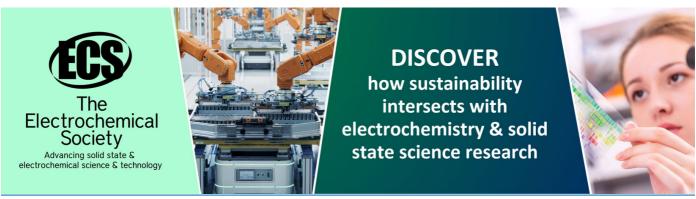**PAPER • OPEN ACCESS**

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Importance of computer science in the results of the evaluation of higher education in Colombia

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Abstract. Information and communication technologies have transformed social behavior into teaching and learning processes, however, it is debated whether greater access to technology influences the quality of knowledge acquired by undergraduate students. This article aims to determine the incidence of information technology and communication tools in the results obtained in the Saber Pro 2017-2018 tests by administration and related students; these tests are the exams that the Colombian state performs annually to determine the quality of higher education in public and private universities. The achievement of this objective was carried out through an analysis of variance that consists in evaluating if there are significant differences in the results, according to the students who have a computer, have access to the Internet and the time in hours dedicated to this. The analysis of variance left as the main conclusion that the use of Information and Communication Technologies increases the chances of improving the results obtained by students.

1. Introduction

The new information and communication technologies (ICT) have transformed today's social behavior and education is one of the sectors most permeated by them, because the teacher has ceased to be the main source of information and has passed to take the role of a knowledge guide within the classroom or a group of students. However, the presence of technology also has a strong leisure component which indicates that if it is not used properly, it can affect the learning capability of those involved.

According to Castro, *et al.* [1], they point out that in order to have a true impact of ICTs on students, it is necessary to implement teaching and learning models that allow adjust learning moments or visionary educational cycles that incorporate strategies in their curricula that lead those interested to develop training activities through digital spaces such as blog, discussion forums, platforms, chat, and other tools including email.

The use of technological tools in educational processes becomes an important factor since they increase interaction with the world through research and knowledge generation, these significant changes in our way of living, interacting, relating and learning are challenges that all generations are facing thanks to the requirements of globalization. Several studies contemplate that the technological tools are, as they claim, Aliaga, *et al.* [2], a great support in the teaching process where it is affirmed that the personal computer as a tool in the support of the learning process is nowadays of great importance, becoming this a first need good and not a luxury one, it is worth mentioning that if this is implemented in a computer room, in colleges and universities, it must fulfill the role of being a personal device in which the student can have their own files, their internet favorites and even

download the educational programs that are required and that these remain the hard disk of the personal computer and that does not become simply a tool for reading and writing interface. Due to the importance of the ICTs mentioned above; In this article it is proposed to outline the most relevant aspects in learning results through certain components such as the computer, the connection to the household Internet and the time spending online in hours, make the results obtained by students on Saber Pro tests are better or not.

To achieve this objective, the database of the "Instituto Colombiano para la Evaluación de la Educación Superior (ICFES)" was taken as a reference, especially the survey of students of "Administración de Empresas (AE)" related to public universities that they presented the Saber Pro test in 2017 and 2018. Within this survey, variables related to ICTs were identified, such as those that inquire if students have a computer in their home, if they have an Internet connection and the hours dedicated to it; with this information, an exploratory analysis was carried out to determine which of them influenced the test results and therefore the improvement or not of the overall score.

Castañeda [3], say what the Saber Pro tests are important for the Colombian state as these allow, among others, to measure the students' competencies, comparison between programs of the technological and university institutions and collect information that build evaluation indicators. For the student obtaining good scores can represent benefits such as forgiveness of debt with the "Instituto Colombiano de Crédito Educativo y Estudios Técnicos en el Exterior (ICETEX)" access scholarships for postgraduate studies in and outside Colombia.

2. Framework
Trends in the use of ICT in higher education, nowadays, according to Padilla, *et al.* [4], progress is being made vertiginously thanks to the emergence of ICT and, one of the branches most touched by the digital era is education at all levels of training; this is how it is analyzed that higher education in Colombia has presented important variations highlighting the results of the Saber Pro tests as an indicator of the quality in the level of learning of the basic and generic skills of undergraduate students of public universities.

Regarding the role that ICTs play in higher education, García, *et al.* [5] state that "Information and communication technologies in higher education represent the new learning environments and, due to their impact on education, are the necessary skills developers for learning and life skills generating".

According to the above, the access to technological tools is a permanent challenge that students face, in addition to having the skills for a proper use, there are other factors such economic limitations for the purchase of computer equipment and payment to the internet access. It is said that in such a globalized world it is essential that technology is in continuous progress, so it is very important to be at the forefront of it, which is why today ICTs are considered as knowledge tools, which allow meaningful learning for students, because they facilitate the exchange of information, generating a better communication between students and teachers, thus contributing to the construction of knowledge, through observation, the exploration and analysis of the diversity of phenomena, contexts, scenarios and situations, stimulating reading comprehension, creativity and innovation in students, leading them to become young researchers [6].

Related studies to the subject as the one of Rodríguez, *et al.* [7] state that "the use of ICT in education demands the student's research, analysis and comparison of information with their reference knowledge and the construction of ideas, which gives meaningful learning strengthening the communication with peers and teachers, a fact that gives rise to collaborative work".

Regarding the role that ICTs play in education, it can be seen that in an investigation carried out at the "Universidad Francisco de Paula Santander (UFPS)", Ocaña, Colombia [8], that today the pedagogical practices of teachers have changed towards the use of virtual environments, where the motivation of the transmission of knowledge to the new generation can increase through the use of video tutorials which are a mechanisms to support to their classes and get their achievements as they rise interest in learning knowledge topics.

Regarding similarity of the objectives pursued by this study, it is necessary to refer to the so-called [9], "influence of ICT on the academic performance of Latin American students, Programme for International Student Assessment (PISA), 2012 test". Is a study that refers to the impact that they have the ICTs on the academic performance of Latin American students, this study concludes that the use of ICTs positively impacts the academic performance of children. On the other hand, higher education is currently projecting towards curricular flexibility where ICTs play a very important role in the learning process and that is where the academic programs of a university must develop connection mechanisms around the use of ICT and internet within their subjects [10]. "The curricular flexibility in higher education presents opportunities such as offering different training routes so that the student has the possibility to select the one that best suits their interests and needs". It should be noted that today teachers and students are updated through the use of the Internet to consult tasks, concepts, research topics, news of interest among others, and has moved to the first place as an indispensable tool in ICT for educational performance, because it connects us with national and international news. About the use of the internet, Uribe, *et al*. [11] argue the following: in this way it has been possible to identify the Internet as a set of electronic tools and network services which are intended to support the various missionary processes of the university. As a contribution to this research, ICTs are considered to have a great influence on the education system and have generated great mobility of knowledge, eliminating geographical barriers in new generations.

Regarding the added value that ICTs can deliver to student training, and according to the article, "proposal for measuring the impact of ICTs in university education", the authors [12] establish that in the process of training students it must include a complete analysis that allows identification of their integration and use; In this regard and in terms of resources, it is necessary to consider in the studies what refers to Hardware, Software, network capabilities and any other type of digital resources used for teaching and learning.

Respect to access to internet connectivity Blazquez [13], he says that the changes in the practice of the use of the internet and its access to information and the work carried out through it, without adequate and permanent access to this technological tool, a society runs the risk of being left behind. At present, in Colombia have low internet connectivity despite being in the 21st century, in a globalized context which demands a change of knowledge. The devices must also be provided so that the communities have the tool that will allow them to use the web, however, digital literacy must be taken into account, which is a factor that generates an impact on the digital society, without a doubt the people who are in remote areas are those who generally have less connection possibilities, a fact that limits their learning and knowledge processes regarding those who reside in the big cities, who that can be at the forefront of the new ones technologies [14].

3. Methodology

The purpose of the work of this research is to find the possible relationship that exists in the results obtained by the students of business administration (BA) and related of the Colombian public universities in the Saber Pro tests and the fact that these are seen permeated or influenced by the use of ICT, more specifically, to the fact that students have an Internet connection or not, have a computer or not and also the hours they spend connected to the network. To achieve the proposed objectives, It was used the database of results of the Saber Pro prepared and published by the ICFES, taking as reference the years 2017 and 2018, 11988 and 10938 students were selected respectively who presented the evidence of the administration and related component of public universities; together with the results of the tests, the ICFES includes the characterization of the student within which the variables referring to the ICTs described in the previous paragraph were chosen as study variables.

Regarding the type of variables selected, they are: one of a quantitative type, the results of the global Saber Pro test score and three of a qualitative type, having access to the internet, having a computer, hours of connection on the web. With the ICFES database, we proceeded to perform the different filters that showed only the variables of interest described, with this information we proceeded, with the help of the Xlstat software, to obtain, in the first instance, a general description of

the population object of study, then an analysis of the Saber Pro tests, according to the student's social status that is a Colombian index of wealth, access to the Internet or not, the possession or not of the computer and the connection time on the web. Subsequently, an "analysis of variance (ANOVA)" was carried out, which allows to verify if there are significant differences between groups [15], and thus corroborate the results of the tables of the incidence or not of ICTs in the improvement of results. in the Saber Pro tests.

4. Analysis of results

Table 1 allows to observe some of the data which the ICFES through its database characterizes the business management students from public universities in Colombia. It describes the gender being female who has the largest number of students, corresponding to 61.9% in 2017 and 61.4% in 2018; the discrimination by social status is also observed, being strata from 0 to 3 where the majority of students enrolled in these careers are concentrated with 92.7% in 2017 and 89.8% in 2018.

Regarding internet tenure, it is observed that the rate of the families with connection is 77.4% in 2017 which raised to 79.3% in 2018, reducing in 1.9% the families that do not have access to it, in the same way, compared to the possession of computer it is observed that the majority has at least one at home, that is 86.3%, compared to 13.7% that does not have one in 2018, a very similar result that was obtained in 2017; Most students spend between 1 and 3 hours using the Internet in both years.

Finally, the Table 1 indicates that in 2018 59.6% study in face-to-face mode followed by 38.5% who do so in the distance mode and 1.9% do so in the virtual mode.

Table 1. Student descriptions.

Variable\Statistic	Category	Frequency (2018)	Relative frequency (2018)	Frequency (2017)	Relative frequency (2017)
Student_gender	Female	6712	61.4%	7422	61.9%
	Male	4226	38.6%	4566	38.1%
Fami_housingstratum	Social stratum 0	291		48	0.4%
	Social stratum 1	2557	23.4%	2985	24.9%
	Social stratum 2	4185	38.3%	4637	38.7%
	Social stratum 3	3080	28.2%	3487	29.1%
	Social stratum 4	617	5.6%	659	5.5%
	Social stratum 5	155	1.4%	133	1.1%
	Social stratum 6	53	0.5%	39	0.3%
	No reports	246	2.2%		0.0%
	No social stratum	45	0.4%		00%
Fami_ithasinternet	No	2268	20.7%	2705	22.6%
	Yes	8670	79.3%	9283	77.4%
Fami_ithasacomputer	No	1499	13.7%	1632	13.6%
	Yes	9439	86.3%	10356	86.4%
Student_internetdedication	Less than an hour	3093	28.3%	3558	29.7%
	Between 1 and 3 hours	6194	56.6%	6631	55.3%
	More than 4 hours	1651	15.1%	1799	15.0%
Student_method_prgm	Distance	4211	38.5%	4878	40.7%
	Virtual distance	208	1.9%	91	0.8%
	Face-to-face	6519	59.6%	7019	58.6%

Table 2 also shows the relationship between the average result of the global score obtained by the students in the Saber Pro test regarding Internet access, computer ownership and Internet time dedication discriminated by the social stratum. It shows that the results obtained in the Saber Pro tests by the administration and related students of public universities in Colombia are better in all strata for those students who have access to the internet. This same situation is repeated for those students who have a

computer. However, the results obtained by the students according to the dedication to the use of the Internet have the following characteristics, in 2017 the results improve when they spend more than one hour a day, but decrease when you have exceeded 4 hours, however in 2018 it is evident that greater dedication to the internet has a positive relationship with the results achieved in the tests. The data thrown and described in Table 2, only show us the means of the global scores, but does not contemplate the variation between the groups, hence to verify if the observed differences are really significant, an analysis of variance is carried out (ANOVA), where the hypotheses submitted for confirmation also called null hypothesis (H_o) or rejection also called alternative hypothesis (H_a) were:

- H_o = the averages of the global scores are the same regardless of whether they have a computer, have internet and internet time duration.
- H_a = the averages of the global scores are different since the students have a computer, have internet and internet time duration.

The ANOVA models for 2017 and 2018 had a significant result with an expected probability or Pr value of less than 0.05 thus rejecting H_O in favor of the alternative Ha, that is to say that the values found are below the established probability of rejecting the null hypothesis of P = 0.05. Indicating that the information provided by the explanatory variables is significantly better than what the average could provide.

Table 2. Global averages in relation to ICTs variables and discriminated by socioeconomic status.

Global score means	Have internet		Have computer		Time spent on internet		
Row name	No	Yes	No	Yes	Less than an hour	Between 1 and 3 hours	More than 4 hours
Social stratum 0	127.7	136.0	122.6	134.8	131.2	127.3	137.8
Social stratum 1	132.3	134.8	130.6	134.8	131.8	134.5	134.6
Social stratum 2	136.9	142.9	136.0	142.4	139.5	142.6	142.2
Social stratum 3	139.8	146.1	140.5	145.9	143.3	146.7	145.3
Social stratum 4	150.7	148.6	138.9	149.0	147.7	149.5	147.6
Social stratum 5		151.5	133.4	152.2	152.0	152.1	149.1
Social stratum 6	117.0	157.7	155.0	156.7	159.3	160.0	147.1
Grand total 2017	135.0	143.1	133.9	142.4	138.8	142.4	142.1
Social stratum 1	132.3	138.3	131.5	137.2	133.6	136.5	137.0
Social stratum 2	138.3	144.0	135.8	143.9	140.1	144.0	144.2
Social stratum 3	141.6	147.2	140.6	147.2	142.9	147.5	150.2
Social stratum 4	139.8	147.4	135.3	147.5	139.8	148.8	153.8
Social stratum 5	130.8	147.3	131.8	147.3	137.4	146.6	154.4
Social stratum 6	116.0	143.7	133.6	143.9	124.2	140.2	162.6
No reports	127.0	138.7	129.7	137.2	131.0	137.8	138.9
No social stratum	122.5	134.0	125.1	131.5	127.5	133.0	120.4
Grand total 2018	135.1	144.2	134.1	143.7	138.7	143.4	145.4

Table 3. Results of the analysis of the sum of squares type III of the variables under study.

Source	Grades of liberty	Sum of squares	Middle squares	Fisher value	Pr > Fisher
		2017			
Fami_ithasinternet	1	61630.751	61630.751	124.275	< 0.0001
Fami_ithasacomputer	1	28961.311	28961.311	58.399	< 0.0001
Estu_internetdedication	2	15838.045	7919.023	15.968	< 0.0001
		2018			
Fami_ithasinternet	1	60987.466	60987.466	139.256	< 0.0001
Fami_ithasacomputer	1	35902.711	35902.711	81.979	< 0.0001
Student_internetdedication	2	43172.009	21586.004	49.289	< 0.0001

On the other hand, as observed in Table 3, the three variables contemplated in the study also obtained a significant result evidencing that the variables related to ICTs provide significant information to explain the variability of the results of the global score for both years. , therefore, these results confirm the sense that ICTs are relevant in improving the results of the Saber Pro tests.

Finally, Table 4, focuses on the variable time of dedication that students spend connected to the internet in 2017; given that this variable comprises three categories whose results decreased after 4 hours, by means of a pairwise comparison it allows us to observe which groups show differences between them, resulting in the dedication between 1 and 3 hours and more than 4 hours, no they generate marked improvement in the results of pro knowledge, but a dedication of less than one hour per day increases the chances of having a lower test result.

Table 4. Tukey honestly-significant-difference (HSD)/analysis of the differences between categories with a 95% confidence interval (global score).

	Dedication internet		
Contrast	between 1 h. and 3 h. vs less 1 h.	between 1 h. and 3 h. vs plus 4 h.	plus ofe 4 h. vs less 1 h.
Difference	2.7	0.5	2.2
Standardized difference	6.2	1.0	3.5
Critical value (2.3)	3.15	3.15	3.15
Pr > Diff	< 0.0001	0.6	0.0
Significant	Si	No	Si
Category	between 1 h and 3 h.	between of 4 h.	less 1 h
Means	139.0	138.4	136.2
Standard error	0.3	0.6	0.4
Groups	A	A	B

5. Discussions of results

The public university student, the higher the social status the better the result is in the Saber Pro Tests; therefore, it can be inferred that the socioeconomic conditions that facilitate access to ICTs affect academic performance in a positive way. Hence, it is recommended to make a comparative study with private universities that allows evidence of this result, it can be investigate the fact that 38.5% are students of distance and virtual modality, who supposed to have high access to the computer. The "Instituciones de Educación Superior (IES)", according to Quintero and Moreno [16], must generate strategies that allow students to have a greater impact on the passage through their classrooms, to be reflected in the increase in the scores obtained in the competences that ICFES evaluates in the application of the Saber Pro tests. The previous sections continue to leave the discussion process open in the face of the impact that ICTs have on the results of the Saber Pro tests; because in addition to having limitations for access to connectivity, to the purchase of computer equipment, many questions are raised about the quality of time spent on it, making it clear that for those who have access to the internet and a computer at home increases the probabilities of positively impacting the results [3]. As corroborated by Aliaga, *et al.* [2], that educational results are extraordinarily complex and, of course, multidimensional phenomena. That is why we are well aware that there are many factors that are influencing these results. With previous studies such as that carried out by Osma, *et al.* [17], it is evident that it coincides that the students belonging to the middle and high strata are those who obtain high and very high scores. Likewise, these authors analyze other variables such as the highest scores are more associated to the male gender and the lower scores to the female gender and that the high and very high results favor students from public institutions rather than private ones, as well as students who have parents with higher studies. Likewise, on the study carried out by Botello, *et al.* [9], regarding the influence of ICT on the results on tests, they conclude that effectively the use of them positively impacts the academic results of children by a percentage between 5% and 6% in each of the study areas analyzed by them, they coincide, in general terms, with the results obtained by the authors of this study.

6. Conclusions

The students from the administration and related programs of the public universities of Colombia, it shows that those of low social status with strata 1, 2 and 3 are the most likely to have difficulties owning a computer (22.4%) and internet access (13.8%). The scores of the students who present the Saber Pro tests improve if they have a computer and access to the internet, highlighting that it deteriorates in those who spend less than an hour on the use of the internet. The use of ICT improves educational efficiency by developing new teaching methodologies that benefit the student's training process. In addition, they offer a greater impact for the development of their skills. ICTs have been rapidly incorporated into educational teaching-learning processes and consequently has led to the strengthening of educational informatics.

The ANOVA analysis confirms that there is a significant difference in the test results between students who have a computer and not; internet access and not; also, between those who last more than 1 hour a day connected to the internet and those that last less than 1 hour. Evidence that the access of ICTs really improves the academic performance of the students analyzed in the present study, however, it will always be an absolute condition, it will be necessary to study and analyze multiple factors that affect the competencies evaluated by the ICFES and that are of measurement in the results of the Saber Pro.

Finally, the authors consider that the IES must generate different strategies that allow them to leave a greater impact on the students through their classrooms, in order not only to improve the results in the Knowledge Pro Tests, but also their hard skills which allows them to strengthen their skills to face job challenges; This will only be achieved taking into account in addition to the variables studied in this research, multiple aspects that were not contemplated in the present study.

References

[1]   Castro S, Guzmán B, Casado D 2007 *Laurus Revista de Educación* **13(23)** 213
[2]   Aliaga F, Bartolomé A 2005 *El impacto de las nuevas tecnologías en educación* (España: Universidad de Valencia y Universidad de Barcelona)
[3]   Castañeda E M 2015 *Saber Pro (ECAES) ¿Para qué sirven?* (Medellín: Grupo Educación y Empresa Educando en Competencias)
[4]   Padilla J, Vega P, Rincón D 2014 *Entramado* **10(1)** 272
[5]   García M R, Reyes J, Godínez G 2017 *RICSH Revista Iberoamericana de las Ciencias Sociales y Humanísticas* **6(12)** 299-
[6]   Sampedro J L 2002 Técnica y Globalización *Boletín Económico de ICE, Información Comercial Española* **2750** 45
[7]   Rodríguez N, Mendoza M, Ferrer L 2014 *Hallazgos* **11(22)** 440
[8]   Rodríguez Suárez A M, Moreno Montagut J A, Trigos Rodríguez M 2016 *Revista Ingenio UFPSO* **10(1)** 37
[9]   Botello H, Guerrero A 2014 *La influencia de las TIC en el desempeño académico de los estudiantes en América Latina: Evidencia de la prueba PISA 2012* (Perú: Memorias Virtual Educa)
[10] Trigos Rodríguez M, Contreras Suarez S, Ropero Gaona C A, Hormaza Fajardo O 2017 *Revista Ingenio UFPS* **13(1)** 97
[11] Uribe Tirado A, Preciado J F, Arroyave Palacio M, Ramírez Marín G, Pineda M, Valderrama Muñoz Á 2008 *Revista Avances en Sistemas e Informática* **5(2)** 47
[12] Ávila G, Riascos S 2011 *Educación y Educadores* **14(1)** 169
[13] Blázquez Entonado F 2001 *Sociedad de la Información y Educación* (Mérida: Junta de Extremadura)
[14] Volpe P F 2012 *Comunicación y Cultura en el Siglo XXI o la Era del Acceso* (Argentina: Pensar Iberoamerica)
[15] Webster A L 2005 *Estadística Aplicada a los Negocios y la Economía* (México: McGraw-Hill Interamericana)
[16] Quintero B, Moreno J 2018 *Revista Espacios* **39 (35)** 9
[17] Osma C A, Mojica P D, Rivera F E 2014 *Revista Innovaciencia* **2(1)** 22