



Access to learning technologies and their impact on medical students' academic performance in times of pandemic

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Abstract: Background: Information and communication technologies played a fundamental role during the pandemic, because they allowed to advance in the process of teaching-learning. Nevertheless, there are careers in the health area that maintain their opposition to this type of technologies, especially in higher levels previous to graduation, because of the importance of the learning only acquired by the face-to-face learning and the practice. **Objective:** For that reason, it is important to determine if learning technologies influence in the academic performance of the students of the Medicine Career in the pandemic time. **Methods:** An analysis to a total of 309 students from second to tenth level was made, to which a survey was applied. **Results:** the results show that students with internet connection doubled the percentage in the categories "excellent" and "good" in their academic performance to the students that had no access to the described technologies, even if there is no direct relationship between the connection hours and the measured performance of grades. It is also important to highlight that the academic performance of the female students is better than the male students and the living zone or region of the students does not represent a limiting for accessing teaching and learning technologies. **Conclusions:** The access to communication and information technologies do have a relationship in virtual environments and the academic performance.

Keywords: Academic performance, university students, Medicine, technologies

1. Introduction

Along the history, the Academic Performance has been used as a concept that is only related to evaluations of diverse educative institutions in their different levels (school, high school, and superior education). Nowadays, academic performance is considered as one of the most studied variables in the education field [1,2], because of the different means they can involve, considering the learned knowledge of the students and their grades.

Due to the analysis of the academic performance allow to identify if the student accomplishes with the learning standards that the educational curricula disposes in order to be promoted to the next level, multiple studies have been made from different points of view [1–10], especially with the purpose of establishing the different factors that influence, being positive or negative, in the teaching-learning process.

Some of the studies are focused in the learning styles [3], others in the curriculum efficiency and the processes of curricular evaluation [11]; meanwhile, in the health areas they are focused in some aspects as the determination of the factors that directly influence to the performance [1] the nutritional state [12], family influence and support [13]. Whichever the focus is, the important thing is to know the different methodologies and tools that a professor may have in order to provide an adequate support and guidance.

In the last years information and communication technologies have become a necessary input, because they provide different elements to improve the teaching-learning [14], increasing the probabilities of reaching proposed learning objectives [15,16]. Nevertheless, there is a lot of controversy in the health areas, because it has been considered for decades the importance of

being an exclusively face-to-face career, especially at the moment of performing pre-professional practices.

However, after the COVID-19 pandemic, the changes in the different learning methodologies and tools to be used were necessary and essential in order to keep imparting class in a remote way in order to avoid delays for both students and university. For teachers, these changes were drastic, and there was the need to acquire new knowledge related to the use of communication and information technologies that were more usable for both students and teachers on line; because, as it is logic, there was ignorance of the use of technological tools [17]. This, with the proposed objective of not stopping only the health sciences classes, but in the rest of the careers offered by higher education institutions.

Based on the last approach, we are focused in answering the following question: Does the access to learning and knowledge technologies (LKT) influence in the academic performance of the Medicine career students during the pandemic?

2. Materials and Methods

2.1 Study area

The population of the study was formed by 1560 students of the medicine career of the Catholic University of Cuenca, Azogues Campus, located in the province of Cañar, city of Azogues (San Francisco of Peleusí of Azogues) – Ecuador.

2.2 Sample

A calculation for the finite sample was applied and it was obtained as a result 309 students to be surveyed through a random probability sampling. The instrument was structured in five blocks: socio-demographic, familiar, psychological, social and reproductive health, and electronic devices.

The statistical analysis will be done with the program "R Studio" while performing correlational studies, confronting study variables with the information obtained in the data collection instrument.

2.3 Academic performance

In order to determine the approval of a student to be promoted to the next level of the Medicine career, there is a range of grades (90-100, 80-89, 70-79 and less than 70). It is necessary to obtain an average of 70 or higher in each subject, otherwise the student will fail the subject that has not the minimum score. This is in accordance with the current normative of the Catholic University of Cuenca described in the Regulation of the Student Evaluation System [18], approved by the Higher Education Council (CES), resolution RPC-SO-22 N. 267-201, accepted and signed on January, 2017.

In order to answer the previously established questions, the following hypothesis were created, which will be proved through econometric models with the R Studio software.

2.4 General hypothesis:

The access to learning and knowledge technologies (LKT) increased the academic performance of the students in the Medicine career during the pandemic.

2.5 Specific hypothesis:

H1: The number of connection hours influence in the academic performance.

H2: Sleep habits improve the Medicine career students' academic performance

H3: There is or there is not an important difference in the Medicine career students' academic performance differentiated by genre.

H4: The urban/rural location limits the access to learning and knowledge technologies (LKT) of the Medicine career students.

H5: The perception of teaching-learning in the virtual environment of the Medicine career students is or not positive.

3. Results

On Table 1, it is evidenced that, for the model, the correlation coefficient is $R = 0.9023$, this indicates that there is a positive higher lineal relation between the variables. The P value is $2.2e-16 < 0,05$, admitting a null hypothesis. The independent variables "rendimiento_catbueno", "rendimiento_catregular" and "rendimiento_catsobresaliente", are statistically important. A student with a low academic performance with access to learning and knowledge technologies (LKT) will need to obtain 18.09 points in order to have a good performance, if he/she obtains 8, 55 additional points, his/her academic performance will be regular, and if he/she obtains 26,07 additional points, the academic performance will be excellent. The determination coefficient $R^2 = 0,9013$, indicates that 90,13% of the academic performance is explained by the connection hours.

Table 1. Summary model of lineal regression of learning and knowledge technologies (LKT) and academic performance.

Coefficients:				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	66.3548	0.5150	128.84	<2e-16 ***
rendimiento_catbueno	18.0952	0.6343	28.53	<2e-16 ***
rendimiento_catregular	8.5489	0.5711	14.97	<2e-16 ***
rendimiento_catsobresaliente	26.0668	0.6036	43.19	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
 Residual standard error: 2.868 on 305 degrees of freedom
 Multiple R-squared: 0.9023, Adjusted R-squared: 0.9013
 F-statistic: 938.9 on 3 and 305 DF, p-value: < 2.2e-16
 Ho: The access to learning and knowledge technologies (LKT) increased in the academic performance of the students of the Medicine career during the pandemic.
 Ha: The access to learning and knowledge technologies (LKT) did not increase the academic performance of the students of the Medicine career during the pandemic.

For the hypothesis text, it is necessary to do a regression model in order to measure the co-relation between the variables, in which Y= academic performance (grades), and X= Connection hours. However, the variable Y "Grades" (quantitative) and variable X (qualitative) with more than 2 categories, become in a binary category, being X1= Hhoras1a2, X2= Hhoras3a4, X3= Hhoras7amas, staying as reference variable "5 to 6 hours". For this model, the correlation coefficient is (R = 0,0107), this indicates that there is not a lineal relationship between the variables. The P value is 0,3494 > 0,05, accepting the hypothesis as null. The independent variables "Hhoras1a2", "Hhoras3a4", and "Hhoras7amas" are not statistically important. A student that connects to class from 5 to 6 hours, will obtain 8,77 more points in the grade. If the student connects from 1 to 2 hours, he/she will obtain 0,48 less points. If the student connects from 3 to 4 hours and he/she will obtain 1,39 more points in the grade if the student connects 7 hours or more. The determination coefficient (R² = 0,00097), indicates that 0,09% of the academic performance is explained by the connection hours. (See Table 2).

Table2. Summary lineal regression model of connection hours and academic performance

Coefficients:				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	79.7257	0.8584	92.881	<2e-16 ***
Hhoras1a2	8.7743	6.5088	1.348	0.179
Hhoras3a4	-0.4757	3.3382	-0.142	0.887
Hhoras7amas	1.3872	1.0883	1.275	0.203

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
 Residual standard error: 9.124 on 305 degrees of freedom
 Multiple R-squared: 0.0107, Adjusted R-squared: 0.0009716
 F-statistic: 1.1 on 3 and 305 DF, p-value: 0.3494
 Ho: The number of connection hours does not influence in the academic performance
 Ha: The number of hours influence in the academic performance

In order to prove the hypothesis: existence of important differences between academic performance and students' genre, in Table 3 is made a calculation of T Student test for establishing if there is a difference between the averages of the two samples. The samples in this case have the variable "genre" (1= man y 2=woman) and the academic performance (grade), and it is necessary to know if there is an important difference between the genre and the obtained grade. As it is possible to observe, the p-value = 0,01014 is lower than 0,05, it is accepted and alternative hypothesis, which indicates that there is an important difference between the academic performance and the genre of the student. Women average is higher in grades (81,75 points) than men (79,05 points).

Table 3. T Student Test for the importance of academic performance (grade) and genre (man and woman).

data: BASE_PARA_R\$nota by BASE_PARA_R\$Sexo		
t = -2.5869	df = 307	p-value = 0.01014
alternative hypothesis: true difference in means between group 1 and group 2 is not equal to 0		

95 percent confidence interval:	
-4.7427465	-0.6447653
sample estimates:	
mean in group 1	mean in group 2
79.05344	81.74719
Ho = There is no important difference between academic performance and students' genre	
Ha = There is an important difference between academic performance and students' genre	

In Table 4, with respect to the urban/rural location limits or not the access to learning and knowledge technologies (LKT) of the Medicine career students. As there are two qualitative variables (X= Zone and Y= Internet access), a contingency table is made for the data crossing, meaning, between X and Y.

Based on the results, it is possible to conclude that the zone does not limit the access to learning and knowledge technologies (LKT) of the Medicine Career students, so the null hypothesis is accepted, corroborated by the chi square test of Pearson with a level p-value $0,135 > 0,05$.

Table 4. Contingence table of zone and academic performance

	Sin acceso	Con acceso
Rural	28	44
Urbana	70	167

Pearson's Chi-squared test

data: tabla

X-squared = 2.2307, df = 1, p-value = 0.1353

Ho = The urban/rural location does not limit the access to learning and knowledge technologies (LKT) of the Medicine career students.

Ha = The urban/rural location limits the access to learning and knowledge technologies (LKT) of the Medicine career students.

On the other hand, in order to prove if the hypothesis: adequate sleeping habits improve or not the academic performance of the Medicine career students, in Table 5, it is shown that is necessary to create a model of regression in order to measure the correlation between the variables, where Y= aca-demic performance (grade), and X= Hours of sleep. The variable Y for "grades" (quantitative), and variable X (qualitative) with more than 2 categories becomes a binary variable, being: X1= horas_suenoEntre 8 y 9 horas, X2= horas_suenoMas de 10 horas, X3= horas_suenoMenos de 5 horas, being as reference the variable "between 6 to 7 hours".

For this model, the correlation coefficient is (R = 0,03119), this indicates that there is a weak lineal relation between the variables. The P value is $0,02149 < 0,05$, rejecting the null hypothesis. The independent variables "horas_suenoEntre 8 y 9 horas", "horas_suenoMas de 10 horas", and "horas_suenoMenos de 5 horas" are not statistically important. A student that sleeps between 8 and 9 hours or 6 and 7 hours will obtain 4.23 more points in the grades that sleeping between 8 and 9 hours, if the student sleeps more than 10 hours will lose 147,98 points in the grade, and if the student sleeps less than 5 hours will lose 1,67 points the grade. The determination coefficient (R² = 0,02166), indicates that 2,17% of the academic performance is explained by the connection hours.

Table 5.Regression model of sleeping hours and academic performance

Coefficients:				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	80.9836	0.6675	121.327	<2e-16 ***
horas_suenoEntre 8 y 9 horas	4.2386	2.2305	1.900	0.0583
horas_suenoMas de 10 horas	-14.9836	9.0541	-1.655	0.0990
horas_suenoMenos de 5 horas	-1.6658	1.0989	-1.516	0.1306

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 9.03 on 305 degrees of freedom

Multiple R-squared: 0.03119, Adjusted R-squared: 0.02166

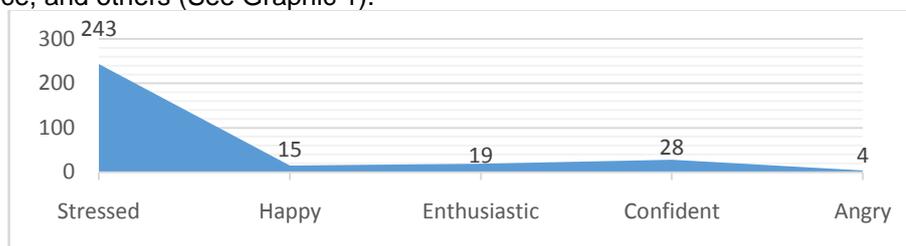
F-statistic: 3.273 on 3 and 305 DF, p-value: 0.02149

Ho = The adequate sleeping habits do not improve the academic performance of the Medicine career students

Ha = The adequate sleeping habits improve the academic performance of the Medicine career students

In regards to the perception of teaching-learning about the virtual environment of the Medicine career students, if it is or not positive, the 79% of students feel stressed with the

virtual teaching-learning process, 9% feel confident, 6% enthusiastic, the 5% feel happy with this methodology, and finally 1% feel angry. The general perception when the stress feeling is interpreted as non-positive, it is possible that it is related not only with the amount of hours the student has to be connected in order to have class, but also there is the important role of the environment, meaning, the zone where the student lives, the access to internet, the type of device, and others (See Graphic 1).



Graphic 1. Perception of the Medicine career students in relation to teaching-learning in virtual environments.

4. Discussion

In relation to the important differences between the genre and the academic performance, the results of the present study agree with the results of the research made by S. E. Bravo Salinas et al (6), according to the female genre has a better academic performance than the male genre. It is not like that with the relation between the academic performance and the sleeping hours. In this study there is a positive relation. It means that with more rest hours, better grades are obtained.

In other study made by Amador-Salinas & González-Rivera[19], within the analysis between the grade average and its relation with sleeping hours, it was found that students with short sleeping patterns had a better grade average than the students with medium and large patterns; meaning that, with less sleeping better performance, establishing an inverse relationship. This result is different to our study, because the regression analysis showed that the average of the students that sleep more have an improvement in the academic performance.

As to the geographic location or urban/rural zone limits or not the access to the learning and knowledge technologies (LKT), the results obtained in the research work of Cabezas Paredes [20] indicate that for the 90,4% of students, geographic location, the access to internet does limit their academic performance. These results differ from our research work in which residence zone does not limit the access to learning and knowledge technologies, in terms of internet access.

When it is talked about perception of teaching-learning in the virtual environments García et al [21] indicates that 5 % are completely satisfied, 15% very satisfied, 63% as neutral, 15% as less satisfied, and 2% as non-satisfied. These results have similarities in some aspects (despite the terminology difference) according to our results, because 79% of students manifest stress, 9% are confident, 5% are happy, 6% are enthusiastic, and 1% are angry, even if there are not a neutral answer. It can be assumed stress as "null or low satisfaction", confident, happy, and enthusiastic as "satisfaction".

5. Conclusions

Even if after the sanitary emergency several changes in education were made in an improvised way in order to solve the needs that appear, the access to learning technologies related to an adequate internet connection, and the availability of technological resources are necessary for accomplishing a correct academic performance. During the Covid-19 pandemic, the virtual learning was needed as an alternative to continue the teaching-learning process. It became a radical change in the traditional models of teaching, creating benefits for the educative community, as well as the information organization, the management of new concepts, the increase of language that improves communication, and connectivity; but, on the other hand there were the disadvantages as the lack of access to technological tools and/or internet connection.

Does the access to learning and knowledge technologies (LKT) influence in the academic performance of the Medicine career students during the pandemic? Based on the obtained data of the answers to the applied instrument, and using the statistical analysis, it is concluded that, there is a direct relationship between the access to the learning and knowledge technologies through the internet access in the virtual environment and the academic performance, because the students with internet connection doubled in percentage within the categories "excellent"

and “good” in their academic performance compared to the students that did not have access to the described technologies. It is also important to notice that the academic performance in the female genre is better than the male genre, and that the zone or living region of the student does not represent a limiting factor in order to access to the teaching and learning technologies.

6. Patents

Author Contributions: “Conceptualization, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; methodology, A.M.M and JRRR.; software, A.M.M and JRRR; validation, A.M.M and J.R.R.R.; formal analysis, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; investigation, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; resources, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; data curation, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; writing—original draft preparation, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; writing—review and editing, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; visualization, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; supervision, S.E.B.S., A.M.M., L.M.T.C. and J.R.R.R.; project administration, S.E.B.S.; funding acquisition, S.E.B.S.,. All authors have read and agreed to the published version of the manuscript.

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