SOCIOCULTURAL AND DEMOGRAPHIC FACTORS THAT INFLUENCE ACADEMIC PERFORMANCE: THE PRE-UNIVERSITY CASE OF THE UNIVERSIDAD POLITÉCNICA ESTATAL DEL CARCHI

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Abstract

The pre-university course established at the Universidad Politécnica Estatal del Carchi (UPEC) after the disappearance of the Sistema Nacional de Nivelación y Admisión (National Equalization and Admissions System, known by its Spanish acronym as the SNNA) posed new challenges for the organizational and academic structure of this university. To start with, the challenge began with the adaptation of a curricular structure according to the educational needs of the nine undergraduate degrees offered at the university. It was followed by the implementation of the program, and finally its evaluation. The present research was designed and carried out as part of the latter goal. Its main objective was to determine the sociocultural and demographic factors that influence the academic performance of the students in the course. For the purposes of this investigation, from a methodological perspective, academic performance was associated with the number of subjects passed by the student. Using multivariate dependency techniques, a logistic regression was performed, which determined the degree of incidence of sociocultural and demographics factors on academic success. After applying the model, the results indicated that the demographic factors in this case do not influence academic success, while variables such as the educational level of the student's parents, the student's grade on university entrance exams and work status are significant when it comes to establishing a cause and effect relationship in this case study.

Keywords – Academic achievement, Regression analysis, Higher education, Entrance examination.

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1. Introduction

A student's academic performance (AP) covers a conglomerate of variables that are not based solely on a grade. In order to obtain a deep understanding of what is involved in this construct in an educational

context, it is necessary to know and evaluate the factors that have an influence on it, as well as the variables that allow us to predict it. The idea focuses on meeting the various needs of educational institutions, which would allow us to solve problems associated with this setting (Nájera-Saucedo, Salazar-Garza, Vacío-Muro & Morales-Chainé, 2020)

For the purposes of establishing a weighted mean value, each institution of higher education established its own evaluation criteria, using benchmarks such as the number of subjects, the number of hours and the grade earned in each of the subjects. In the latter case, if we wish to establish it as a measure of the learning results, it must be considered that these are the product of certain conditions, such as the personal characteristics of the student and the instructor's teaching strategies, as well as institutional and contextual factors; all these aspects have a direct or indirect effect on academic performance (Garbanzo, 2007).

With regard to research focusing on the analysis of academic performance or retention rates, different analytical methods have been used with different approaches to their analysis, as indicated by Alvarez, Callejas and Griol (2020), emphasizing parameters such as family background, socioeconomic status of the family and results on entrance exams.

Sánchez, Naranjo, Vidal, Salazar, Pérez and Jaramillo (2021) indicate that academic performance at the university level is associated with different factors, such as prior academic preparation, access to technology and scores on entrance exams. For this research, other additional variables were considered, such as those of a socioeconomic nature, including monthly family income, residence in rural areas, type of dwelling and gender.

Study habits and learning styles are very closely related to academic performance. This was demonstrated by Magulod (2019) in a study of 75 science students at Cagayan University in the Philippines. This same study also found a relationship between the father's occupation and the type of school of origin and learning styles; it also detected a relationship in the students' study habits when grouped according to academic level in secondary school, writing skills, the educational level of the mothers and test anxiety. The academic offerings of the universities also strongly influence student satisfaction. In a study conducted between 2014 and 2018, at the Universidad Politécnica de Cartagena, in Spain, with subjects in the field of Electronics, it was shown that by implementing new teaching methodologies, such as flipped classrooms, project-based learning, discussion sections and proprietary methodologies, student satisfaction with the classes increased by 15% (Hinojosa, Martínez-Viviente, Garcerán-Hernández & Ruiz-Merino, 2020).

Furthermore, the current use of ICT – and even more so as the result of the COVID-19 pandemic – is a key point in university academic activities. A study on 76 public universities in Thailand sought to identify the basic digital competences required in students by interviewing 1126 specialists; it identified seven components related to digital information: fundamentals, access, use, creation, communication, management and evaluation (Suwanroj, Leekitchwatana & Pimdee, 2019). But these competences are rendered useless when the student does not have access to the Internet or a computer. As a matter of fact, Suana (2018) conducted a study on 10 schools in urban areas in the province of Lampung, in Indonesia, focused on gender-related topics, with a group of 798 students in their final years of study. This study indicated that there were no gender gaps in this regard, and that women even had greater access to the Internet and computers and were the ones who made the most academic use of these resources.

Research on a global level has demonstrated that there are other factors that influence academic achievement. For example, in a public university in Colombia, the performance of 460 students in an undergraduate program was analyzed, identifying twenty-two attributes grouped into four factors: students, family, community and university, which allowed a correct classification of 91.7% to be obtained when associating academic performance with human factors, as opposed to material resources (Castrillón, Sarache & Ruiz-Herrera, 2020). Likewise, at the Universidad Peruana de Ciencias Aplicadas, a study was conducted with 28,586 students from the College of Information Systems and Computing between 2009 and 2014, using Knowledge Discovery in Databases (KDD) and decision tree methodology, obtaining a correct classification rate of 90.69% (Apolaya, Espinosa & Barrientos, 2015).

In a study conducted at the Universidad Agraria La Molina in Peru, analyzing 914 students during the second semester of 2013 and the first semester of 2014, four models were generated to predict passing the General Statistics course; the logistic regression method obtained an accuracy rate of 68.4%; the decision trees with J48 showed a rate of 68.3%; neuronal networks were 67.9% accurate; and the Naive Bayes classifier had an accuracy rate of 71.0% (Menacho-Chiok, 2017).

When researching online education, the influence of social networks on the students' daily activities must also be considered. In this regard, Lau (2017) conducted a study at the University of Hong Kong in which 348 students from eight different colleges participated. Using hierarchical regression analysis, this researcher reached the conclusion that if social networks were used for academic purposes, there was no significant influence on performance, but if they were used for non-academic purposes, particularly in the case of video games, they had a direct relationship with low academic performance.

With regard to the above, the fundamental objective of this study is to determine the sociocultural and demographic factors that influence academic performance in the lower levels of the Universidad Politécnica Estatal del Carchi, as well as to propose a model estimating the probability that students fail at least one subject as opposed to academic success.

2. Methodology

2.1. Participants

The study population consisted of 444 students who entered the equalization system at UPEC, the list of which was provided by the national Secretariat for Education, Science and Technology and Innovation (known by its Spanish acronym SENESCYT) for the second semester of 2020, which was held online between November 2020 and March 2021. The students aspired to nine different degrees offered at the institution in the different programs. During the equalization period, all the students studied the generic subjects of Language and Communication and Mathematics; in addition, they also took a course called Introduction to the Profession, which is specific for aspiring students of each degree.

Two surveys were administered during the academic semester: the first was administered at the start of the period in order to identify the sociocultural characteristics and technological aspects of the students; the second was given at the end of the equalization period, in order to determine the level of academic demand, motivation, instructor attitude, instructional procedures and group management. Consent was obtained from 444 students, of whom 37% were male and 63% were female. The average age was 20, and most lived in an urban area (62%). With regard to parental education, the largest percentage corresponded to basic education (47%). 7% of the students worked and studied at the same time, and 93% of the students had Internet access at home. Consent was obtained from all participants to publish the results on a general level.

It should be mentioned that 506 students were originally admitted, of whom 62 dropped out; for this reason, they were not considered for the purposes of this research study.

2.2. Data

The data on student grades in Mathematics, Language and Communication and Introduction to the Profession were obtained from the academic records of the UPEC for the semester that ran from November 2020 to March 2021.

Table 1 shows a summary with the measures of central tendency for Mathematics, Language and Communication and Introduction to the Profession, as well as the final average corresponding to the non-weighted mean of the grades earned by the students over the course of the semester in the aforementioned courses.

The grades in Mathematics, Language and Communication and Introduction to the Profession and the final average are calculated with a maximum grade of 10.

It must be added that the present study is focused on academic success. Table 2 presents the proportion of students who passed the different subjects, taking into account that the minimum passing grade is a 7.

Statistic	Mathematics	Language and Communication	Introduction to the Profession	Final Average
Mean	7.96	8.78	8.01	8.25
Median	8.00	9.00	8.33	8.44
Standard deviation	0.95	0.90	1.10	0.87
Range	6.34	7.33	6.67	6.34
Minimum	3.33	2.67	3.00	3.00
Maximum	9.67	10.00	9.67	9.34
Coefficient of variation	12%	10%	14%	10%

Table 1. Descriptive summary of the data

Category	Mathematics	Proportion	Language and Communication	Proportion	Introduction to the Profession	Proportion
Pass	422	95%	431	97%	413	93%
Fail	22	5%	13	3%	31	7%
Total	444	100%	444	100%	444	100%

Table 2. Pass and fail frequency

2.3. Materials and Methods

For the analysis of academic performance, the use of multivariate dependence methods through logistic regression is proposed, since it is a robust methodology in case the strict assumptions of normalcy and homoscedasticity are not met.

In this case, there is one single categorical dependent variable, represented by academic performance, and several independent variables (sociocultural and demographic factors). The dependent variable is related to academic success/failure based on passing the courses and academic performance; to determine this, two categories were assigned, according to the number of courses passed; if the student has passed all three subjects, they are assigned to category "1", and if they have passed one or two courses, they are assigned to the category "0", as indicated below:

$$RA = \begin{cases} 1 = passing\ 3\ subjects \\ 0 = passing\ 1 - 2\ subjects \end{cases}$$

It should be clarified that these nominal categories were constructed based on the general student regulations at UPEC, in Art. 5 of the admissions guidelines, where it indicates that the equalization phase for the degree program must be successfully completed (UPEC, 2019).

The logit model fit was evaluated by means of a Confusion Matrix and the Receiver Operating Curve (ROC). To supplement this, a Hosmer and Lemeshow test was applied, in which the null hypothesis (Ho) states that there are no differences between the real and predicted values.

3. Results

The independent variables associated with the logit model in this study – and the degree of incidence on the performance of which we intend to determine – were classified as follows:

Sociocultural factors: labor aspect, educational level of the parents, prior academic training and performance (grade on the university entrance exam), number of children.

Demographic factors: gender, age, income level in the home, area of residence.

Table 3 shows the study variables and their characterization.

Variable	Type of variable	Assigned values
Labor aspect	Categorical	1 = Works
		2 = Does not work
Father's educational level	Categorical	1 = None
		2 = Basic education
		3 = Mid-level education/Baccalaureate
		4 = Higher education/Graduate degree
Mother's educational level	Categorical	1 = None
		2 = Basic education
		3 = Mid-level education/Baccalaureate
		4 = Higher education/Graduate degree
Gender	Categorical	1= Female
		2= Male
Area of residence	Categorical	1= Urban
		2 = Rural
Household income	Categorical	1 = Quintile 1
		2 = Quintile 2
		3 = Quintile 3
		4 = Quintile 4
		5 = Quintile 5
Age	Quantitative	Age in years
Number of children	Quantitative	Number of children
Grade on university entrance exam	Quantitative	Student's score on the university entrance exam, with a maximum score of 1000

Table 3. Characterization of the study variables

The model makes it possible to correctly estimate 92.8% of the cases (Table 4), discarding some variables that are not statistically significant, which is to say that in statistical terms, their effects are not relevant on the academic performance in the lower levels at UPEC during the second semester of 2020.

Generally speaking, the model indicators allow us to conclude that the selected factors (entrance exam grade, father's level of education, work status) help explain the likelihood of whether the students of the equalization course at UPEC will pass all three subjects in the course (academic success), which is reflected by the percentage of correct predictions obtained by the model.

Independent variables	β coefficient	Wald statistic	Level of significance (p)	Exp(B) Odds Ratio
Entrance exam grade (EG)	.018	15.087	.000	1.018
Father's level of education (None)	-	14.295	.003	-
Father's level of education (Basic education) (FEBE)	2.489	13.757	.000	12.050
Father's level of education (Mid-level education/Baccalaureate) (FEMB)	2.199	10.771	.001	9.012
Father's level of education (Higher education/Graduate degree) (FEHG)	1.855	6.038	.014	6.391
Does not work (NW)	1.459	7.655	.006	4.304
Constant	-14.287	15.953	.000	.000

Table 4. Results of the logistic regression model

2LL Initial	-2LL Final	Correct Percentage	Hosmer-Lemeshow Test
212.31	195.44	92.8	Chi square = 7.803 p = 0.453

Table 5. Statistical summary of the logistic regression model

For this model, the three predicting variables were significant that allow us to estimate academic success using the following equation:

$$Performance = \frac{1}{1 + e^{-H}} \ (Eq.\,1) \tag{1}$$

$$H = -14.2865 + 0.0175\,(EG) + 1.45\,(NW) + 2.4891\,(FEBE) + 2.1985\,(FEMB) + 1.8548\,(FEHG) \tag{2}$$

After analyzing the results of the model, it can be stated that the entrance exam grade had a positive coefficient and the odds ratio is greater than one; therefore, as the entrance exam grade increases by one unit, the student is 1018 times more likely to pass all the subjects.

The variable referring to the father's level of education has a positive coefficient for higher levels of education; this indicates that students whose fathers have a basic level of education have a 12050 times greater chance of achieving academic success than those whose fathers had no level of formal education, those with Baccalaureate have a 9012 times greater chance and those with a higher education and/or graduate degree have a 6391 times greater chance.

The variable referring to the work aspect (Does not work) has a positive coefficient (β = 1.459) and an odds ratio greater than 1, which means it can be stated that students who do not work are 4304 times more likely to achieve academic success as compared to students who work and study at the same time.

Upon analyzing the confusion matrix, in which both the correct and incorrect estimations are quantified using the original data, it can be concluded that the percentage of correct predictions by the model is 92.8%.

	Predicted		
Observed	Passing 1-2 subjects	Passing 3 subjects	% Correct cases
Passing 1-2 subjects	1	31	3.1%
Passing 3 subjects	1	411	99.8%
Overall percentage			92.8%

Table 6. Confusion matrix of the logistic regression model

The area under the ROC curve (Figure 1) allows us to conclude that the model distinguishes students who achieved academic success from those who failed at least one subject with a probability of 0.7819.
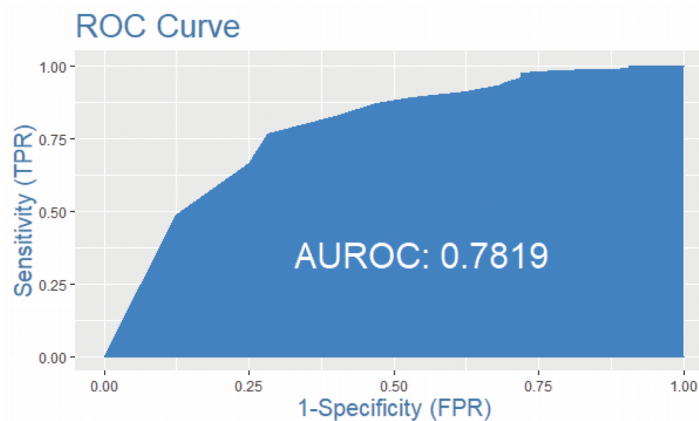

Figure 1. ROC curve of the logistic regression model

4. Discussion

University entrance exams do not always ensure the academic success of the students. At Innopolis University in Russia, one study showed that the compulsory state exam for university admission did not provide sufficient data to predict a student's academic potential (Stanko, Zhirosh, Johnston & Gartsev, 2017). In Ecuador, Sandoval, Ninazunta and Yaselga (2016) used a study conducted at the Escuela Politécnica Nacional to demonstrate that the Exonera group of students, who were identified as high-performing according to a standardized state exam, showed no better academic performance than the rest of the students who did not belong to said group. There are other cases in which there was a strong dependent relationship with the entrance exam. For example, at Universidad de San Martín de Porres in Peru, in a study conducted on 1034 students in the Computer Engineering and Systems degree program, it was found that the variable with the greatest impact on academic performance is the university admissions exam (Yamao, 2018); another study with 415 students who were admitted to the Computer Science degree program between 2016 and 2019 at Universidad Autónoma de Yucatán found the entrance exam to be a very significant predictive attribute; this study used a logistic tree model and attained an accuracy rate of 75.42%, with 0.805 of the area under the ROC curve (Ayala-Franco, López-Matínez & Menéndez-Domínguez, 2021). At Universidad Técnica de Ambat, a study conducted between March and July 2019 found the predictive variables to be average grade in Baccalaureate studies, results on the Baccalaureate exam, and grade point average during the first semester of the degree program (López-Altamirano, Gómez-Morales, Mayorga-Alvarado & Paredes-Ojeda, 2020).

This research shows results similar to those reported by Requena-Santos (1998), who concluded that there is no significant difference in the variable comparing men to women or in that related to age, with the most relevant variables in terms of academic performance being other factors, such as study schedule, and specifically the time spent on studies over the weekend.

Other research shows slight differences between the influence of gender on academic performance. The study carried out by Bakieva (2011), for example, was able to establish a 6% variance in the correlation of these two variables; it is important to stress that these results showed that women demonstrate better academic results in subjects related to communication, while men earn better grades in mathematics. The results reported by Echavarri, Godoy and Olaz (2007) are very similar: they state that men and women use different strategies to solve complex problems; men tend to use more spatial and abstract reasoning, while women use verbal strategies.

In the present study, the variable related to ethnic self-identification fails to show any significant differences in terms of academic performance, since by itself, this variable lacks any representative arguments; other extrinsic factors should be analyzed, such as quality of life, family climate and cultural practices, as indicated by Muñoz-Agredo, Ávila-Díaz and Grisales-Grisales (2014), who also indicate that these aspects constitute a fundamental part of diversity, an intrinsic characteristic of the educational context.

Although many studies state the contrary, not all authors agree on establishing a direct relationship between economic income and academic performance, in spite of the fact that a good economic level facilitates aspects such as access to educational resources and disinterest in searching for work activities that would allow the student's needs to be met, among others. Serrano-Ruiz (2013) states that when traits related to types of intelligence are controlled, the economic aspect has no influence on academic indicators such as grades.

The research conducted by Espejel and Jiménez (2019) analyzed the incidence of educational level and the parents' occupation on academic performance of university students, demonstrating a positive relationship. Similarly, Rodríguez and Guzmán (2019) corroborated this relationship by showing that the academic performance of university students is directly related to their parents' education. When considering the educational level of the parents, the educational level of the mother is more closely related than that of the father, and from an occupational perspective, the occupation of the father is more

relevant than that of the mother; this may be related to the socioeconomic aspect, since it provides access to technological resources for learning and complementary courses.

Caballero and Abello (2018) explain that the stress caused in the workplace for those students who are employed has an influence on academic performance; furthermore, Nieves and Zuluaga (2016) conclude that when the student is required to work to pay for their studies, their academic performance depends to a great extent on their will power, and involves a great effort on their part, since study time takes away hours from their resting time. From this perspective, we must point out that there are implications in terms of academic success for students who work and study at the same time, bearing in mind that those who do not work dedicate their time completely to studying.

5. Conclusions

The research conducted by Espejel and Jiménez (2019), having analyzed the incidence of educational level and the parents' occupation on academic performance of university students, shows a positive relationship. This corroborates the claims made by Rodríguez and Guzmán (2019), indicating that the academic performance of university students is directly related to their parents' education. When considering the educational level of the parents, the educational level of the mother is more closely related than that of the father, and from an occupational perspective, the occupation of the father is more relevant than that of the mother; this may be related to the socioeconomic aspect, since it provides access to both technological resources for learning and complementary courses.

- According to the percentage of correct predictions attained by the model of 92.8%, the variables with the most influence on academic success of the students in the present research are the entrance exam grade, level of father's education and work status.

- For this case study, the grades were considered in three subjects taken by students of the pre-university course at UPEC, with the subject Introduction to the Profession having the greatest coefficient of variation (14%).

- Demographic factors did not prove to be significant for this study. However, given the high percentage of correct classifications within the logic regression, it would be recommendable to continue to explore new predictors and student profiles within the virtual modality.

- The grade on the entrance exam proved to be a predictor of academic performance, which reflects special importance, as it is a variable on which we can act, strengthening academic performance through prior knowledge.

Declaration of Conflicting Interests

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References

Alvarez, N.L., Callejas, Z., & Griol, D. (2020). Predicting Computer Engineering Students' Dropout In Cuban Higher Education With Pre-Enrollment and Early Performance Data. *Journal of Technology and Science Education*, 10(2), 241–258. https://doi.org/10.3926/jotse.922

Apolaya, C., Espinosa, A., & Barrientos, A. (2015). Predicción del Rendimiento Académico en Carreras de Computación utilizando Arboles de Decisión. *Ieee Transactions on Journal Name, Mindata* (1-8). Available at: https://www.researchgate.net/publication/333582116_Prediccion_del_Rendimiento_Academico_en_carreras_de_Computacion_utilizando_Arboles_de_Decision

Ayala-Franco, E., López-Matínez, R.E., & Menéndez-Domínguez, V.H. (2021). Modelos predictivos de riesgo académico en carreras de computación con minería de datos educativos. *Revista de Educación a Distancia*, 21, 1-36. https://doi.org/10.6018/red.463561

Bakieva, M. (2011). Actividades Extraescolares Y Rendimiento Académico: Diferencias En Autoconcepto Y Género. *Revista de Investigación Educativa*, 29(2), 447-465.

Caballero, C., & Abello, R. (2018). Relación del burnout y el rendimiento académico con la satisfacción frente a los estudios en estudiantes universitarios. *Avances En Psicología Latinoamericana*, 25, 98-111. Available at: https://revistas.urosario.edu.co/index.php/apl/article/view/1208

Castrillón, O.D., Sarache, W., & Ruiz-Herrera, S. (2020). Predicción del rendimiento académico por medio de técnicas de inteligencia artificial. *Formación Universitaria*, 13(1), 93-102. https://doi.org/10.4067/s0718-50062020000100093

Echavarri, M., Godoy, J.C., & Olaz, F. (2007). Differencias de género en habilidades cognitivas y rendimiento académico en estudiantes universitarios. *Universitas Psychologica*, 6(2), 319-329.

Espejel, M., & Jiménez, M. (2019). Nivel Educativo y Ocupación de Los Padres: Su Influencia en el Rendimiento Académico de Estudiantes Universitarios. *RIDE Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, 10(19). https://doi.org/10.23913/ride.v10i19.540

Garbanzo, G. (2007). Factores asociados al rendimiento académico en estudiantes universitarios, una reflexión desde la calidad de la educación superior pública. *Revista Educación*, 31, 43-63. https://doi.org/10.15517/revedu.v31i1.1252

Hinojosa, J., Martínez-Viviente, F.L., Garcerán-Hernández, V., & Ruiz-Merino, R. (2020). Teaching-learning model for the science of electronics. *Journal of Technology and Science Education*, 10(1), 87-100. https://doi.org/10.3926/jotse.604

Lau, W.W.F. (2017). Effects of social media usage and social media multitasking on the academic performance of university students. *Computers in Human Behavior*, 68, 286-291. https://doi.org/10.1016/j.chb.2016.11.043

López-Altamirano, D.A., Gómez-Morales, M.J., Mayorga-Alvarado, F.R., & Paredes-Ojeda, M.E. (2020). The Ser Bachiller test score as a predictor of university academic performance universidade. *Polo Del Conocimiento*, 5(03), 69-91. https://doi.org/10.23857/pc.v5i3.1323

Magulod, G. (2019). Learning styles, study habits and academic performance of Filipino university students in applied science courses: Implications for Instruction. *Journal of Technology and Science Education*, 9(2), 184-198. https://doi.org/10.3926/jotse.504

Menacho-Chiok, C.H. (2017). Predicción del rendimiento académico aplicando técnicas de minería de datos. *Anales Científicos*, 78(1), 26. https://doi.org/10.21704/ac.v78i1.811

Muñoz-Agredo, S.M., Ávila-Díaz, W.F., & Grisales-Grisales, M.C. (2014). Prácticas culturales y su influencia en el rendimiento académico. *Plumilla Educativa*, 13(1), 176-193. https://doi.org/10.30554/plumillaedu.13.406.2014

Nájera-Saucedo, J., Salazar-Garza, M.L., Vacío-Muro, M.Á., & Morales-Chainé, S. (2020). Evaluación de la autoeficacia, expectativas y metas académicas asociadas al rendimiento escolar. *Revista de Investigación Educativa*, 38(2), 435-452. https://doi.org/10.6018/rie.350421

Nieves, M., & Zuluaga, C. (2016). Factores que influyen en el rendimiento académico del estudiante. *Escenarios: Empresa y Territorio*, 5(5), 93-118.

Requena-Santos, F. (1998). Género, redes de amistad y rendimiento académico. *Papers. Revista de Sociología*, 56, 233. https://doi.org/10.5565/rev/papers.1952

Rodríguez, D., & Guzmán, R. (2019). Rendimiento Académico: Y Factores Sociofamiliares de Riesgo Variables Personales que Moderan su Influencia. Perfiles Educativos, 40(164), 118-34. https://doi.org/10.22201/iisue.24486167e.2019.164.58925

Sanchez, T., Naranjo, D., Vidal, J., Salazar, D., Pérez, C., & Jaramillo, M. (2021). Analysis of Academic Performance Based on Sociograms: A Case Study With Students From At-Risk Groups. *Journal of Technology and Science Education*, 11(1), 167-179. https://doi.org/10.3926/jotse.1110

Sandoval, I., Ninazunta, J., & Yaselga, S. (2016). Análisis del examen exonera y su relación con el rendimiento académico de los estudiantes de primer semestre de las carreras de ingeniería y ciencias de la Escuela Politécnica Nacional – Quito – Ecuador. *Sexta Conferencia Latinoamericana Sobre El Abandono En La Educación Superior.* https://doi.org/10.18687/LACCEI2017.1.1.341

Serrano-Ruiz, L. (2013). La influencia de los factores socioeconómicos en el rendimiento académico. *Universitas Almeriensis*, 1(1), 4-48.

Stanko, T., Zhirosh, O., Johnston, D., & Gartsev, S. (2017). On possibility of prediction of academic performance and potential improvements of admission campaign at IT university. *IEEE Global Engineering Education Conference, EDUCON* (862-866). https://doi.org/10.1109/EDUCON.2017.7942949

Suana, W. (2018). Students' internet access, internet self-efficacy, and internet for learning physics: gender and grade differences. *Journal of Technology and Science Education*, 8(4), 281-290. https://doi.org/10.3926/jotse.399

Suwanroj, T., Leekitchwatana, P., & Pimdee, P. (2019). Confirmatory factor analysis of the essential digital competencies for undergraduate students in Thai Higher Education Institutions. *Journal of Technology and Science Education*, 9(3), 340-356. https://doi.org/10.3926/jotse.645

UPEC (2019). *Reglamento general de estudiantes de la Universidad Politécnica Estatal del Carchi.* Available at: http://190.15.129.78/handle/123456789/52

Yamao, E. (2018). Predicción del rendimiento académico mediante minería de datos en estudiantes del primer ciclo de la Escuela Profesional de Ingeniería de Computación y Sistemas, Universidad De San Martín De Porres, Lima, Perú. In *Universidad de San Martín de Porres – USMP* (8672). Available at: http://repositorio.usmp.edu.pe/handle/20.500.12727/3555 https://doi.org/10.24265/campus.2018.v23n26.05