Un Diseño De Experimento Unifactorial Aplicado A La Prueba Icfes Saber 11 Presentada En El Distrito De Barranquilla – 2017

A Design Of Experiments With A Single Factor Applied To The Test Icfes Saber 11 District Of Barranquilla Made In 2017

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Resumen

En este artículo se aplica un diseño de experimentos unifactorial a los resultados obtenidos por los estudiantes de los colegios del distrito de Barranquilla en la prueba Saber 11 del año 2017. Se tomó como tratamiento al calendario académico de los colegios y se estudiaron los promedios ponderados de las asignaturas evaluadas. Se demuestra que existe diferencia significativa entre los tipos de calendario, el calendario B obtiene mayor promedio ponderado en comparación con los demás tipos de calendario.

Palabras clave: Diseño de experimentos, Estándares, ICFES, Saber 11, Análisis de datos.

Abstract

In this paper a design of experiments, with a single factor, is applied to the results obtained by students of the high schools in the district of Barranquilla to the test Saber 11 realized in 2017. The treatment used here is the type of schedule corresponding to each school, being studied the weighted average of the subjects tested.

Key words: Design of experiments, standards, ICFES , SABER 11, data analysis.

1.   Introduction

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This article is a continuation of the recent work of the authors in Ruiz Escorcia et. (2018),in whichthe main component analysis technique was applied to study the results obtained by students in the Saber 11 tests in the various official and private establishments in the city of Barranquilla (Colombia),and following the curriculum guidelines established by the Colombian Ministry of National Education (MEN) in terms of competency assessment. At present,a design of unifactorial experiments was carried out to study the possible effects of the academic calendar on the results obtained by students of the educational institutions of the district of Barranquilla (Atlantic). This city was chosen as a reference urban center in the Colombian Caribbean regionor in educational,economic andcommercialissues is. (Pico, C. R. R., & Zapata, O.S. , 2017).

Since 1968, the state exams have been conducted in Colombia, which for more than 30 years were called ICFES Exams, the name of the state institute that applies them. Likewise, and from 1980 they became the official evaluations applied by the State for the admission of students from the secondary basic to higher education. But, starting in 2010 and responding to a strong restructuring of the test, it ends up focusing more on assessing the skills developed during the school year, and its scopeextends to the third, fifth and ninth grade courses of schooling.

On the Atlantic Coast, the overall results have not been comparatively good to the Andean area of the country (Molina et al., 2013). Areas such as mathematics, language and physicshave historically yielded the lowest results in the region. Contrary to this, and looking at it as a case of successful study, the city of Barranquilla, which being the most important city in the Atlantic region, has excelled in the region and in some years in the country for its good results in the test. Despite this, the levels of academic failure of many of these students in university bodies are very worrying (Contreras et al., 2010),which is why it is important to know the areas in which efforts to improve the student mass of the district should be concentrated by studying the different variables of the process and true infuencia in it.

Then, in Figura 1 are exposed some results e nthe areas of Mathematics, Physics and Language of the city of Barranquilla during the years 2005 – 2014. Which have been graphically compared to the results obtained in the same period of time in the cities of Bogota and Medellin. Both belonging to the Andean area of thecountry, and that by their historical result in the test are ideal to establisha forngo and define the level of middle educationestablishments. It becomes unquestionable in the light of theresults, that the city has had a good participation in the examination, but in turn is concerned that dichos results do notshow acertain stability, but are oscillating and inconstant over time, demonstrating a marked heterogeneity in the population evaluated year after year.
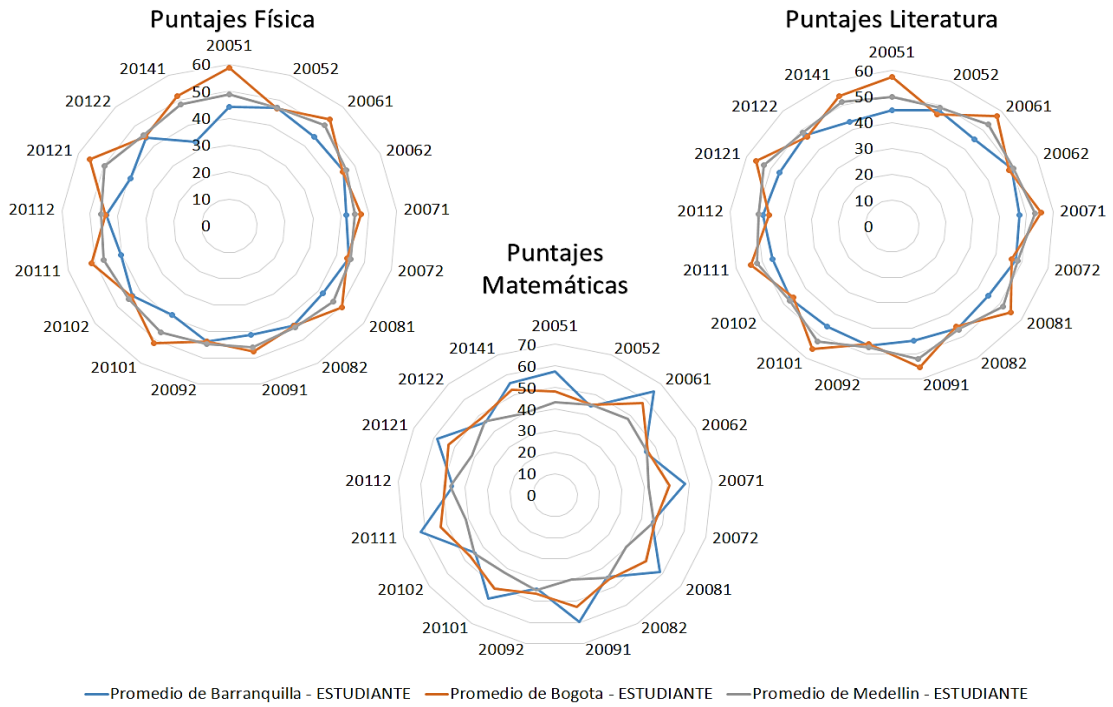
Figure 1. Results in the areas of Mathematics, Physics and Language (2005 – 2014) in Barranquilla, Bogotá and Medellin. Source: andownwork.

Moreover, as mentioned in Ruiz Escorcia et. al. (2018), continuous and permanent evaluation is essential to project and assess the quality of service as a fundamental aspect of the educationalprocess, González, L. E., & Espinoza, ., (2018). This because it exposes different types of information, allowing you to make decisions with ahigher level of depth and thus be able to understand the teaching-learning processes that are not so clear without their application. Likewise, through the pedagogical use of the results obtained on the basis of evaluation as a means of measurement, the work of institutions, teachers, students and parents is oriented. Hence the importance of seeing evaluation as a tool to enhance the learnings and processes that occur in the classroom. MEN (2008).

In fact, in order to obtain dynamic and feedback information regarding the quality of education at all levels and to advance research on the factors that affect educational quality,the Ministryof National Education (MEN) hhas established census evaluations through the ICFES as a designer and applicator of the tests in their different versions,i.e. Know 3, 5, 9 and 11;name s thatfollows n of the degree of schooling of the evaluated. All this seeking continuity in evaluation processes that ensure better preparation and degree of student schooling. ICFES (2018).

This evaluation is based on the structure of the curriculum standards issued by the MEN and is developed by the Colombian Institute for the Evaluation of Education (ICFES), becoming a thermometer to determine whether students manage to meet the minimum standards required

by that entity, López et. (2011). Similar tests have been developed in other countries, as can be seen in the case of Spain through the LOGSE, Garres Pérez, F.J. tests (2017). Or the annual assessment applied by the OECD globally or PISA (Programme for International Student Assessment), which measures students' academic performance in the areas of mathematics, science and reading. Fernández-González, N. (2015). To motivate further interested readers in this topic, we include additional references related with similar research works of the authors, see Morillo (2013), Morillo (2020) among others.

2. Conceptual framework

The Experiment Design (DOE) technique consists of conducting a series of experiments inducing intentional changes in the variables of a process in order to observe and identify the causes of changes in the outputresponse, see Montgomery,D.C. & Runger, G.C. (2010). Fisher in England in the 1920s was the one who first applied the design of experiments. At that time his experiments were applied to the field of agriculture and his experiences encouraged him to publish his book Design of Experiments in 1935, laying some of the main bases known today,seeKirk, R.E.(2007).
From Fisher's work, several researchers have contributed to the application and development of experiment design in their different areas. There are four stages in the development of experiment design. The first stage, characterized by the introduction and systematic use of scientific thinking as well as the application of variance analysis and complete and fractional factorial design in scientific experimental research. Box and Wilson in 1951 began the second stage of the development of experiment design, a stage characterized by the development of the response surface (RSM), see Tanco, M. et. al. (2009),showing that there were differences between industrial and agricultural experiments. In the late 1970s the third stage began with Taguchi's work on robust parameter design (RPD), see heriberto, A. N. E., et. al., (2015), Taguchi, G. & Wu, Y. (1980) and Taguchi, G. (1980). The fourth stage began in the 1990s with optimal designs and the use of software for the analysis and design of experiments,see Hayter, A. (2012).

Generally speaking, the Saber 11 tests are the Colombian state tests conducted by ICFES,as acentralized entity, for eleventh graders to continue a university career. This test consists of a common core and a flexible component (with 15 questions each). The ICFES SABER 11 assessment consists entirely of 249questions, divided into components defined through conceptual or topical categories of the area or the study discipline. The cores and components that are part of the test are described below in Table 1.

Table 1. Common core and flexible component of the ICFES Saber 11 test.

Common core	Componente flexible
Language (24 questions)	Profundizaciones

Mathematics (24 questions)	Biology
Biology (24 questions)	Social Sciences
Chemistry (24 questions)	Math
Physics (24 questions)	Language
Social Sciences (30 questions)	Interdisciplinary
Philosophy (24 questions)	Violence and Society
English (45 questions)	Environment

Source ICFES Saber 11 (2012)

Likewise, the test evaluates the competencies developed by students through cognitive processes that you must perform to solvea question, and that point to the demonstration of a previousknowledge related to learning to do and develop skills in the areas of study. The following are the aspects that the Knowledge 11 exam evaluates in each common core test, by component and competence:

Table 2. Components and competences

Common core	Components	Competences
Language	1-Function semantics of local information	1- Interpretative action
	2-Setting the global sense	2- Argumentative action
	3-sense of the text in relation to other texts.	3- Proposive action
Math	1-Numeric - Variational	1- Communication
	2-Geometric – métric	2- Reasoning
	3-Random	3- Troubleshooting
Chemical	1- Analytical aspects of substances.	
	2- Physicochemical aspects of substances	
	3- Analytical aspects of mixtures	1- Comprehensive use of knowledge
	4- Physicochemical aspects of mixtures	

Physical	1- Classic mechanics	2- Explanation of phenomena
	2- thermodynamics	
	3- Ripple events	
	4- Electromagnetic Events	
Biology	1- Mobile	3- Indegation
	2- Organísmico	
	3- Ecosistématico	
Social sciences	1- Space, territory, environment and population.	
	2- Power, economics and social organizations.	1- Interpretative
	3- Time and cultures.	2- Argumentative
Philosophy	1- The question of man in front of his social and cultural world.	3- Propositive
	2- The question of being	
	3- The question of knowledge	

Source: Ruiz Escorcia et. al. (2018)

Likewise, the test involves a common core of English which presentsa different structure, oriented to the internationalization of content and the skill in the management and interpretation of a second language. Con the basis of the above, the MEN in 2006 formulated the basic standards of competition in foreign language – English,which stillgovern. These standards are aligned with the Common European Framework, which is why this test consists of 45 questions, divided into seven partsand their results refer to the bands of the Common EuropeanFramework, i.e.:

- A1 and A2: basic user
- B1 and B2: Independent User English   Test   Parts
- Relationship between words and descriptions that account for   its definition.
- Complete five short conversations.
- Complete a text (8 words).
- Understanding a text (7 questions).
- Understanding a text (5 questions).
- Complete a text (10 words).

2.   Methodology

For the methodological development of the project, as a source of information the database published by the ICFES was used in its institutional portal, regarding the results for the tests to know 11o obtained by the students of the city of Barranquilla, Department of the Atlantic (Colombia).   Debugging the database of 12710 institutions at the national level to 384 institutions related to the district of Barranquilla.

For the analysis of the data, the commonly used diagrams of boxes and whiskers were initially made, to have an initial description of the distribution of them andcompare the datasets of the test Icfes Saber 11 presented in 2017 by the students of the district of B arranquilla. Then, an experiment was carried out that had as a treatment structure a factorial arrangement under a completely random design, where the objective was mainly to determine the prevalence of significant differences between the values of the reference response variables the qualifications obtained by students specifically in the modules of Reading, Mathematics, Natural Sciences, Social Sciences and English, in order to know what this relationship is like and generate knowledge that allows actions and decisions that improve the performance of the process. The factors used were gender with two levels (Male, female) and the type of institution where students performed their middle education training process with two levels (official, unofficial), both established as qualitative factors.
The mathematical model used is described in equation 1.

$$y_{ijk} = \mu + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \varepsilon_{ijk} \qquad (1)$$

Where, Y_{ijk} was the variable response in the $i - $ th experimental unit, for the $j - $ th level of the gender factor, of $k - $ th level of the institution factor. μ was the overall mean of treatments, α_j was the main effect of $j - $ th encourage level of the gender factor, β_k was the main effect of the $k - $ th level of the institution factor, $(\alpha\beta)_{jk}$ is the effect of $j - $ th level of the gender factor, with the effect of the $k - $ th factor of the institution level, ε_{ijk} was the random error in the $i - $ th experimental unit for the $j - $ th level of the gender factor and $k - $ th level of the institution factor.

To corroborate the above, a variance analysis was performed to detect differences between the mean values of the response variables by effect of the respective double interaction$(p \leq 0.05)$. In addition, the Bonferroni multiple comparison test was performed to identify significant minimum differences between the treatments analyzed in the study. It should be clarified that to test the hypotheses it was assumed that the errors of the model were random variables that followed a normal and independent distribution with mean equal to zero (μ-0) and variance σ^2. Similarly, it was assumed that this variance σ^2 was constant, so treatments are said to be subject to the same conditions and the only variant is the factors under study, all of which implies that observations are mutually independent.

Finally to check these assumptions are performed the normality test with the Shapiro-Wilkmethod, and the homogeneity test of variance of the factors gender and institution by means of the Bartlett test. The following set of hypotheses for normality is then raised:
Null hypothesis H0: Treatment errors have normal behavior.

Alternate hypothesis H1: Treatment errors do not have normal behavior.
For the homogeneity of variance of the factors under study, the hypotheses evaluated $H_0 : \sigma_1^2 = \sigma_2^2 = \sigma_3^2 = ... = \sigma_n^2$were versus $H_1 : \sigma_i^2 \neq \sigma_j^2$for some i≠j.

3.   Results and discussion

For the analysis of the results of the Saber 11 tests applied in 2017, descriptive techniques were initially used, especially diagrams of boxes that allowed an X-ray to detect whether the nature of educational institutions (Official and Unofficial) affects the academic performance of students in each of the generic competencies that evaluates the test

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Null hypothesis H0: Treatment errors have normal behavior.

Alternate hypothesis H1: Treatment errors do not have normal behavior.

For the homogeneity of variance of the factors under study, the hypotheses evaluated were versus for some $i \neq j$.

The following figures and tables shown a summary of our results.

Figure2. Box diagrams for response variables according to study factors.
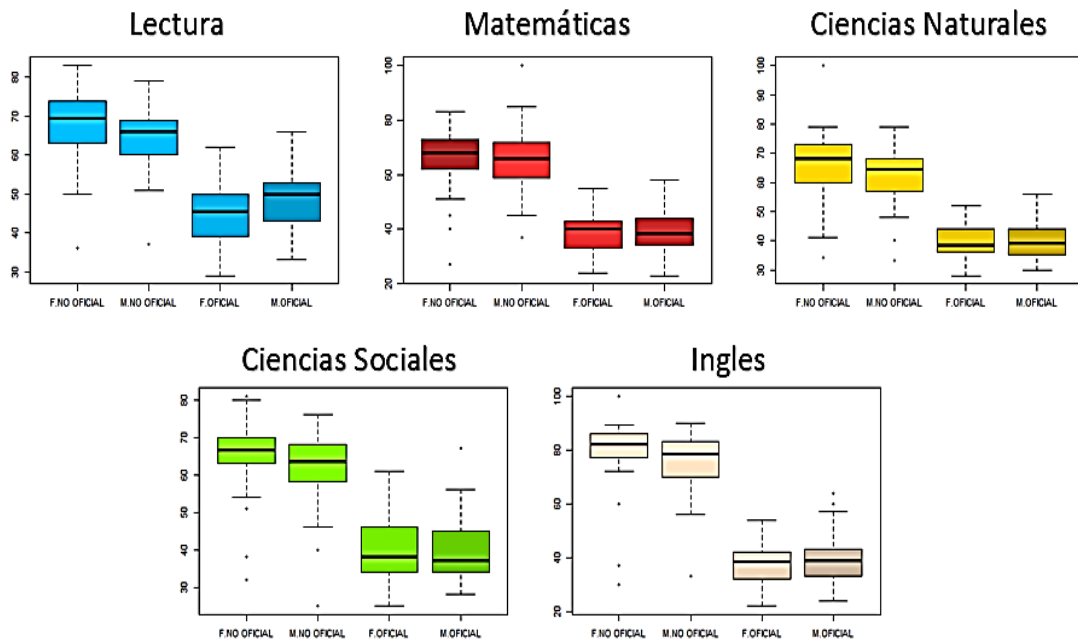
Source: own elaboration

Figure 2 shown the situation of data relating area (factors) with type of school (response variable).

Table 3. P-values for response variables.

INTERACTION FACTORS	P-values				
	Reading	Math	Natural	Social	English
Son-in-law	0.991	0.759	0.306	0.253	0.619
Institution	0.000	0.000	0.000	0.000	0.000
Genero × Institution	0.007	0.797	0.090	0.182	0.115

In Table 3 we observe the P-values for interaction factors with response variables (topics).

Table 4. Bonferroni comparison tests for the study variables α-0.1.

8

Variable	Institution	Gender	
		Male	Female
Reading	Unofficial	68.13[a]	64.63[a]
	Official	44.81[a]	48.34[a]
Natural Sciences	Unofficial	39.15[a]	40.10[a]
	Official	NS	NS

Table 5. Analysis of the simple effect of factors separately.

Variable	Institution		Gender	
	Official	Unofficial	Male	Female
Math	Ns	ns	52.71[a]	52.22[a]
Social Sciences	Ns	ns	50.78[a]	52.51[a]
English	Ns	ns	58.07[a]	58.93[a]

Conclusions

In this research an experimental design was able to show what was in principle a   hypothesis given the factors and trajectory of the results in the state tests was supposed to be better to be in an official school than in an unofficial one placed the vast majority of the best scores in the tests know 11 were obtained by the students of the schools of the official sector.

When debugging the dataand selecting the   city of Barranquilla's best score you can know 11 on the Atlantic coast, Experimentsdesign is applied to corroborate the hypotheses raised in the study. The database was provided by the Icfes, the box diagrams allowed to carry out a study if the nature of the educational institutions (Official and Unofficial) affects the academic performance of the students in each of the generic competencies that evaluates the test and are not relevant with respect to the gender if it is (female or male).

concludes that the calendar is better than being the city of barranquilla with the best results on the Atlantic coast.

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