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Relationship Between The Academic Programs Of Universidad De Sucre, The Competencies In Mathematics, And The Performance Of The Students

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ABSTRACT

Below are the results of an investigation executed in order to describe the student's academic performance at the University of Sucre, in the different mathematical competencies that are evaluated by the SABER PRO test, applying a questionnaire with this type of interrogation and whose results also allow us to determine the relationship between the University of Sucre academic programs that participated in the test, the competences in the area of mathematics and the student's performance in them. In accomplishing this test, students from 5 academic programs of the university participated, such as Economics, Public Accounting, Business Administration, Agro-industrial Engineering, and Mathematics. To analyze the relationship type between these variables, a 2x2 factorial design was implemented.

Keywords: Mathematical Competencies, Saber Pro Tests, Factorial Design, Academic Performance, Descriptive Statistics.

1. INTRODUCTION

The following article shows the results of an investigation executed with the evaluating purpose, in advance, the possible results that students would have in the SABER PRO test, in the different mathematical competencies that are evaluated by it; and in this way, with the results obtained, decisions can be made that contribute to the quality improvement of the training offered to students, in mathematical competences at a higher level.

With this study's results, improvement plans can be designed that involve, among others, workshops, tests, and drills, where these competencies are evaluated, which in turn would be important for the student preparation when presenting the mentioned Test.

On the other hand, it would make it possible to identify in which of the evaluated competencies the students register strength and in which they register weakness, and thus be

able to work on the latter with a view to improving performance, without neglecting, of course, the former.

2. METHODOLOGY

2.1 Kind of investigation

The type of study to be executed is Applied Research, with a Transversal Design and a Quantitative Approach.

2.2 Study Population

The population under study are the students of the Economics, Business Administration, Public Accounting, and Bachelor of Mathematics programs at the University of Sucre.

2.3 Sample

Simple random sampling will be applied to select the students from the academic programs mentioned above who were part of the study.

2.4 Information Collection Technique

A questionnaire was designed with SABER PRO test-type questions, where the Formulation and Execution, Argumentation, Interpretation, and Representation competencies were evaluated in the mathematics area. These questionnaires were employed to the students from the Economics, Business Administration, Public Accounting, and Bachelor of Mathematics programs, chosen for this purpose.

2.5 Information processing

To collect the necessary information, a questionnaire was designed with SABER PRO test-type questions, where the 3 mathematical competencies were evaluated: Formulation and Execution, Argumentation, Interpretation, and Representation.

The questionnaire was made up of 15 questions, distributed in such a way that each mathematical competence was evaluated by 5 of them and had a value of 20 points each, for a total of 300 points, which is the maximum score of the SABER PRO test.

Once the information was collected, a 2x2 factorial design was applied.

Subsequently, and with the variance executed analysis results, it was identified whether the student's performance in the test depended or not on the academic program to which the student belongs, as well as on the competence evaluated.

For this, two variables X and Y were defined, such that:

Variable X is an independent and qualitative variable, which in this study had two categories or levels: Academic Program and Mathematical Competence.

Variable Y is a dependent and quantitative variable, which in this study represented the score recorded in each competition. These scores range from 0 to 20 points, on average, in each mathematical competence evaluated.

3. ANALYSIS OF RESULTS

3.1 Descriptive Data Analysis

The instruments where the information is collected must be reliable, in relation to this, Chávez (2007). It defines reliability as "the congruence degree with which the variable measurement is executed", for which a pilot sample of 5 students belongs to the population under study. The instrument reliability was processed using the Kuder-Richardson coefficient, which is relevant for instruments with two response alternatives (1= correct answer, 0= incorrect answers), through the Excel calculation tool a coefficient is obtained. KR of 0.772; indicating that the instrument is valid for your application. The results are shown in the following table:

Table 1. Kuder-Richardson test

ID	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	Total
1	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	4
2	1	1	0	1	0	0	0	1	0	0	1	0	0	1	0	6
3	1	0	1	1	1	1	1	1	1	1	0	0	0	1	0	10
4	1	0	1	1	0	0	0	0	1	1	0	0	0	1	1	7
5	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	11
Totales	5	2	4	4	2	1	1	4	3	3	2	0	1	5	1	
P	1	0.4	0.8	0.8	0.4	0.2	0.2	0.8	0.6	0.6	0.4	0	0.2	1	0.2	
Q	0	0.6	0.2	0.2	0.6	0.8	0.8	0.2	0.4	0.4	0.6	1	0.8	0	0.8	
p*q	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0.2	0	0.2	
sum(p*q)	**2,32**															
Var	**8,3**															

K	**15**
r(kr20)	**0,772**

Table 2 shows the descriptive statistics of the scores obtained in each of the programs of the University of Sucre that participated in the study. It should be noted that the test had a maximum score of 300 points, and the Economics and Mathematics degree programs had students who reached the highest score in the study (260 points). The program with the best average score (194.3) was the Economics program, followed by the mathematics degree program (192), even though the latter program has a greater foundation in quantitative reasoning, it was surpassed on average by the mathematics program. Economy. The Public Accounting program was the one with the lowest average.

Table 2. Descriptive Statistics by Program

Programs	Minimum	Maximum	Mean	Desv. Typical
Business Administration	80	240	170,8	51,4
Public Accounting	20	200	140	73,5
Economy	140	260	194,3	36
Agro-industrial Engineering	40	220	160	57,8
Mathematics Bachelor	100	260	192	51

Table 3, shows the 3 quartiles of the scores obtained in the quantitative reasoning test

Table 3. Quartiles

	Score	
Quartiles	25	140
	50	180
	75	200

According to the results obtained in the test, the students were classified according to the three quartiles, this corresponds to the group that results in dividing the total students number of in the given sample into four parts. Table 4 shows the classification of the students:

Table 4. Classification by Scores

Scores	Ranking
$X \leq 140$	Very Low
$140 < X \leq 180$	Low
$180 < X \leq 200$	High
$X > 200$	Very High

Table 5 shows the classification of student scores using quartiles, in it, we can see that 53.2% of students have a classification between very low and low, this tells us that efforts should be made by the University of Sucre so that the students of the study programs improve their mathematical skills, and thus obtain better results in the quantitative reasoning tests.

Table 5. Classification by Quartiles

Classification	Students	Percentage
Very Low	12	25,5%
Low	13	27,7%
High	14	29,8%
Very High	8	17%

3.2 Factorial Design Analysis

To perform the data analysis, a factorial design was employed with two factors as qualitative independent variables and one response variable as the quantitative dependent variable, which are described below.

Independent Variables:

Factor A: Mathematical Competence
Factor B: Academic Program

Dependent Variable:

Variable Response: Score

Hypothesis to Test:

Mathematical Competence Factor

Ho: The score does not depend on the mathematical competence evaluated.

Hi: The score does depend on the mathematical competence evaluated.

Academic Program Factor

Ho: The score does not depend on the academic program evaluated.

Hi: The score does depend on the academic program evaluated.

Interaction of Mathematical Competence* Academic Program

Ho: There is no interaction between the mathematical competence evaluated and the academic program.

Hi: If there is an interaction between the evaluated mathematical competence and the academic program.

3.3 Variance analysis

The results of the applied factorial design are shown in the following variance analysis table or ANOVA table. The analysis was performed with a significance $\alpha = 0.05$.

Table 6. Analysis of Variance

ANOVA	SS	D.F.	SM	Fo	F(α,a-1,ab(n-1))	P - VALUE
MATHEMATICAL COMPETENCE	712,1066667	2	356,0533333	15,38248848	3,150411311	4,04565E-06
ACADEMIC PROGRAM	133,12	4	33,28	1,437788018	2,525215102	0,232611481
MATHEMATICAL COMPETENCE*ACADEMIC PROGRAM	92,16	8	11,52	0,497695853	2,096968313	0,853114108
ERROR	1388,8	60	23,14666667			
TOTAL	2326,186667	74				

According to the ANOVA results table, and with respect to the P - Values, the following can be observed:

As the P – Value associated with the Mathematical Competence factor is less than the significance $\alpha = 0.05$, this is P – Value = 4,04565E-06 ≤ 0.05, the null hypothesis is described as:

Ho: The score does not depend on the mathematical competence evaluated, it is rejected, which indicates that the score obtained by the student does depend on the mathematical competence in which it is being evaluated.

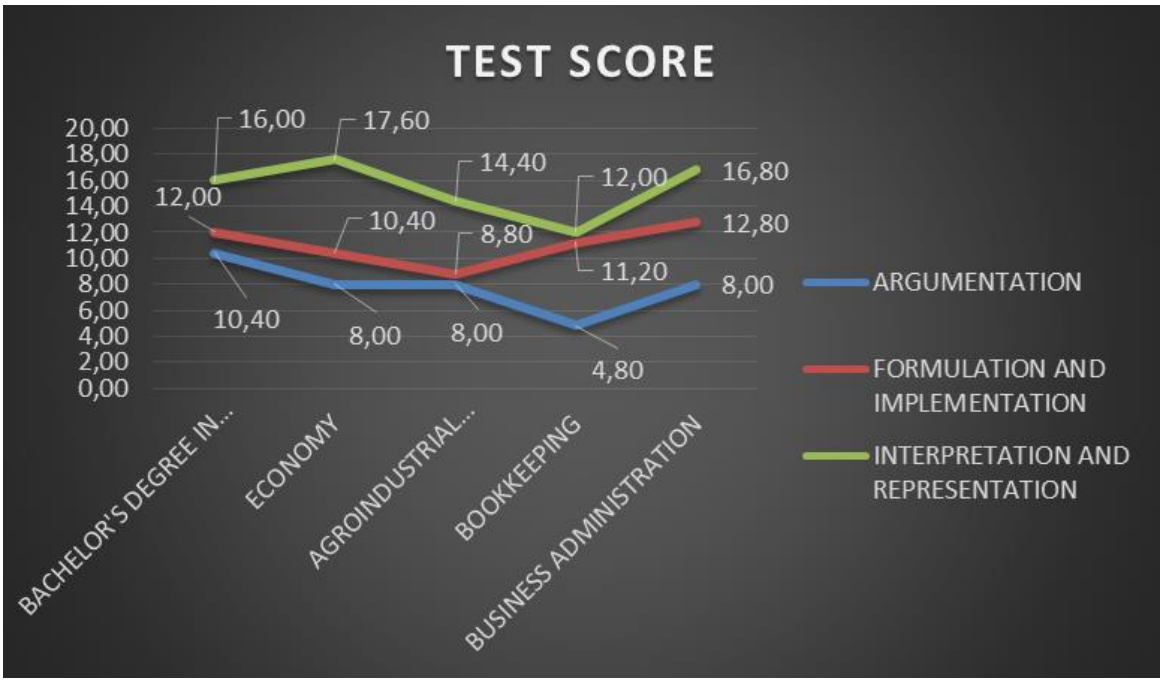
As the P – Value associated with the Academic Program factor is greater than the significance $\alpha = 0.05$, this is P – Value = 0.232611481 > 0.05, the null hypothesis is described as:

Ho: The score does not depend on the academic program evaluated, it is accepted, which indicates that the score obtained by the student does not depend on the academic program to which it belongs.

As the P – Value associated with the Assessed Competence*Academic Program interaction is greater than the significance $\alpha = 0.05$, that is P – Value = 0.853114108 > 0.05, the null hypothesis is described as:

There is no interaction between the mathematical competence evaluated and the academic program, it is accepted, which indicates that there is no interaction between the factors of mathematical competence evaluated and the academic program. This last result is verified with the interaction graph shown below.

Figure 1. Interaction Graph



In the previous graph it is observed that, since there is no intersection or crossing between the 3 lines that represent the 3 mathematical competencies evaluated, this indicates that there is no interaction between the factors defined above, as evidenced by the interaction hypothesis test executed, which means that the academic programs to which the students

belong do not exert any type of influence on the results or scores obtained in the 3 mathematical competencies evaluated.

It can also be seen in the graph that of the 3 competencies evaluated, Interpretation and Representation is the competency in which students obtain the best results, with the Economics program obtaining the highest average score, 17.60 points on a scale of 0 to 20 points. While the Accounting program obtains the lowest average score, 12 points on a scale of 0 to 20 points.

Similarly, Argumentation is the competition in which students obtain the lowest results, with the Bachelor of Mathematics program obtaining the highest average score, 10.40 points on a scale of 0 to 20 points. While the Accounting program obtains the lowest average score, 4.80 points on a scale of 0 to 20 points.

On the other hand, in the Formulation and Execution competition, the Business Administration program registers the highest average score, 12.80 points on a scale of 0 to 20 points. While the Agro-industrial Engineering program has the lowest average score, 8.80 points on a scale of 0 to 20 points.

Assumptions Verification

Normality Test:

Ho: The data is normally distributed.

Hi: The data is not normally distributed.

The Shapiro-Wilk test was applied, obtaining the following result.

Shapiro-Wilk normality test

Date: Score

W = 0.92709, P-Value = 0.0003365

As the P-Value of the Shapiro – Wilk test is less than the significance $\alpha = 0.05$, that is P – Value = $0.0003365 \leq 0.05$, the null hypothesis is described as:

Ho: Data is normally distributed, reject, then data is not normally distributed.

Homoscedasticity test:

Ho: Variances are equal

Hi: Variances are not equal

Bartlett's sphericity test was applied, obtaining the following result.

Bartlett homogeneity test of variances

Data: list (Argumentation, Formulation Execution, Interpretation Representation)

Bartlett's K-squared = 0.4906, df = 2, P - Value = 0.7825

As the P-Value of Bartlett's sphericity test is greater than significance $\alpha = 0.05$, that is P – Value = 0.7825 > 0.05, the null hypothesis is described as:

Ho: The variances are equal, it is accepted, then there is a homogeneity of variances between the groups studied, that is, the competencies evaluated. This indicates that the assumption of homoscedasticity is fulfilled.

Independence Test:

Ho: The errors are independent

Hi: Errors are not independent

The Durbin-Watson test was applied, obtaining the following result.

Durbin–Watson test

Date: Model

DW = 2.5244, P-Value = 0.4871

Alternative hypothesis: true autocorrelation is not 0

Since the P-Value of the Durbin-Watson test is greater than significance $\alpha = 0.05$, this is P – Value = 0.4871 > 0.05, the null hypothesis is described as:

Ho: The errors are independent, it is accepted, then there is independence in the data. This indicates that the assumption of independence is fulfilled.

Although the assumption of normality is not fulfilled, the independence assumption, which is the most delicate, is fulfilled. In addition, the analysis of variance is a robust test that supports the normality assumption violation. This indicates that the results of this analysis are valid and therefore the conclusions drawn in this study are also valid.

Since the P-Value of the Durbin-Watson test is greater than significance $\alpha = 0.05$, this is P – Value = 0.4871 > 0.05, the null hypothesis is described as:

Ho: The errors are independent, it is accepted, then there is independence in the data. This indicates that the independence assumption is fulfilled.

Although the assumption of normality is not fulfilled, the independence assumption, which is the most delicate, is fulfilled. In addition, the analysis of variance is a robust test that supports the normality assumption violation. This indicates that the results of this analysis are valid and therefore the conclusions drawn in this study are also valid.

Comparison Between Group Means

Comparison between Competency Means

Tukey multiple comparisons of means

95% family-wise confidence level

Fit: aov (formula = Model, data = Table)

$Competition	diff	lwr
Formulation and Execution-Argumentation	3.20	-0.07025865
Interpretation and Representation-Argumentation	7.52	4.24974135
Interpretation and Representation-Formulation and Execution	4.32	1.04974135

$Competition	Upr	p adj
Formulation and Execution-Argumentation	6.470259	0.0563964
Interpretation and Representation-Argumentation	10.790259	0.0000022
Interpretation and Representation-Formulation and Execution	7.590259	0.0066010

According to the P – Values to test the hypotheses of average scores equality between competencies, it should be noted that the average scores of the Formulation - Execution and Argumentation competencies are equal, with a significance of 5%.

When comparing the Interpretation - Representation and Argumentation competencies, as well as the Interpretation - Representation and Formulation - Execution competencies, according to the P - Values, their average scores are different, with a significance of 5%.

Comparison Between Program Means

Tukey multiple comparisons of means

95% family-wise confidence level

Fit: aov (formula = Model, data = Table)

$Program	diff	lwr	upr	p adj
Accountancy- Business Administration	-3.2000000	-8.140829	1.740829	0.3710466
Economy- Companies Administration	-0.5333333	-5.474163	4.407496	0.9981001
Agro-industrial Engineer-Business Adm.	-2.1333333	-7.074163	2.807496	0.7431059

Mathematics Bachelor-Business Adm.	0.2666667	-4.674163	5.207496	0.9998771
Economy-Accountancy	2.6666667	-2.274163	7.607496	0.5551175
Agro-industrial Engineer-Accountancy	1.0666667	-3.874163	6.007496	0.9734303
Mathematics Bachelor-Accountancy	3.4666667	-1.474163	8.407496	0.2914111
Agro-industrial Engineer-Economy	-1.6000000	-6.540829	3.340829	0.8916751
Mathematics Bachelor-Economy	0.8000000	-4.140829	5.740829	0.9909104
Mathematics Bachelor –Agro-industrial	2.4000000	-2.540829	7.340829	0.6513368

According to the P – Values to test the hypotheses of average scores equality between programs, it should be noted that the average scores of the academic programs evaluated are equal, with a significance of 5%.

Sample size

The sample size was calculated using the equation:

$$\phi^2 = \frac{nbD^2}{2a\sigma^2}$$

Where:

a = 3

b = 17

σ^2 = 2869.243697

D = 50

With the help of the characteristic operation curves, a significance α = 0.05, a power of 1-β = 0.98, the following sample size was obtained:

$$\phi^2 = \frac{n(17)(50)^2}{2(3)(2869{,}243697)} = 2.47n$$

N	ϕ^2	ϕ	a(n-1)	β	(1-β)
3	7.41	2.72	6	0.40	0.60
4	9.88	3.14	9	0.12	0.88
5	**12.35**	**3.51**	**12**	**0.02**	**0.98**

Sample size: $\mathbf{n = 5}$

Con $\alpha = 0.01$,
$\beta = 0.02$
$(1 - \beta) = 0.98$

4. CONCLUSIONS

The scores obtained by the students do depend on the mathematical competence to which they are being evaluated; whereas the scores obtained by the students do not depend on the academic program to which they belong.

It is also observed that there is no interaction between the mathematical competence evaluated and the academic program, that is, there is no perceived change in the scores when moving from one academic program to the other.

Of the 3 competencies evaluated, Interpretation and Representation is the competency in which students obtain the best results, with the Economics program obtaining the highest average score, 17.60 points on a scale of 0 to 20 points. While the Accounting program obtains the lowest average score, 12 points on a scale of 0 to 20 points.

On the other hand, Argumentation is the competition in which students obtain the lowest results, with the Bachelor of Mathematics program obtaining the highest average score, 10.40 points on a scale of 0 to 20 points. While the Accounting program obtains the lowest average score, 4.80 points on a scale of 0 to 20 points.

While in the Formulation and Execution competition, the Business Administration program registers the highest average score, 12.80 points on a scale of 0 to 20 points. While the Agro-industrial Engineering program has the lowest average score, 8.80 points on a scale of 0 to 20 points.

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