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Statistical analysis of social factors influencing academic performance at the University of Puerto Rico's Business Faculty

Análisis estadístico de los factores sociales que influyen en el rendimiento académico en la Facultad de Empresas de la Universidad de Puerto Rico

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Abstract

Introduction: The academic preparedness of incoming students at the Faculty of Business Administration, University of Puerto Rico Río Piedras Campus, has significantly declined, creating challenges in improving fundamental skills and academic outcomes. **Objective:** Identify social factors affecting students' development and performance. **Methodology:** A cross-sectional descriptive and inferential approach was used, examining variables such as residence, school type, and entry scores from 2018-2019 to 2022-2023. **Results:** Findings reveal that dependency status and prior education quality, whether from public or private schools, notably impact academic success. The study also highlights a consistent decline in academic performance over the past six years. **Conclusions:** The need for targeted interventions to address social disparities and improve student success is emphasized.

Keywords: Social factors; Academic performance; Statistical modeling; Descriptive analysis; Inferential analysis.

Resumen

Introducción: La preparación académica de los estudiantes de nuevo ingreso en la Facultad de Administración de Empresas, Recinto de Río Piedras de la Universidad de Puerto Rico, ha disminuido significativamente, creando retos para mejorar las destrezas fundamentales y los resultados académicos. **Objetivo:** Identificar los factores sociales que afectan el desarrollo y desempeño de los estudiantes. **Metodología:** Se utilizó un enfoque descriptivo e inferencial transversal, examinando variables como residencia, tipo de escuela y puntuaciones de ingreso desde 2018-2019 hasta 2022-2023. **Resultados:** Los hallazgos revelan que la situación de dependencia y la calidad de la educación previa, ya sea de escuelas públicas o privadas, impactan notablemente en el éxito académico. El estudio también destaca un descenso consistente en el rendimiento académico en los últimos seis años. **Conclusiones:** Se enfatiza la necesidad de intervenciones específicas para abordar las disparidades sociales y mejorar el éxito de los estudiantes.

Palabras clave: Factores sociales; Rendimiento académico; Modelización estadística; Análisis descriptivo; Análisis inferencial.

Introduction

Academic performance is a complex construct shaped by a multitude of interconnected factors. Sociodemographic, psychosocial, pedagogical, institutional, and socioeconomic elements intertwine to mold students' educational trajectories. The study conducted by Alvarado et al. (2018) provides a valuable perspective on the influence of socioeconomic factors on the academic performance of university students. This quantitative-correlational study, which was carried out through surveys among Accounting and Auditing students in Santo Domingo, sheds light on this matter.

The studies conducted by Garbanzo (2013; 2014) involved administering questionnaires to a cohort of university students in Costa Rica. The results reaffirmed that social, personal, and institutional-academic factors influence academic performance. Multiple regression models identified psychosocial, institutional, sociodemographic, and pedagogical factors associated with high-demand career students' performance. Additionally, significant differences were observed between students who applied for scholarships and those who did not, highlighting the relevance of the socio-economic context in student performance.

In their recent research, Montalvo and Garay (2021) utilized a panel data regression model with control variables including poverty level, special education, and urban school location. They determined that the budget per student significantly impacts standardized META test results but not subject grades. Additionally, the poverty level and the percentage of students in special education were significant for META.

Additionally, Montero et al. (2007) state that poverty level and the percentage of students in special education were significant for META test results in certain regions while rarely impacting academic performance as measured by grades. Urban location was found to have a substantial, negative, and inelastic effect on META test results. Moreover, questionnaires and interviews with school principals found that these administrators perceive budget management positively affecting the teaching and learning process and potentially improving academic performance.

Carrillo et al. (2009) investigate the interplay between motivation and learning, shedding light on this crucial aspect within the context of education. Furthermore, in his reflective analysis, Garbanzo (2013) examines factors associated with the academic performance of university students, drawing insights from studies conducted in Spain, Colombia, Cuba, Mexico, and Costa Rica, offering perspectives on public higher education quality. He indicates that academic performance variables can be personal, social, and institutional. Cognitive competence, motivation, academic self-concept, perceived self-efficacy, and psychological well-being are some personal determinants of academic performance. Social determinants include differences in social background, family environment, mother's educational level, socioeconomic context, and demographic characteristics. Garbanzo highlights institutional determinants such as program complexity, support services, student environment, and student-teacher relationships.

Amidst the complex interplay of factors, a pressing need emerges for a comprehensive exploration of the determinants of academic performance, particularly within Puerto Rico's evolving

social landscape. Notably, there is a dearth of research addressing this issue, especially concerning students enrolled in the Faculty of Business Administration (FAE, by its acronym in Spanish) at the University of Puerto Rico, Río Piedras Campus (UPRRP). Recent studies have highlighted a troubling decline in academic performance among Puerto Rican students, with various social factors exacerbating the risk of attrition. For instance, a survey by Morales-Reyes et al. (2022) delved into the impact of gender, socioeconomic status, and school on the Spanish proficiency skills of Puerto Rican students. Furthermore, Segarra (2020) shed light on relevant issues by examining the factors influencing academic performance in public schools in Puerto Rico. This trend is particularly alarming for FAE, accredited by prestigious bodies such as AACSB and ABET, where the graduation rate is a critical quality indicator.

Aligned with global agendas, the imperative for quality education resonates strongly. UNESCO underscores the pivotal role of education in fostering development, curbing inequality, and propelling progress towards sustainable development goals. Alpízar et al. (2023) delve deeply into the complex dynamics surrounding higher education in Latin America in their work. Similarly, the United Nations emphasizes the transformative impact of higher education on individuals' quality of life, advocating for increased access to quality educational opportunities. Mitter (2016) explores the Sustainable Development Goals and their approach towards education proposed by the United Nations. In 2022, Rodríguez et al. studied the global goals for sustainable economic development proposed by the United Nations. Thus, this research endeavor is motivated by a commitment to enhancing educational quality and making a substantive contribution toward elucidating the factors crucial for achieving this objective.

The university population in Puerto Rico serves as the cornerstone for future economic, social, and personal advancement. The trajectory of this development hinges significantly on educational outcomes. Consequently, a meticulous examination of the factors influencing academic performance is warranted, offering invaluable insights for program enhancement and proactive measures to address potential challenges in both professional and social spheres. The results in this article are part of a pilot study, which will then be extended to the Río Piedras campus and finally to the entire UPR system.

Theoretical framework

The theoretical component associated with research on academic performance encompasses various perspectives and approaches. Firstly, understanding the nature of academic performance is crucial. It can be defined as evaluating knowledge acquisition progress and describing the student's achievement level. Medina et al. (2018) delve into the intricacies of this issue. This concept entails quantitative outcomes, such as exam grades, and qualitative aspects of learning, including comprehension and content application.

In line with UNESCO, it's acknowledged that socioeconomic factors primarily affect academic performance in Latin America (UNESCO, 2015). Regional comparative and explanatory studies

support this assertion by indicating that students with better grades mainly come from higher socioeconomic levels (UNESCO & OREALC, 2016). Therefore, researching and understanding these factors compromising academic performance is crucial.

Several studies have addressed this issue from various methodological perspectives. For instance, Garbanzo (2013) study on the factors associated with academic performance in university students based on socioeconomic status provides valuable insights into socioeconomic influences in higher education. Similarly, statistical analyses, such as the one conducted by Zulkifli et al. (2019), offer a systematic review of predictive models and factors affecting academic performance. Additionally, Garbanzo's (2014) influential study on university academic performance thoroughly investigates associated factors, particularly emphasizing the crucial role of socioeconomic status through multiple regression analysis.

Various studies, such as the one conducted by A. Wan et al. (2021), focus on establishing correlations between different factors to develop predictive algorithms for determining future academic performance. In another study by Ekwochi et al. (2019), which adopts a cross-sectional and analytical approach, factors influencing good academic performance are explored using convenience sampling. Additionally, Khan et al. (2020) research delves into specific aspects, such as medical students' perceptions of factors affecting their academic performance.

Therefore, understanding academic achievement theoretically requires acknowledging its multidimensional nature. This involves considering socioeconomic factors, analytical methodologies, and diverse disciplinary perspectives to ensure a thorough examination of this critical aspect of the educational process. In Puerto Rico, the relationship between socioeconomic factors and academic performance is particularly complex due to a series of disruptive events that have significantly impacted the island's society and economy in recent years. The economic recession, devastating natural disasters, such as hurricanes Irma and María in 2017, and more recently, the COVID-19 pandemic in 2019 have presented unprecedented challenges that have profoundly affected the lives of Puerto Ricans and the education of its students (Enchautegui et al., 2020). In this context, this study aims to analyze the factors influencing the academic performance of first-year students at the Faculty of Business Administration, University of Puerto Rico, Río Piedras Campus. To achieve this, the following specific objectives are proposed: (1) Identify and analyze the social factors influencing academic performance, and (2) Evaluate the statistical relationship between the identified social factors and the academic performance of students at the Faculty of Business Administration, University of Puerto Rico, Río Piedras Campus.

Methodology

Participants

A quantitative approach based on statistical data analysis was employed to conduct this study. Data collection was carried out through various offices of the University of Puerto Rico, Río Piedras

Campus, including the Registrar's Office, the Division of Research and Institutional Assessment (DiiA) under the Dean of Academic Affairs (DAA), and the Student Financial Aid Office. The analysis was conducted on the entire student population of 2,264 first-year students enrolled between the academic years 2018-2019 and 2022-2023. Demographic, socioeconomic, and educational information of these students was collected. The data were analyzed using descriptive and inferential statistical techniques to identify and evaluate the relationships between social factors and academic performance. Tools such as regression analysis and correlation were used to determine the significance and impact of the independent variables on the dependent variable, which in this case is academic performance measured by grade point average (GPA). This methodological approach allowed for a comprehensive understanding of how various social factors influence the educational performance of first-year students in the Faculty of Business Administration.

Table 1.
Frequency of student admission by the program in the last 5 years

Program	Frequency
GENERAL PROGRAM	273
ACCOUNTING	759
ECONOMICS	94
FINANCE	289
APPLIED STATISTICS	30
COMPUTERIZED INFORMATION SYSTEMS	168
HUMAN RESOURCES MANAGEMENT	158
MARKETING MANAGEMENT	314
OPERATIONS AND SUPPLIES MANAGEMENT	104
OFFICE MANAGEMENT	75
Total	2,264

Table 2.
Frequency of student admission by year of study

Year of Study	Frequency
2018-2019	461
2019-2020	444
2020-2021	461
2021-2022	485
2022-2023	413
Total	2,264

Variables

Various variables examined the relationship between social factors and academic performance. These variables encompass dependent and independent factors, crucial for understanding the complex dynamics shaping students' educational experiences. The dependent variable, academic

performance, is assessed through grade point average (GPA), while the independent variables encompass a variety of social, demographic, and educational factors. In addition, control variables are used to consider possible confounding factors that may influence the observed relationships.

Dependent variable: Academic Performance by the Grade Point Average (GPA) students attain in their first-semester courses each academic year. For classes, laboratories, workshops, and seminars in which at least one official exam is given or in which at least one project can be quantitatively evaluated, the letter grade system is used, with corresponding numerical values used to calculate the averages: "A" (4.00), "B" (3.00), "C" (2.00), "D" (1.00), "F" (0.00). The indication "I" (Incomplete) may be assigned by the professor for justifiable reasons in courses where part of the assigned work has not been completed. In these cases, a provisional grade is indicated based on the portion of the work completed ("I-C," "I-D," etc.). If the work is not completed by the end of the next regular semester, the provisional grade will become the official course grade.

How can I calculate my grade point average (GPA)? The number of honor points is divided by the total number of credits accumulated in the subjects in which the student has received a final grade, including the "F" not repeated. Table 3 shows an example of the GPA calculation of a student who enrolled 15 credits.

Table 3.
Example: GPA of a student with 15 credits

Courses	Credits	Score	Score Value	Credits*Score Value	Honor point
ECON 3021	3	W	-	-	-
SICI 3211	3	A	4	3*4	12
MECU 3031	3	F	0	3*0	0
ESPA 3101	3	B	3	3*3	9
INGL 3101	3	D	1	3*1	3
Total	15				24

Note: Courses with a "W" grade do not count towards the grade point average.

$$GPA = TotalHonorPoint \div TotalCredits = 24/15 = 1.6$$

Once the GPA is estimated, in some circumstances, the variable is recorded into two groups: medium-low performance (for GPAs less than 2.5) and high performance (for GPAs equal to or greater than 2.5). This last step was necessary to put into practice some analysis techniques, as will be seen later.

Independent Variables: Data was collected on social factors that could influence students' academic performance. These include Academic Year, Type of School, Educational Region, Gender, Concentration Program, Dependency Status, and Parental Occupation.

Procedure

The following describes the systematic methodology used to explore the influence of social factors on the academic performance of first-year students of the Faculty of Business Administration

of the University of Puerto Rico, Río Piedras Campus.

Definition of the study's objective: Initially, the specific objectives of the research were established, focusing on identifying and analyzing the social factors that influence the academic performance of first-year students of the Faculty of Business Administration of the University of Puerto Rico, Río Piedras Campus.

Sample selection: A sample of 2,264 first-year students was created from 2018-2019 to 2022-2023.

Data collection: Several university offices were consulted to collect relevant data. The Registrar's Office provided basic academic and demographic information; the Division of Institutional Research and Assessment (DiiA) under the Dean of Academic Affairs (DAA) provided additional academic performance and contextual data; and the Student Financial Aid Office provided information on students' socioeconomic status.

Data Organization and Cleaning: Collected data was organized and reviewed to ensure completeness and consistency. Data cleaning procedures were performed to remove duplicate entries, correct errors, and manage missing data.

Statistical analysis: Descriptive statistical techniques were applied to obtain an overview of the characteristics of the sample. Subsequently, inferential statistical methods, such as correlation analysis and ANOVA tests, were used to explore and evaluate the relationship between the identified social factors and students' academic performance.

Interpretation of results: The statistical analysis results were interpreted to identify patterns and significant relationships between the variables studied. Special attention was paid to how social factors influence students' grade point averages (GPA).

Additional Considerations: Since only first-semester data from each academic year are analyzed to avoid biases, it is essential to understand the impact of external events, such as natural disasters and the COVID-19 pandemic, on academic performance. Measures will be included to control for confounding variables affecting the study's results.

This methodology is expected to identify critical factors influencing the academic performance of first-year students at the Faculty of Business Administration of the University of Puerto Rico, which could help inform policies and practices to enhance educational experiences and student success.

Data analysis

Statistical analyses were conducted utilizing R statistical software (version 3.4.2). Various parametric and non-parametric statistical techniques assessed the relationship between the independent variables and students' academic performance.

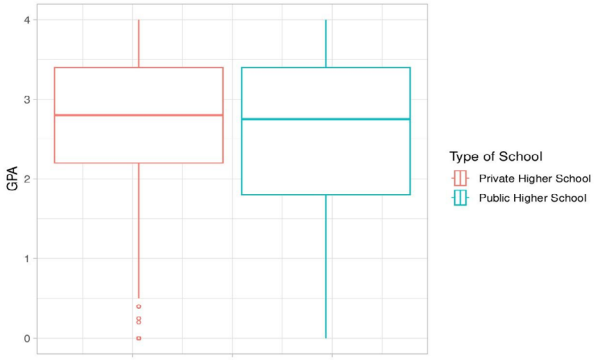
In the descriptive analysis, box plots and the Shapiro-Wilk test were utilized to portray the distribution of academic performance. Mean comparisons were conducted using the Mann-Whitney-Wilcoxon, ANOVA, and Student's t-tests. Specifically, the Mann-Whitney-Wilcoxon test was employed for pairwise group comparisons due to data non-normality. In contrast, the student t-test (with unequal variances) was used to compare genders' academic performance. The Fligner-Killeen test assessed variance equality before conducting ANOVA or t-tests. For multiple group comparisons, one-way ANOVA and Welch's ANOVA were used, followed by Tukey's test for post-hoc analysis. Chi-square tests assessed linear trends in ordinal variables and independence between categorical variables.

RESULTS

It begins by carrying out hypothesis tests that will help us confirm some behaviors of the Academic Performance variable.

Type of School vs. Academic Performance: When analyzing the relationship between the variables *Type of School and Academic Performance,* the aim is to observe how academic performance varies depending on whether the student graduated from a public or private secondary school. Figure 1 shows the academic performance by type of school through the box plot for new students in their first academic semester in the periods 2018-2019 until 2022-2023, evidencing that there do not seem to be differences in academic performance by type of school, for example, for two kinds of schools 75% of the students have a GPA less than 3.5. In addition, the academic average GPA in the public and private groups is 2.48 and 2.62, respectively.

Figure 1.
Box plots for GPA scores by school type for new students in the academic years 2018-2019 through 2022-2023

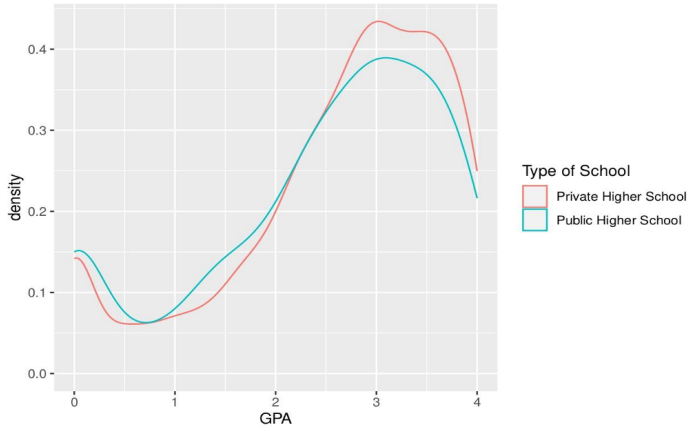


This led us to believe that there are no significant differences between public and private high schools based on academic performance. To verify this, a non-parametric Mann-Whitney Wilcoxon test of means was performed due to the lack of normality in the data, as seen in Figure 2 (It can also be seen that they have the same type of distribution) and as corroborated by the Shapiro-Wilk test of Normality W=0.90129, $p\text{-}value<2.2\times10^{-16}$. It is considered to compare the two means using the hypothesis test:

$$H_0: \mu_{public} = \mu_{private}$$
$$H_1: \mu_{public} \neq \mu_{private}$$

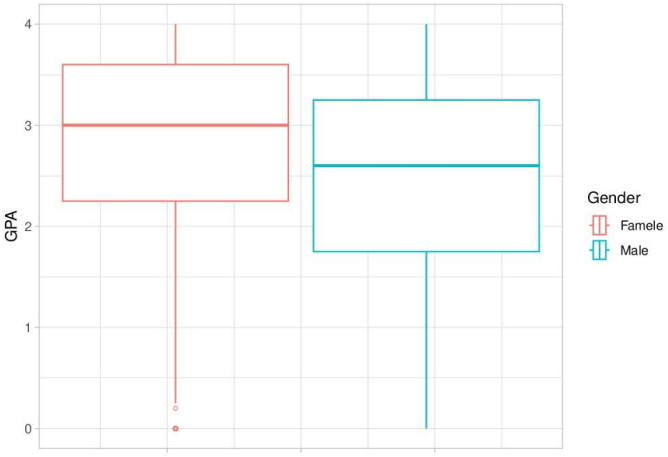
Where the variances are equal, a *Fligner-Killeen* test checks this (*FlignerKilleen: medchi - square*=3.2314, *df*=1,*p - value*=0.07224). For the non-parametric test, the traditional statistical significance (α=0.05) is not considered due to the large size of the data and to avoid a Type I Error, in this case, an adaptive significance $\alpha_{0.05}$=0.000455. It was taken; for more details, see Vélez et al. (2022). The non-parametric test shows no significant differences between public and private higher schools' academic performance at an adaptive significance level of 0.000455 (*W*=645782, p - *value*=0.009128).

Figure 2.
GPA Density by Type of School



Gender vs. Academic Performance: Figure 3 illustrates the behavior of academic performance according to gender, female or male. In the box plots, it can be seen that the female gender presents a higher performance than the male gender in the past five academic periods from 2018-2019 to 2022-2023.

Figure 3.
Box plots for the GPA score by gender for new students in the academic years 2018-2019 through 2022-2023.



From the results, it can be said that 50% of the female students have a GPA greater than or equal to 3.00, and 75% have a GPA greater than or equal to 2.25, while only 50% of the male students have a GPA greater than or equal to 2.6. A t-test of means, with different variances (since the Fligner-Killeen homoscedasticity test confirms this (*FlignerKilleen:medchi-square*=7.4372, *df*=1, *p-value* = 0.006389), it allows us to say that there are differences. The t-test (*t*=7.7001, *df*=221.3, *p-value*=2.035×10^{-14}), allows us to conclude that female students have a higher GPA than male students in the periods included between 2018-2019 to 2022-2023.

Parental Occupation vs. Academic Performance: Parents are the teacher's par excellence for their children. This is because they are the first to exchange with them, which allows them to encompass the cognitive potential they innately bring. Parents are the main educators and have a moral and natural obligation to educate their children. For this reason, it is interesting to know if parents' education or occupation influences students' academic performance.

For this study, the 2018 Standard Occupational Classification (SOC) system, which federal statistical agencies use to categorize workers and jobs into occupational categories, collects, calculates, analyzes, or disseminates data. For occupations such as house husband, housewife, unemployed, incapacitated, does not live, and retired, reclassification of work inactivity was used. Figure 4 shows the differences between the different occupations by parents; it was found that the students with the highest academic performance are those whose father's occupations are *"Manager, Professional and Related Occupations"* and *"Technician, Sales, and Admin Support Occupation"* where 50% of the students in these two groups have a GPA greater than or equal to 3.0. Likewise, it can be seen that in the rest of the groups, there do not seem to be many differences. For example, in all these groups, 50% of students have a GPA less than 3.0 and 25% less than or equal to 2.0.

Figure 4.
Box plots for the GPA score by father's occupation for new students in the academic years 2018-2019 through 2022-2023".

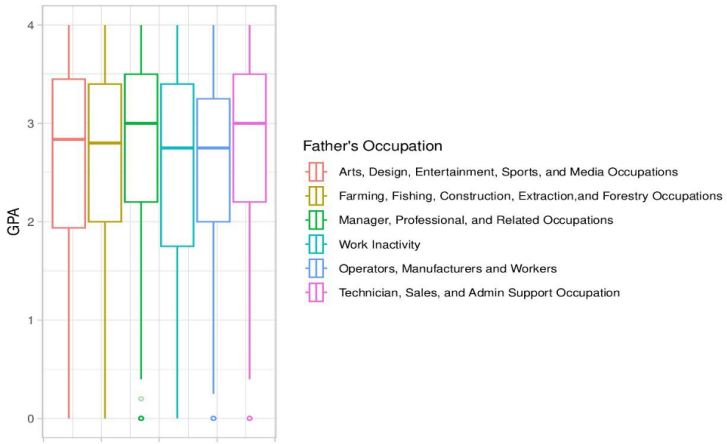
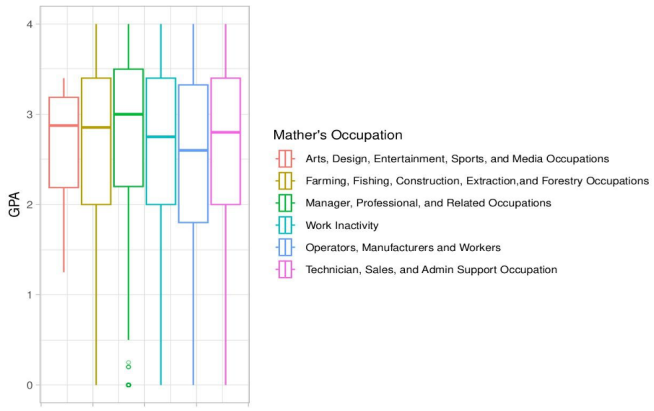


Figure 5, on the other hand, shows the academic performance of the mother's occupation. It should also be noted that differences are pointed out between the *"Manager, Professional, and Related Occupations"* group and the rest of the groups. This group, for example, is the only one in

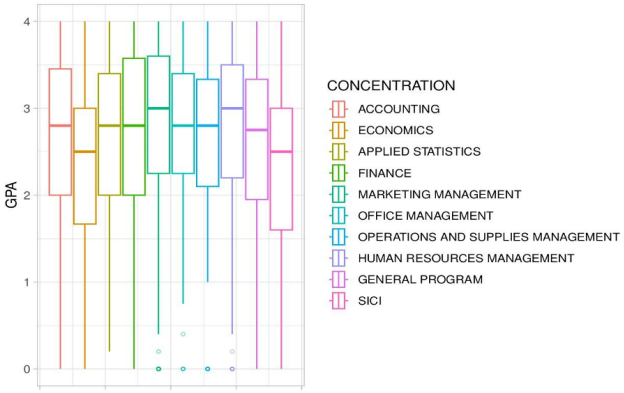
which 50% of the students have a GPA greater than or equal to 3.0 and 25% greater than 3.5. These differences were tested with a One-Way ANOVA test (F_{val} = 2.459, df_1 = 5, df_2 = 2104, *p-value* = 0.0313. This is the case with the mother's occupation, which reveals significant differences. In the case of the father's occupation, a Welch ANOVA test was used (F_{val}=3.8819, *p-value* =0.002083) Since the homogeneity of the groups was not met, showing that there are significant differences between the groups.

Figure 5.
Box plots for the GPA score by mother's occupation for new students in the academic years 2018-2019 through 2022-2023



Concentration Program vs. Academic Performance: Of the 11 FAE concentration programs, the Entrepreneurship concentration was excluded from the study, since it began in August 2022, and data is only available for the 2022-2023 academic year. Figure 6 shows that the students of the SICI (Computerized Information Systems) and ECONOMICS concentration seem to have an academic performance below the rest, this may be significant because, in the first academic year, all concentration programs share the same Curricular Sequence. Furthermore, it was noted that in all concentrations the average GPA does not exceed 3.0, with the concentrations with the lowest scores being SICI and ECONOMICS, with 2.19 and 2.25 respectively. On the other hand, in the MARKETING MANAGEMENT and HUMAN RESOURCES MANAGEMENT concentrations, 50% of their students have a GPA greater than or equal to 3.0. Also, in the APPLIED STATISTICS, ECONOMICS, and SICI concentrations, more than 25% of the students have a GPA less than 2.0.

Figure 6.
Box plots for the GPA score by concentration program for new students in the academic years 2018-2019 through 2022-2023



To verify if these differences were a reality, a One-Way ANOVA was performed (F_{val} = 4.4173, df_1 = 9, df_2 = 2254, $_{p\text{-}value}$ = 9.474×10^{-6}, where Table 4 shows the results of the Tukey test, evidencing the differences previously stated.

Table 4.
P-value, for Tukey's multiple comparison test for the mean GPA of the SICI concentration and the rest of the concentrations

Test: Tukey	p-value
SICI-ACCOUNTING	0.0002296
SICI-ECONOMICS	0.9999956
SICI-APPLIED STATISTICS	0.9052954
SICI-FINANCE	0.0030576
SICI-MARKETING MANAGEMENT	0.0000482
SICI-OFFICE MANAGEMENT	0.0283626
SICI-OPERATIONS AND SUPPLIES MANAGEMENT	0.5114000
SICI-HUMAN RESOURCES MANAGEMENT	0.0136937
SICI-GENERAL PROGRAM	0.3098555

Trend Analysis

This analysis aims to determine whether any factors affecting academic performance follow a linear trend. For this analysis, the factors of *Dependency Status, Academic Year* and *Educational Region* will be considered as ordinal variables, while Academic Performance will be treated as a nominal variable to test the hypothesis:

H_0: There is no linear relationship between the proportions of *Academic Performance* and the values of the ordinal variable.
H_1: If there is a linear relationship between the proportions of *Academic Performance* and the values of the ordinal variable.

Dependency Status vs. Academic Performance: The Chi-square test for trend will be described, where one variable is binary *(Academic Performance)*, and the other is categorically ordered *(Dependency Status)*. The goal is to evaluate if the association between these variables follows a trend. This analysis aims to determine whether academic performance, as categorized in Table 5, is associated with the economic *Dependence (D) or Independence (I)* of students who participate in the FAFSA. The FAFSA form is the application that students complete to receive student aid for college or career school, and it is used by colleges and career schools to determine the amount of financial aid a student is eligible to receive, including grants, scholarships, work-study funds, and loans. In other words, the distribution of a binary variable *(Academic Performance)* will be compared across the levels of an ordered categorical variable *(Dependency Status)*. For simplicity, it is assumed that all other factors influencing academic performance are consistent for all students.

Table 5.
Economic dependence or independence according to the Academic Performance scale in the academic years 2018-2019 through 2022-2023.

Academic Performance	Dependent (D)	Independent (I)	Total
GPA < 2.5	722	19	741
GPA ≥ 2.5	1335	14	1346
Total	**2057**	**33**	**2090**

The objective is to determine whether the proportion of students with academic performance below a GPA score of 2.5 increases or decreases across different dependency status groups. To address this question, a numerical score will be assigned to all dependency status groups, starting with the number 1 for the group with the lowest scale and 2 for the group with the highest scale. Refer to the last row of Table 6 for these assignments.

Table 6
Economic dependence or independence according to the Academic Performance scale in the academic years 2018-2019 through 2022-2023.

Academic Performance	Dependent (D)	Independent (I)
GPA<2.5	35%	56%
GPA≥2.5	65%	42%
Total	**100%**	**100%**
Score	**1**	**2**

From the results of Table 6, it is observed that the percentage of students with a GPA greater than or equal to 2.5 decreases from 65% to 42% when they go from being a student with a dependency status, dependent to independent. This trend was corroborated by the Chi-square test, which rejected the null hypothesis, indicating that there is a significant linear trend between the proportions of Academic Performance and the groups of Dependency Status (X^2=7.1698, *df* =1, *p-value* = 0.007414). The conclusion is that cases decrease as the economic status transitions from dependent to independent.

Academic Year vs. Academic Performance: The study of the profile of those admitted to a university is essential to determine their knowledge and skills when entering university. In addition, it allows programming and designing the courses to be offered in such a way that the reality of new students is considered. At the Faculty of Business Administration (FAE), Quantitative Methods courses represent a challenge for new students. In the academic years 2019-2020 until 2022-2023, the Institute of Statistics and Computerized Information Systems (IESICI) used the score obtained in the mathematical achievement part called Mathematics of the test administered by the College Board (CB) of Puerto Rico. So, to place new students in the Quantitative Methods for Business Administration I (MECU3031) course, they must obtain a score of 610 or more in the mathematics part of the test as mentioned above. Table 7, the period 2018-2019 was not considered since in that year the test was known as the University Admission and Evaluation Test (PEAU for its acronym in Spanish) and included two math parts (achievement and reasoning), and to place

students in the precalculus course (MECU 3031), the Institute considered a score of 650 or more in the math achievement part. After that 2018-2019 period, the College Board unified the two math parts (achievement and reasoning) into one, Mathematics. In addition, the name PEAU was changed to Admission Test (PAA or its acronym in Spanish). For purposes, students who did not obtain the minimum required score (610) corresponding to, the academic period did not have the minimum skills required to perform effectively in a precalculus course (MECU3031). Table 7 shows the number of students with the minimum skills required to be able to take a precalculus course and who could be enrolled in MECU3031, during the periods of the academic years 2019-2020 until 2022-2023. From Table 7 it can be seen that the percentage of students who enter the FAE without minimum skills in mathematics has been increasing from the academic year 2019-2020 to 2022-2023, marking a trend.

Table 7.
Frequency and percentage frequency of new students who do and do not possess the minimum skills required to take the subject Quantitative Methods for Business Administration I (MECU3031), in the academic years 2019-2020 through 2022-2023.

Academic Year	Total Students	Number of Students without minimal skills	Number of students with minimum skills	Percentage of students without minimal skills	Percentage of students with minimal skills
2019-2020	444	357	87	80%	20%
2020-2021	461	363	98	79%	21%
2021-2022	485	408	77	84%	16%
2022-2023	413	357	56	86%	14%

From this perspective, an analysis of the Academic Performance of these students was carried out from the academic years 2018-2019 to 2022-2023. Table 8 summarizes students' GPA data during these academic periods. It says that in all periods except 2020-2021 and 2021-2022 where classes were 100% online due to the COVID-19 pandemic, 50% of the students had a GPA below 3. In addition, it can be noted that after returning to the face-to-face, 2022-2023 period, 25% of the students have a GPA below 1.5 the lowest GPA in all quartiles.

Table 8.
Summary of the five numbers for the GPA score by academic year, for new students

Academic Year	Min (0%)	Q1 (25%)	Median (50%)	Q2 (75%)	Max (100%)
2018-2019	0	2.2	2.8	3.25	4
2019-2020	0	2.0	2.75	3.21	4
2020-2021	0	2.5	3.25	3.60	4
2021-2022	0	2.0	3.0	3.50	4
2022-2023	0	1.5	2.5	3.20	4

Furthermore, it can be noted that as the years go by, students new to the FAE, after their first semester, tend to have an increasingly lower GPA; this is aligned with the fact that there are fewer and fewer students with mathematical skills to take and complete a Precalculus course successfully.

This decreasing trend in terms of GPA scores was studied with a Chi-square test of trend in proportion, where one variable is binary *(Academic Performance)* and the other is ordered categorically *(Academic Year)*, as stated in Table 9.

Table 9.
Conditional distribution of Academic Year, conditional on Academic Performance

		Academic Performance			
		GPA<2.5		GPA≥2.5	
Academic Year	Total Students	f	f.r	f	f.r
2018-2019	461	161	19.56%	300	20.81%
2019-2020	444	187	22.72%	257	17.83%
2020-2021	461	104	12.63%	357	24.77%
2021-2022	485	172	20.89%	313	21.72%
2022-2023	413	199	24.17%	214	14.85%

The results presented in Table 9 indicate a consistent decrease in the percentage of students achieving a GPA greater than or equal to 2.5 over the years. The Chi-square test tells us that the null hypothesis that there is no linear trend between the proportions of Academic Performance, and the groups of cases in the variable *Academic Year* is rejected with a significance of α=0.05(X^2 = 6.4092, df=1, *p-value* = 0.01135). The conclusion drawn is that there exists a linear decrease in the proportion of cases as the academic year category changes.

Educational Region vs. Academic Performance: Over the past decades, the Department of Education (DE) has organized its educational regions and school districts in a variety of ways, primarily to adapt to the changing demographics of the school population or in response to different views on the functions of these units in supporting education school educational management. According to the current directory of Educational Regions of Puerto Rico Department of Education (DE), 7 educational regions divide the country, which are: San Juan, Bayamon, Humacao, Caguas, Arecibo, Ponce, and Mayagüez, as shown in Figure 7.

Figure 7.
Educational Region of Puerto Rico Department of Education (DE).

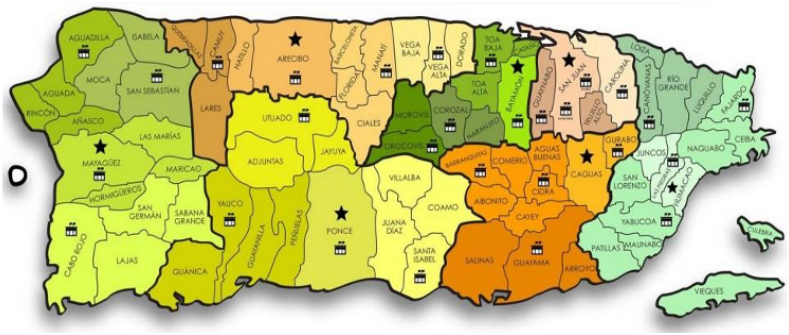
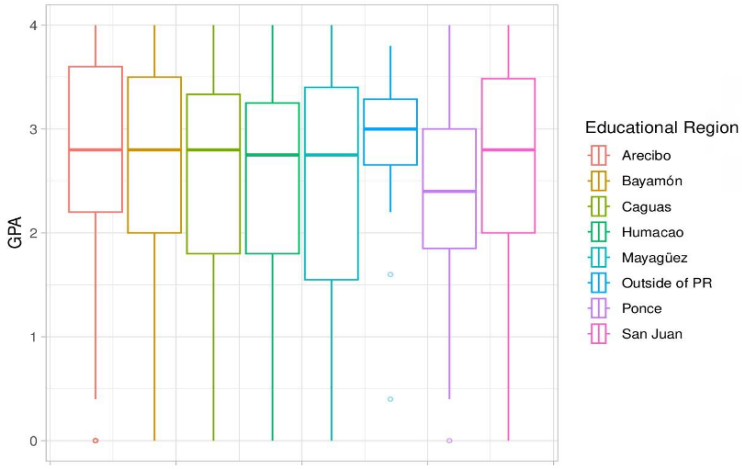


Figure 8 shows the academic performance of new students, considering this division by regions in the country and students from outside the country. It can be observed from the box plots that over the last five academic years, there appear to be no significant differences in academic performance in relation to educational region. Furthermore, there does not seem to be any trend. This pattern was verified through a One-Way ANOVA test (F_{val} = 1.273, df_1 = 7,df_2=2256, *p-value* = 0.26) and a Chi-square test of trend in proportion (X^2=0.18012, df = 1, *p-value* = 0.6713).

Figure 8.
Box plots for GPA scores by educational region for new students in the academic years 2018-2019 through 2022-2023.



DISCUSSION

This section highlights the social factors that influenced students' academic performance at the School of Business Administration of the University of Puerto Rico based on the analysis carried out. Both the coincidences and contradictions with the existing literature are highlighted, emphasizing the unique and important contributions of this study.

The study found no significant difference in performance between public and private school students, diverging from earlier research by Garbanzo (2013; 2014). It also showed consistent underperformance among male students compared to female peers, echoing Morales-Reyes et al. (2022) and suggesting gender-based differences in learning approaches. Additionally, the influence of parents' occupational status on performance aligns with studies by Alvarado et al. (2018), emphasizing the role of socio-cultural support in academic success.

Unlike Montalvo and Garay (2021), this study found no regional differences in performance, implying homogenous institutional quality across Puerto Rico. However, a worrying decline in incoming students' math skills necessitates targeted interventions, such as remedial support. Economic dependency status also emerged as a significant factor, with financially dependent students performing better, highlighting the need for financial support mechanisms for economically independent students.

Implications include fostering collaboration between educational institutions to bridge preparedness gaps and adopting adaptive statistical approaches to understand socio-academic dynamics. The study underscores the importance of targeted interventions to support at-risk populations and calls for gender-sensitive and financial support measures to ensure equitable academic success.

CONCLUSIONS

The following conclusions summarize the main contributions of the study and the implications aligned with its objectives:

1. The study highlighted the significant roles that gender, parental occupation, economic dependency status, and declining math preparedness play in academic performance. These findings contribute to a broader understanding of how socioeconomic and demographic factors influence student success, emphasizing the need for targeted interventions.

2. The lack of significant differences in academic performance between students from public and private high schools contradicts previous research, offering new insights into the specific context of Puerto Rican higher education.

3. A concerning decline in academic preparedness was identified, particularly in mathematics, underscoring the need for remedial programs and enhanced support mechanisms.

4. The statistical analysis conducted in the study assessed the relationship between these social factors and student academic outcomes, effectively demonstrating their impact on GPA.

5. Recommendations, such as fostering collaboration between public and private schools, establishing financial support for economically independent students, and implementing gender-sensitive interventions, directly address the identified issues and support the study's goal of improving academic outcomes through targeted initiatives.

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Estrategia de omnicanalidad para la satisfacción y fidelización del cliente en una empresa de venta de muebles