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Academic Performance And Beliefs About Mathematics In College Students

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Abstract

The objective of this research is to consider the possible relationship between academic performance and university students' beliefs about Mathematics, particularly in the subject of Integral Calculus. The methodology employed is quantitative, descriptive and correlational, based on a non-experimental design. The instrument used for the collection of information was based on a structured questionnaire of questions with Likert scale type answers, whose validity and reliability were studied, applied to 30 Mechanical Engineering students of the Universidad Francisco de Paula Santander, Cúcuta,

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Norte de Santander, Colombia, selected by non-probabilistic sampling. For academic performance, the grades of the first pre-test (corresponding to 23.33 % of the final grade of the subject) of Integral Calculus were used. The results strengthen the conclusion that beliefs about Mathematics, from the students' perspective, are related to their academic performance in this area.

Keywords mathematics education, beliefs, college students, academic performance.

Introduction

The teaching-learning process of mathematics generates many difficulties in students, especially in higher education, of different nature. Some of them have their origin in factors such as low academic performance, high absenteeism rates, etc. High dropout rates, mainly in higher education, have been identified as consequences of these difficulties encountered by students and have become concerns of governmental educational institutions, as well as teachers at all educational levels (Chong, 2017). Within this wide range of options, a great interest arises in the study of the affective domain of Mathematics considering it is composed of beliefs, attitudes and emotions about the teaching/learning of this subject (Fernandez et al., 2018). It is presumed that many students do not like Mathematics. In addition, they are usually seen by university students as a subject with no use in life, difficult, boring, in general, impractical, asserting that its teaching-learning requires additional time for its dedication and that it is not affordable for everyone (Castillo-Sánchez et al., 2020). Undoubtedly, many aspects influence this fear, for example, the attitude of mathematics teachers towards students, the teaching styles and the attitudes and beliefs towards mathematics that are transmitted to them. These beliefs, both of teachers and students, very possibly influence inadequate learning of mathematics and even grade repetition and dropout (Cosgaya-Barrera & Castro-Villagrán, 2019).

A change in the perception of the teaching-learning of mathematics by university students and teachers, especially in higher education, is necessary. In general, in Colombia, depending on the university and academic program, Mathematics teachers are mostly teachers of other specialties different from Mathematics Education graduates, which suggests that their liking for Mathematics is debatable.

In the Colombian context, the Ministry of National Education (Mineducación), through processes such as those required for qualified registrations and high-quality accreditation, emanates quality criteria and referents for the different areas and components that make up a university educational community, thereby promoting the strengthening of academic programs and the improvement of teaching/learning (Decree 1330, 2019).

One way to evaluate the teaching/learning processes and programs is the academic performance of students (Tourón, 1984), defining university academic performance as a result of learning, elicited by the educational activity of the teacher and produced in the student and which is expressed in a grade, quantitative or qualitative in many cases, or a grade, which is consistent and valid will be the reflection of certain learning or level in which pre-established objectives have been achieved. Grades are the reflection of the evaluations and/or exams where the student has to demonstrate his or her knowledge of the different areas or subjects (Cascón, 2000). In most cases, to evaluate the student's academic performance, the teacher relies on the grades or marks taken in the different subjects studied by the student. It could be said that academic performance would be evidence of the ability and effort that the student displays in the classroom, without underestimating his or her attitude and aptitude.

However, academic performance is not the only way to measure the success of the teaching/learning process, since other factors influence it, such as, for example, the breadth of the curricula, the teaching methodologies used, the possibility of employing personalized teaching, the previous concepts that students have, as well as the level of formal thinking that students develop (Benítez et al., 2000).

It seems clear that the most recurrent indicator of academic performance is the grade (Hernández, 2016), and they are considered the reference of academic results since grades constitute in themselves the social and legal criterion of the student's academic performance. Likewise, the grade has an informative purpose for parents and academic authorities in educational systems.

In summary, it can be said that academic performance is an indicator of the level of learning achieved by the student. It is the effect of the different actions that take place in the educational environment in many cases, interpreted as success or failure in the study. So, the university education system attaches great importance to this indicator.

In addition, students with higher mathematical self-concept and higher expectations obtain better grades attributing more dedication to effort than students with lower or low mathematical self-concept (Sampascual et al., 1994). In conclusion, students with higher self-concept beliefs about doing well in mathematics with higher intrinsic motivation obtain better results in learning mathematics, regardless of whether the students have learning problems or not (Pintrich et al., 1994).

Therefore, the present research was developed to determine to what extent there is a relationship between the affective domain towards mathematics in these university students and academic performance in the subject of Integral Calculus.

Methodology

The research approach is quantitative, with a non-experimental, cross-sectional correlational-causal design (Arias, 2012), which allows us to determine the relationships between beliefs about mathematics and academic performance.

Population and Sample

The population consisted of 70 students enrolled in two groups in the year 2019 in the subject of integral calculus in the Mechanical Engineering program of the Universidad Francisco de Paula Santander de Cúcuta, Norte de Santander, Colombia. For the sample, the first group was taken, composed of 30 students of the male and female gender, aged between 17 and 25 years old, selected by non-probabilistic sampling.

The composition of the sample in terms of gender is shown in Table 1.

Table 1 Student Gender

Gender	# of students	Percentage	Cumulative percentage
Female	3	10.0%	10.0%
Male	27	90.0%	100.0%
Total	30	100.0%	

The ages of the students in the sample are shown in Table 2.

Table 2 Age of Students

Age in years completed	# of students	Percentage	Cumulative percentage
17	6	20.0%	20.0%
18	12	40.0%	60.0%
19	5	16.7%	76.7%
20	3	10.0%	86.7%
21	1	3.3%	90.0%
22	2	6.7%	96.7%
25	1	3.3%	100.0%
Total	30	100.0%	

Instruments

The technique used to obtain the affective domain data was the survey. The questionnaire was divided into 3 sections: The first on general information, the second on the affective domain, and the last section referring to mathematical processes in teaching practice. The reliability of the instrument was validated with the Cronbach's Alpha test, obtaining a result of .713 for the whole instrument. However, in this advance of the research, only the results referring to beliefs about mathematics and their possible relationship with academic achievement in mathematics are presented.

The variables established are:

Beliefs about Mathematics

It consists of a 13-question Likert scale-style questionnaire. Students responded to the questionnaire using one of the following alternatives: 1, meaning “I strongly disagree”, 2, “I disagree”, 3, “I neither disagree nor agree”, 4, “I agree”, 5, “I strongly agree”, according to their level of approval. Indicating their positive criterion in favor of increasing the item's value.

Table 3 Items Associated With Beliefs About Mathematics

Second section. Affective Dominance Toward Mathematics					
Ítems asociados con las Creencias sobre las Matemáticas	1	2	3	4	5
Mathematics is useful and necessary in all aspects of life.					
Mathematics is difficult, boring and far from reality.					
In mathematics, it is essential to learn by heart the concepts, formulas and rules.					
Math exercises can be solved quickly if you know the formula, rule or procedure.					
To learn mathematics I must study on my own.					
When I solve a mathematical exercise, I care more about the result than the process used.					
The way I solve mathematical exercises in class is different from the way I solve everyday situations where mathematics is required.					
I look for different ways and forms to solve mathematical exercises.					
From what I do in class, I can invent my math exercises.					
Understanding mathematics helps me to solve doubts in other subjects.					
When I solve an exercise in mathematics, I feel confident in the correct answer.					
I consider myself very capable and skilled in mathematics.					
Mathematics is for intelligent and creative people					

Academic Performance

In this variable, the grade obtained in the first pre-semester of the second academic semester of 2019 was considered, ranging from 0.0 to 5.0. The valuation of the grades achieved is as follows: from 0.0 to 2.9 low performance and failure, from 3.0 to 3.9 basic performance, from 4.0 to 4.5 high performance and 4.6 to 5.0 superior performance, with a grade of 3.0 or higher are approved, according to article 118 of agreement 065 of 1996, "student statute of the UFPS". The test that constituted the first pre-test can be seen in Figure 1.

Figure 1 Items Associated with Academic Performance

PRIMER PREVIO DE CALCULO INTEGRAL

(Semestre II de 2019)

En este previo se evaluarán los temas vistos en clase, los cuales tienen que ver con el desarrollo de integrales utilizando las formulas básicas de integración las que pueden disponer de ellas, tiempo para el desarrollo del previo: 2 horas.
Desarrollar la siguientes integrales y comprobar las dos primeras por medio de su derivación (valor cada punto 1.25).

1. $\int (\sqrt{x} - \frac{1}{2}x + 2/\sqrt{x})\, dx$
2. $\int \frac{(e^{4x} - e^{2x} + 1)dx}{e^{x}}$
3. $\int \frac{xdx}{\sqrt{27+6x-x^2}}$
4. $\int \tan x \ \ln(\cos x)\, dx$

Data processing and analysis

The Excel spreadsheet was used for the presentation of the results and SPSS version 22 software was used for the statistical hypothesis contrasts and calculation of correlations. To determine the degree of association (correlation coefficient) between the study variables. Spearman's Rho was used to determine the dependence or independence of two random variables (Pérez-Tejada, 1998). Spearman's Rho correlation coefficient is used when the variables are ordinal and/or the normality assumption is not met (non-parametric approximation). This coefficient is very useful when the number of pairs of subjects (n) to be associated is small (less than 30). It is a dimensionless value ranging from -1 to +1. From the values it takes, the relationship between the variables is deduced, with the value zero meaning that there is no correlation between the variables analyzed; the value -1 is a high correlation of an indirect or inverse nature (when one grows the other decreases), and the value +1 a high correlation of a direct type (when one grows so does the other) (Aguayo, & Lora, 2007).

Hypothesis testing. A procedure that consists of contrasting a statement about a property of a population and using statistical tests to confirm or refute it. For this research advance, the following hypotheses were raised in contrast to hypotheses:

H1: There is a relationship between beliefs about mathematics and students' academic performance.
H0: There is no relationship between beliefs about mathematics and students' academic performance.

Results

The beliefs about the mathematics of the students in the sample studied are shown in Table 4**.**

Table 4 Students' Perceptions of Beliefs About Mathematics

Level of beliefs about mathematics	# of students	Percentage	Cumulative percentage
Strongly disagree	0	0.0%	0.0%
Disagree	3	10.0%	10.0%
Neither rejects nor accepts	16	53.3%	63.3%
Agree	10	33.3%	96.7%
Totally agree	1	3.3%	100.0%
Total	30	100.0%	

The grade of the first pre-requisite, a quantitative measure of academic performance, is shown in Table 5.

Table 5 Student Academic Performance

Note	# of students	Percentage	Cumulative percentage
1.7	2	6.7%	6.7%
2.0	1	3.3%	10.0%
2.5	4	13.3%	23.3%
2.8	1	3.3%	26.7%
3.0	10	33.3%	60.0%
3.5	1	3.3%	63.3%
4.0	8	26.7%	90.0%
4.1	2	6.7%	96.7%
4.5	1	3.3%	100.0%
Total	30	100.0%	

Table 6 shows Spearman's Rho correlation between the variable's beliefs about mathematics and academic performance.

Table 6 Relationship Between Academic Achievement Level and Students' Beliefs About Mathematics

Correlations			Academic performance	Beliefs about mathematics
Spearman's Rho	Academic Performance	Correlation coefficient	1.000	0.796
		Sig. (bilateral)		0.000
		N	30	30
	Beliefs about mathematics	Correlation coefficient	-------	1.000
		Sig. (bilateral)	-----	
		N	--------	30

Regarding the composition of the sample by gender and age, it is worth noting that it is evident that 90% of the Mechanical Engineering students who make up the sample are male, which is in line with other studies, such as that of Chávez (2018) in his study "Learning strategies and academic performance in the subject Mathematical Analysis II". On the other hand, the mean age of the Mechanical Engineering students who made up the sample is 18.77 years, with a range of 8 years, comprised between 17 and 25 and a standard deviation of 1.81 years. The sample shows that 40% of them are 18 years old and the most repeated age (mode) is 18 years old.

Regarding beliefs, it was found that 53.3% of the students surveyed have neither a positive nor a negative belief towards mathematics, followed by 33.3% who agree with the items raised. In the present research, 36.9% of the respondents think that they have a positive tendency to agree with the beliefs about mathematics agreeing with Mato et al. (2014).

About the academic performance of the students, they presented grades ranging from 1.7 to 4.5, with a range of grades of 2.8, a mean of 3.213 and a standard deviation of .7651. It is also shown that 33.3% of the students scored a grade of 3.0 and were able to pass the pre-test, and it also stands out that 26.7% of the students scored a grade of 4.0. The great majority, 73.3%, of the students obtained grades that indicate that they passed the pre-test. Among them, 36.7% are in high levels or higher. This high performance could be due to the influence of pedagogical practices and the teacher's mastery of mathematics content (Caciá et al., 2012). This enhances a better understanding and learning of mathematics topics by students, as stated by López-Quijano (2014).

As a relationship between performance and beliefs, Spearman's Rho correlation between the variable's beliefs about mathematics and academic performance is shown. A positive correlation is observed, that is, as the positive perception of beliefs about mathematics increases, students' academic performance increases, and vice versa. The correlation has a value of $r = .796$ and a statistically significant p-value of $p<.000$. Therefore, it can be stated that the null hypothesis (H0) is rejected if the $p=.000<.01$, resulting in sufficient statistical evidence to accept that there is a relationship between the Beliefs about Mathematics and academic performance in the students of Integral Calculus of Mechanical Engineering of the year 2019 of the Universidad Francisco de Paula Santander of the Municipality of Cúcuta, Norte de Santander-Colombia.

The correlation between beliefs about mathematics and academic achievement, which were the variables studied, is strong ($r = .796$), presenting certain concordances with the results obtained by Pintrich et al. (1994) and by Sampascual et al. (1994), which show that the achievement of success is related to internal or intrapersonal controllable causes such as effort, ability, and dedication with motivational and cognitive aspects. The results of these studies have confirmed that those students who attributed success to internal causes and control were less anxious, had higher expectations of success, were more mastery-oriented, self-sufficient, effective and metacognitive, and performed better. Additionally, students who believed that their failure was due to unstable and uncontrollable factors were less mastery-oriented, less effective, and had lower achievement expectations and lower academic performance.

In this advance, the research hypothesis is confirmed because there is a significant relationship between beliefs in Mathematics and the academic performance of the students of Integral Calculus of

Mechanical Engineering of the educational institution under study having obtained results similar to Mato et al. (2014) and Bazán and Aparicio (2006), who observed positive and significant values in all cases so that grades increase as a function of attitudes influenced by positive beliefs towards mathematics.

Conclusions

This paper has shown an advance of research that sought to establish the relationship between beliefs about Mathematics and its possible link with academic performance in university students, specifically in this case students of Integral Calculus of the Mechanical Engineering academic program. It is concluded, in light of the results, the existence of a relationship between the student's beliefs about Mathematics and their academic performance, indicating that the higher the positive increase or the better the perception of beliefs about mathematics, the better the academic performance and vice versa, the lower the perception, the lower the academic performance.

As it corresponds to a pilot study, the purpose of this study has not been to generalize this relationship but to have an approximation (partial results) to determine the relationship between these variables in a subsequent study that includes a larger number of students not only from all academic programs and semesters where Mathematics subjects are seen but also from different educational institutions at the primary level, secondary technical and university level in the Department of Norte de Santander - Colombia, to establish a triangulation between the background and the theoretical positions that support it, to account for the logics that explain their perceptions about beliefs, attitudes and emotions as constructs of the affective domain and the pedagogical practice in the mathematical processes of teachers, in terms of academic performance and the light of each of the hypotheses raised.

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