. This population has the following characteristics: it is finite and easy to access for research, the sample is census, and it is determined by the number of students who carried out the survey, which was 987 students.

Table 1 shows the number of students who carried out the survey according to the type of Engineering they were enrolled in:

Table 1. Relation of students who answered the survey

Source: self-made.

Academic program	Number of students
Agronomic Engineering	72
Environmental Engineering and Sanitary	129
Civil Engineering	170
Systems Engineering	185
Electronic Engineering	102
Industrial Engineering	247
Fishing Engineering	82

For collecting the data, the instrument used was the ACRA survey, which presents a series of questions about the study habits of the people, and which refers to a specific type of learning strategy. The survey included 31 questions, of which 2 corresponded to the level of education of the parents, 5 to the information acquisition strategy, 6 to the information coding strategy, 11 to the information retrieval strategy, and 7 to the strategy of support for the processing of information.

There were 5 response options in the survey: “never”, “almost never”, “sometimes”, “almost always” and “always”. Each one of them represents the frequency in the use of the study technique to which reference is made. For the analysis of the results, it is assigned a value to each answer group, being codified in the following way:

Table 2. Coding of the answers

Answer	Coding
Never	0
Almost Never	0
Sometimes	0
Almost always	1
Always	1

Source: self-made.

After obtaining the completed surveys, we proceeded to perform the respective statistical analyses, and thus obtain a basis on which to make a series of proposals for future research or application of the results in the University.

Results

The distribution of students according to each learning strategy is presented below:

Table 3. Learning strategies (that were) used (by students)

Learning strategy	Number (of students)	%
Acquisition	372	37.7
Coding	74	7.5
Recovery	169	17.1
Support	372	37.7

Source: self-made.

Logistic regression

The results of the logistic regression model were obtained with the SPSS 21.0 program, and which are shown in table 4:

The value of Exp (B) represents the times in which a result of one variable is better than another; that is, given a response to a variable, this influences to a greater or lesser extent the expected result for the dependent variable (Performance academic). Ibarra et al. (2010) mention that a positive sign in (B) causes an increase in the probability of the event; while a negative sign, decreases it. In the case that the coefficient is zero or close to zero, it gives a value close to one; that is, it does not affect the probability of occurrence (or not) of an event.

Table 4. Results of the logistic regression model

		B	E.T.	Wald	gl	Sig.	Exp(B)
Step1[a]	Program			50,090	6	,000	
	Program(1)	-,121	,383	,101	1	,751	,886
	Program(2)	1,524	,314	23,615	1	,000	4,590
	Program(3)	,726	,301	5,814	1	,016	2,067
	Program(4)	1,338	,297	20,334	1	,000	3,810
	Program(5)	1,053	,325	10,518	1	,001	2,866
	Program(6)	1,204	,287	17,613	1	,000	3,334
	Constant	-1,131	,257	19,357	1	,000	,323
Step 2 2[b]	Gender(1)	-,460	,156	8,740	1	,003	,631
	Program			49,642	6	,000	
	Program(1)	-,090	,384	,055	1	,815	,914
	Program(2)	1,491	,315	22,356	1	,000	4,440
	Program(3)	,778	,303	6,581	1	,010	2,176
	Programa4)	1,432	,300	22,778	1	,000	4,189
	Programa5)	1,193	,330	13,083	1	,000	3,296
	Programa6)	1,182	,288	16,812	1	,000	3,262
	Constant	-,829	,276	8,980	1	,003	,437
Step 3[c]	Gender(1)	-,473	,157	9,054	1	,003	,623
	Program			49,947	6	,000	
	Program(1)	-,112	,387	,084	1	,772	,894
	Program(2)	1,499	,317	22,400	1	,000	4,479
	Programa3)	,799	,305	6,875	1	,009	2,223
	Program(4)	1,443	,301	22,902	1	,000	4,232
	Program(5)	1,210	,331	13,360	1	,000	3,352
	Program(6)	1,180	,290	16,580	1	,000	3,253
	Strategy			8,865	3	,031	
	Strategy(1)	,120	,153	,613	1	,434	1,128
	Strategy(2)	,313	,265	1,392	1	,238	1,367
	Strategy(3)	,559	,194	8,317	1	,004	1,750
	Constant	-,990	,297	11,080	1	,001	,371
a. Variable(s) entered in step 1: Program.							
b. Variable(s) introduced in step 2: Gender.							
c. Variable(s) introduced in step 3: Strategy.							

To evaluate the model with all the variables included in the model, we start from the following logistic regression equation:

$$P(Y=1) = \frac{1}{1 + exp\,\hat{}(-\alpha - \beta_1 X_1 - \beta_2 X_2 - \cdots - \beta_n X_n)}$$

When including the variables of the model, the following equation was obtained:

$$P(Rendimiento = Bueno) = \frac{1}{1 + \exp^{\wedge}(0{,}990 + 0{,}112P1 - 1{,}499P2 - 0{,}799P3 - 1{,}443P4 - 1{,}210P5 - 1{,}180P6 - 0{,}120E1 - 0{,}313E2 - 0{,}559E3)}$$

In which:

= program (1) (Agronomic Engineering)

= program (2) (Environmental and Sanitary Engineering)

= program (3) (Civil Engineering)

= program (4) (Systems Engineering)

= program (5) (Electronic Engineering)

= program (6) (Industrial Engineering)

= strategy (1) (Acquisition)

= strategy (2) (Coding)

= strategy (3) (Recovery)

The presented model can predict in 61.3% of the cases if a engineering student of the university can have a good or low academic performance.

Decision trees

In the development of the research, it was graphed a decision tree in order to show the relationship between academic performance and the variables "gender," "type of engineering," "social stratum," "type of school" and " learning strategy," which is observed in figure 1.

In Node 1, there are students of the Agronomic, Fishing and Civil Engineering programs, which represent 32.8% (324 students) of the total number of students, and it is appreciated that 67.9% (220 students) of these have a low academic performance and 32.1% (104 students) a good performance, which reinforces what is stated in the logistic regression analysis, where it is presented that these three programs have the lowest values of (B) and Exp(B) within this variable (in descending order: Civil, Fishing and Agronomic Engineering programs). Node 1 is divided into nodes 3 and 4, belonging to students of the Civil Engineering program (node 3) and Agronomic and Fishing Engineering (node 4). In the case of students of the Civil Engineering program (node 3), it is observed that 40% of them have a good academic performance; while the Agronomic and Fishing Engineering programs (node 4) only have 23.4 % of students with good academic performance.

Node 2 includes Systems, Industrial, Electronics, and Environmental and Sanitary Engineering programs; and they represent 67.2% (663 students) of the total number of students; of these, 53.7% (356 students) have a good academic performance, while 46.3% (307 students) have a low performance. Node 2 in turn is divided into nodes 5 and 6, which represent students according to the variable "gender", which is the second most significant variable of the model for these types of engineering. For the case of the 663 students of the Systems, Electronics, Environmental, Sanitary, and Industrial engineering programs, 18.4% (182 students), of 67.2% of students classified in node 2, belong to female gender, and 48.7% (481 students) are of male gender.

In the case of female gender, it is observed that 68.2% (115 students) have a good academic performance and 36.8% (67) have a low performance. The women classified in node 5 present an internal classification according to the type of strategy that they use; 6.1% use the support strategy (node 7), and 12.4% the other strategies (acquisition, coding and recovery; node 8). For those who use the support learning strategy, 51.7% have a good academic performance; while for women who use the strategy of acquisition, coding or recovery, 68.9% have a good academic performance. No more classifications are presented for women, since it is understood that the model does not find the other variables significant when predicting their academic performance.

For male students, 50.1% (241 students) have a good academic performance and a percentage close to 49.9% (240 students) a low performance. In the case of men, one of the variables that influences their performance is the engineering program to which they belong, represented in nodes 9 (Systems, and Environmental and Sanitary Engineering) and 10 (Industrial and Electronics Engineering). 55.4% (129 students) of students of the Systems, and Environmental and Sanitary Engineering programs have a good academic performance, while 44.6% (104 students) have a low performance. For men who are studying these engineering programs, their original school type affects their academic performance, as seen in nodes 11 (state) and 12 (private); 58.4% of men who come from a state school have a good academic performance, while this same result in the performance is obtained for 46.7% (28 students) of those who come from a private school. The decision tree ends in the type of school for the case of the men of the Systems and Environmental and Sanitary Engineering programs, because the other variables do not significantly influence their academic performance.

45.2% (112 students) of the classified men who study Industrial and Electronics Engineering (node 10) have a good academic performance, while 54.8% (136 students) have a low performance; in this case, the variable that allows to better predict the academic performance of the men belonging to the Industrial and Electronic Engineering programs is the social

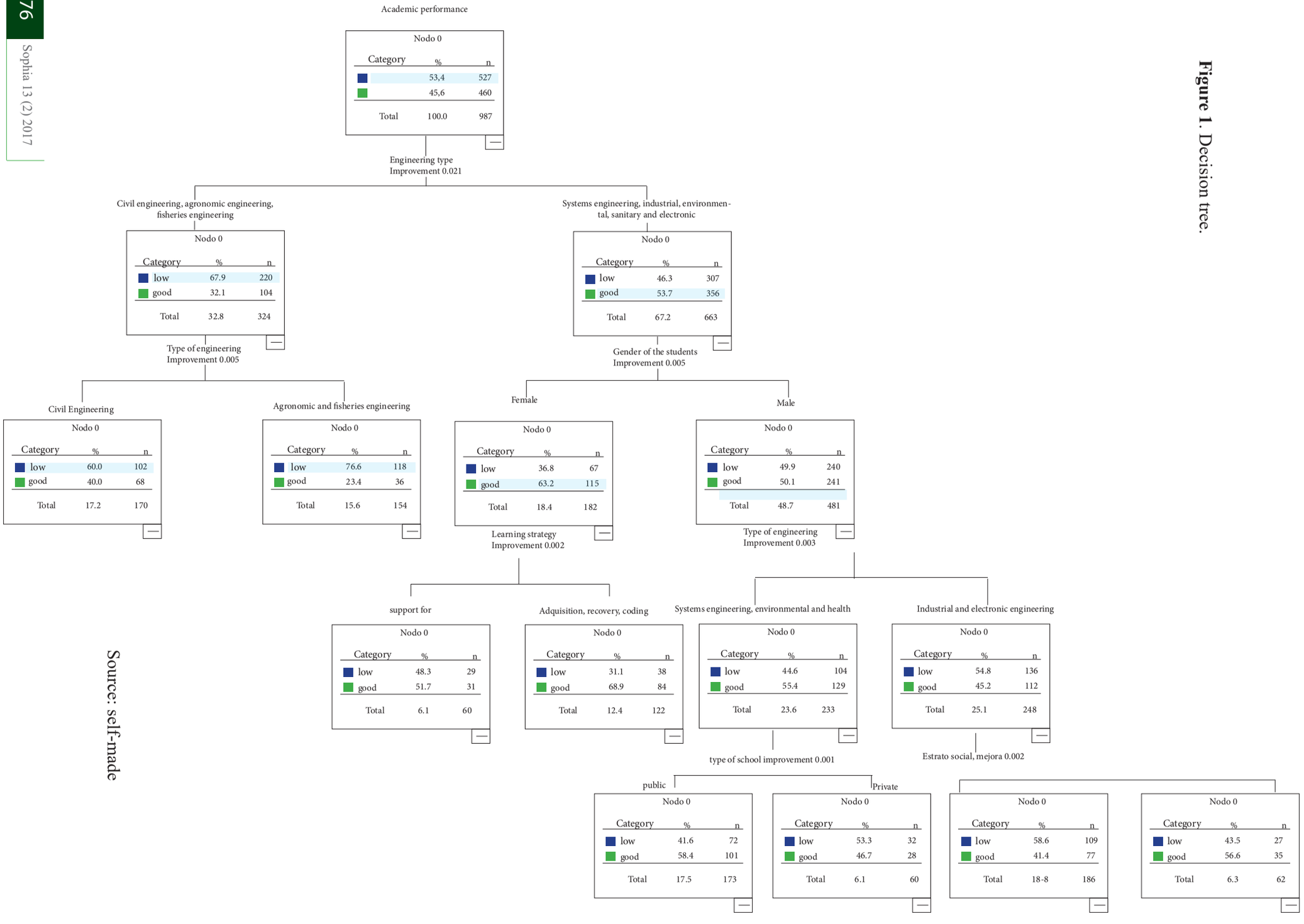

Figure 1. Decision tree.

Source: self-made

stratum: 41.4% (77 students) of students who are within the stratum categories 1 and 2 (node 13) have a good academic performance, and 58.6% (109 students) a low performance; while 56.5% (35 students) of men belonging to the category of stratum 3 (node 14) have a good academic performance, and 43.5% (27 students) have a low performance.

Table 5. Classification of students

Observed performance	Predicted performance	Good	% correct
Low	361	166	68.50%
Good	209	251	54.60%
Global %		42.20%	62%

Growth methods: CRT. Dependent variable: Academic performance.

Source: self-made.

Discussion

The results obtained by logistic regression show that the levels gender=female, program=fishing engineering, and strategy=support are the reference values for the model; therefore, they have a coefficient (B=0) and an Exp(B)=1; and the entire analysis was performed comparing the other results obtained according to these levels.

According to Table 4, it can be seen that the case of the variable "Gender (1)" ("male") results with a negative coefficient (B=-0.460) and the value of Exp(B) (0.623) is lower than one, indicating that male students (= 1), when the other variables remain constant, are 1.6 times less likely to have a good academic performance with respect to those of the female gender (= 0). This probability ratio was determined taking into account the change ratio of Exp(B), when the coefficient (B) changes from 0 (male) to 1 (female).

In the variable "Type of engineering", it is observed that in the case of "program (2)" (Environmental and Sanitary Engineering), its coefficient is positive (B=1,499) and its Exp(B)=4,479, which indicates that students of the environmental and sanitary engineering program are 4.48 times more likely to have a good academic performance in relation to students of the Fishing Engineering program. For the case of "program 1" (Agronomic Engineering), we have that the coefficient is negative (B-0,112) and its Exp(B)=0,894, which is lower than one; therefore, a student of Engineering Agronomic is 1.12 times less likely to have a low academic performance than a Fishing Engineering student.

For the case of the variable "Learning Strategy," we have that the 3 answers given in the model have positive coefficient and their Exp(B) are greater than one, and although the difference between one and another is not much, it can be noted that those students who use "strategy (3)" (Learning Strategy=Recovery) are 1.73 times more likely to perform well than those who use the support learning strategy.

The results presented in the decision tree (Figure 1), agree with the results of the logistic regression, where it is analyzed that the programs with more probability of finding students with good academic performance are Environmental and Sanitary Engineering, and Systems Engineering; and those students belonging to the Fishing and Agronomic Engineering programs are the ones with the lowest academic performance. In the case of gender, the results coincide as the results obtained show that women have a greater probability of a better academic performance than men. This tree allowed to detail a bit more the relationship between the variables and the most probable prediction for a student according to a set of variables; for example, no matter the gender, strategy, type of school or stratum, the students of the programs of Agronomic and Fishing Engineering are more likely to have low academic performance, compared to other programs; a woman is more likely to have a good academic performance than a man; and if she uses the strategy of acquisition, retrieval or coding, her probability of having good performance increases more compared to if she uses the support strategy.

Table 5 shows that the model obtained from the decision tree can predict correctly the performance in approximately 62% of cases. This model predicts a little better the academic performance of students, compared to the obtained logistic regression model, which had general accuracy in approximately 61.3% of the cases. For each category of academic performance, the model offers a slightly higher accuracy in the case of predicting a low performance, with 68.9%.

Proposals

According to the results obtained in the course of this research, the 4 learning strategies are defined as important, and a good use of them allows learning to be successful; but for this, they must be used together, since they present a series of techniques that complement each other and therefore are useful when making better use of knowledge.

The first step to acquire knowledge is to pay attention, so in order to favor these processes in students, as well as the control or direction of any cognitive process towards what is really relevant to it, we recommend:

- Teachers should provide the academic material before the class, so that students can read

about the topic and get to the class to resolve concerns. This material must be organized for greater understanding.

- Students should highlight lines or words that they consider key to remember the key data of each topic.
- Students should review the topics studied in class, either mentally or aloud (or both), so that the repetition improves the memory of the subject.
- In subjects that involve the use of formulas or mathematical or statistical procedures, it is important that teachers provide material with numerous exercises that help students understand their behavior and thus understand the concepts.

After students acquire knowledge, it is important that they encode the information; that is, that they can be able to understand it and keep it for long periods. To help ensure that information is not lost or forgotten quickly, it is important that the following techniques be carried out:

- Reduce the information received to a keyword or phrase, in order to have an easy recall and thus evoke it in a simple way in the future. This also helps to have quick access to information and thus associate it in the future with new knowledge.
- Construct images that represent the information received to keep it and remember it easily.
- Paraphrase a concept or idea of the teacher or an author, since by explaining it with students' own words, they will be able to understand it and remember it.
- Construct conceptual maps or summaries helps to consolidate the given (received) information and capture the most important of it for its application.

In order to improve the memory search systems and speed up the generation of responses, the following techniques must be taken into account:

- Having the information ordered makes it easier to resort to it at any time; that is, if the techniques expressed above are consciously carried out, students can have quick access to all the information that the memory has stored.
- Sorting ideas and writing them helps make it easier to remember or retrieve the information requested at a certain time.

To help boost student performance by increasing motivation and self-esteem, it is necessary to do the following:

- Students should be told words of encouragement to build confidence in them and their abilities.
- Teachers should encourage students, not with grades, but with words that fill them with confidence, encouraging them to trust their own abilities so that they feel they can understand everything they are taught.
- Students must control (their own) anxiety; this is achieved by thinking about what they will achieve with a good study; if they have the confidence to do things, it will be easier (for them) to concentrate.
- Teachers must provide sufficient time for students to prepare adequately for evaluations; and students must allocate (their) time, so they can understand the concepts without unnecessary hassles.
- When studying, it is vital to do it in a clean place (and) with adequate lighting, in order to avoid fatigue.

Conclusions

The results obtained in each of the statistical analyses were contrasted in order to verify a coherence between them and thus have tools that will help to sustain the statements expressed throughout the document.

In the logistic regression, the relationship that existed between the academic performance of students and the other study variables was evaluated, emphasizing the incidence and impact of the change of one of them with respect to the academic performance, obtaining at the end of the analysis a mathematical model that could predict the performance of a student according to a combination of options of the other variables, with a correct prediction of 61.3% of cases. The results obtained with the decision tree indicate a correct prediction of the academic performance of 62% and show coherence with the logistic regression.

The descriptive analysis indicates that the use of learning strategies does not show a marked tendency in relation to the other variables; however, it was observed that the majority of students who completed the survey use learning strategies of acquisition and support, also showing a tendency to have a low academic

performance by students. Analyzing the purpose of each of the learning strategies, it was determined that the coding and recovery strategies allow students to keep knowledge in their long-term memory, and also to be able to evoke it when necessary, and thus relate it to new one.

All the learning strategies are important and complementary; they allow, from different techniques, that the received knowledge be apprehended and can be applied and handled with ease by the person who uses it. According to the type of knowledge, it is necessary to use some technique for learning that improve the receptivity to it and, therefore, contributes to its better use.

The applications of this type of research study allow identifying some learning strategies that influence the academic performance of undergraduate students, with which educational institutions could develop intervention programs to enhance them. From the results of this research, the following is highlighted: that women are more likely to have a good academic performance compared to men; and that social stratum or type of school does not have a significant influence on the academic performance of students.

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