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*Artículos científicos*

## **Rendimiento académico de estudiantes universitarios al final de la transición de la educación presencial a la educación en línea por el covid-19**

*Academic performance of university students at the end of the transition from face-to-face education to online education due to COVID-19*

*Desempenho acadêmico de universitários ao final da transição do ensino presencial para o ensino online devido à covid-19*

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### **Resumen**

Las universidades del mundo en el año 2019 tuvieron que hacer frente al problema de continuar las actividades escolares a distancia debido a la emergencia sanitaria por covid-19. A la fecha, se siguen evaluando los resultados y el impacto que dejó en los estudiantes el cambio tan brusco de modalidad. Por lo anterior, este trabajo planteó como objetivo identificar los factores que influyen en el rendimiento académico de los estudiantes universitarios al pasar de la modalidad presencial a la modalidad a distancia durante la contingencia sanitaria por covid-19. La metodología fue descriptiva y cuantitativa de tipo predictiva; se aplicó un cuestionario a 247 alumnos, se realizaron correlaciones para conocer las variables de mayor impacto, se elaboró un modelo por el método de mínimos cuadrados

ordinarios. En los resultados se encontró que las variables que influyen en aumentar el rendimiento académico de los estudiantes fueron el uso de Google Classroom (0.015), videoconferencia (0.238), recursos didácticos (0.248), acceso a páginas web (0.238), videos (0.234), preguntas dirigidas (0.228), participación en chat (0.187), pizarra digital (0.268), cumplimiento de objetivos (0.009) y evaluación en línea (0.009); se encontró que los mensajes a través de una plataforma educativa influyen de forma negativa en el rendimiento académico (-0.023). Se concluye que las autoridades académicas deben gestionar la capacitación y el uso de recursos tecnológicos educativos (Google Classroom, videoconferencia, recursos didácticos, acceso a páginas web, videos, chat y pizarra digital) para favorecer el proceso de enseñanza y el rendimiento académico.

**Palabras clave:** Classroom, continuidad académica, educación a distancia, educación en línea, Google, herramientas tecnológicas, promedio, videoconferencias.

### Abstract

In 2019, the Covid-19 health emergency required universities around the world to face the challenge of continuing classes during lockdown. In order to do so, classes were delivered online. The results and the impact of that sudden change are still being evaluated. The objective of the work was to identify the factors that influenced the academic performance of university students, when moving from face-to-face to distance classes during the health contingency by COVID19. The methodology was descriptive and quantitative of predictive type; a questionnaire was applied to 247 students, correlations were made to know the variables with the greatest impact, a model was elaborated by the method of ordinary least squares. Results: it was found that the variables that influenced increasing the academic performance of the students were: The use of Google Classroom (0.015), videoconference (0.238), didactic resources (0.248), access to Web pages (0.238), videos (0.234), directed questions (0.228), participation in chat (0.187), digital whiteboard (0.268), achievement of objectives (0.009) and online evaluation (0.009); It was found that the messages through a learning platform have a negative influence on academic performance (-0.023). It is concluded that the academic authorities must manage the training and use of technological online learning tools (Google Classroom, videoconference, didactic resources, access to web pages, videos, chat and digital whiteboard) that allow improving the teaching process and therefore reflect higher academic performance.

**Keywords:** academic continuity, academic performance, average, google classroom, online and distance education, technology tools, video conferencing.

## Resumo

As universidades do mundo em 2019 tiveram que enfrentar o problema de continuar as atividades escolares remotamente devido à emergência sanitária causada pela covid-19. Até o momento, os resultados e o impacto que uma mudança tão abrupta de modalidade deixou nos alunos ainda estão sendo avaliados. Portanto, este trabalho teve como objetivo identificar os fatores que influenciam o desempenho acadêmico de estudantes universitários ao passar da modalidade presencial para a modalidade a distância durante a contingência de saúde por covid-19. A metodologia foi descritiva e quantitativa do tipo preditiva; Aplicou-se um questionário a 247 alunos, fizeram-se correlações para determinar as variáveis de maior impacto e desenvolveu-se um modelo utilizando o método dos mínimos quadrados ordinários. Nos resultados, verificou-se que as variáveis que influenciam no aumento do desempenho acadêmico dos alunos foram o uso do Google Classroom (0,015), videoconferência (0,238), recursos didáticos (0,248), acesso a páginas da web (0,238), vídeos (0,234), perguntas direcionadas (0,228), participação em chat (0,187), lousa digital (0,268), cumprimento de objetivos (0,009) e avaliação online (0,009); Constatou-se que as mensagens por meio de uma plataforma educacional influenciam negativamente o desempenho acadêmico (-0,023). Conclui-se que as autoridades acadêmicas devem gerenciar a formação e uso dos recursos tecnológicos educacionais (Google Classroom, videoconferência, recursos didáticos, acesso a páginas web, vídeos, chat e lousa digital) para favorecer o processo de ensino e o desempenho acadêmico.

**Palavras-chave:** Sala de aula, continuidade acadêmica, educação a distância, educação online, Google, ferramentas tecnológicas, média, videoconferências.

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## Introduction

Universities around the world have closed their doors since mid-March 2020 due to information on covid-19 issued by the World Health Organization (WHO, 2020). In Mexico, the Ministry of Public Education, which establishes the action policies, instructed that the return to face-to-face classes would be until the health authorities indicated that the epidemiological traffic light turned green, so the hybrid model had to be implemented in all educational levels (Government of Mexico City (CDMX), 2020).

At the global level, the academic communities were overwhelmed in every way, since by suspending face-to-face activities and moving them remotely, changes were made for which they were not prepared. To deal with this contingency, the International Institute for Higher Education in Latin America and the Caribbean (IESALC, 2020) supported to carry out actions to implement the use of technologies for monitoring learning. In addition, the universities and higher education institutions that are part of the ANUIES also provided various resources and technological platforms that were used (ANUIES, 2020), such as electronic books, notes, presentations, videos, access to web pages and support with videoconferences. However, reality showed that only 10% in public universities and 56% in private ones had these types of resources (Cabero Almenara and Llorente Cejudo, 2020). In addition, multiple teacher weaknesses were perceived in the use of information and communication technologies (ICT) and in the implementation of distance learning because no one had the time to prepare adequately (Sobaih et al., 2020).

For this reason, attention must be paid to this type of deficiency through the use of educational platforms (UNESCO, 2020) that instruct in the planning of objectives, learning activities, the creation of didactic resources and exams, the monitoring of homework and student work, among others.

Another essential competence is the management of teaching techniques that facilitate the acquisition of significant learning in the student with online education (Díaz Barriga, 2020), since instructors must prepare various learning materials such as literature, videos, websites and discussion forums (Xu, 2016). In this regard, keep in mind that in online education students tend to get lower grades because there are no personalized communication strategies (Glazier, 2016).

In the educational field in Mexico, some emergency strategies that were established to continue academic activities in universities were the support in various organizations, such

as the Common Space for Distance Higher Education (ECOESAD). In this way, access to a repository of educational resources was provided, as well as the use of free educational tools and platforms and licensing such as Moodle, Classroom, Teams or use video conference rooms supported by sending material via email and WhatsApp. , among others.

### **Information and communication technologies in education**

The incorporation of ICT in education has been motivated by the need to improve pedagogical models (Quimis et al., 2021) and promote flexibility and student participation.

In this globalized world of technologies for education, there are several entrepreneurs who have had the vision to design and develop educational tools and platforms that have allowed universities to face the challenge of using and adopting technologies in education. For example, Microsoft is a corporation created by Bill Gates and Paul Allen in 1975 that has made one of the greatest contributions to the adoption of technology in education with its Teams platform. Another has been Google, founded by Larry Page and Sergei Brin in 1997, and which currently has various applications and tools for education, such as Google Classroom, vital resources for online education in times of pandemic.

### **Classroom**

Google Classroom is a virtual educational platform that serves to support learning and has shown a potential for success in educational aspects (Iftakhar, 2015) considering functionalities such as communication, storage of resources in Google Drive, review and evaluation of activities, monitoring learning, scheduling activities, accessing information through search engines and sending messages using email with the Meet and Handgouts tools.

In addition, Google Classroom also considered the educational model of flipped learning (or flipped classroom), which focuses on activities that the student performs before the class or session supported by digital resources (Lage et al., 2000). All this, logically, demands more work from the teacher to define the resources that support the course and, therefore, the learning or the acquisition of knowledge (Bhat et al., 2018). In addition, students must work actively to acquire knowledge at their own pace with the support of technologies, resources and teaching strategies that the teacher can make available to them.

Continuing with Google Classroom, this platform allows students to easily register using a code, which provides access to a large number of files (Kumar and Bervell, 2019). In addition, the video tutorials were considered a valuable resource, since students can watch them as many times as they want, although all this requires smooth internet connectivity to receive feedback from teachers. (Iftakhar, 2015).

## Video conference

Videoconferences are easier to handle, but it is important that the teacher knows and uses them, such as Zoom, Cisco Webex Meetings, Hangouts and Meet, etc., without forgetting that reflection on the topics covered is the key to training (Kocdar et al., 2017; Saltan, 2016).

In the specific case of Google Meet, a recent study in the Vietnamese community indicated that its use is very productive in that country (Bui et al., 2020). Also, for students and teachers in Georgia, the transition from face-to-face to distance learning has been relatively easy, since they were already using technologies such as video conferencing, videos and a set of lessons posted on websites. Specifically, the implementation of the videoconference went smoothly with 98% student attendance, although the higher level students did not perform their activities correctly. Therefore, it is considered necessary to reorganize learning activities and the way of evaluating for a better quality of online education (Basilaia and Kvavadze, 2020).

Likewise, in a public university in New York, it was found that the Zoom videoconference enabled students to actively participate in the process of building knowledge and have a spontaneous conversation, which allowed students to feel more comfortable talking with their peers. peers on a variety of topics. In fact, this served to form friendships between the members of the group, since the participants were interested in the lives of their peers (Lenkaitis, 2020). In other words, video conferencing also helps social relationships, which is of great importance in these times of pandemic.

However, research conducted with students at Pennsylvania State University found that students who received the course via video conference had lower final grades and were less satisfied with the course (Roth et al., 2020).

Even so, and as already stated, videoconferencing is a valid solution to compensate for face-to-face classes in the classroom. This method has been applied in both clinical and

anatomy lessons through the Google Hangouts application, which is available to everyone free of charge through Gmail. (Moszkowicz *et al.*, 2020).

### **Didactic resources**

The teaching resources have been very useful. For example, augmented reality applications have been able to be used on various devices such as computers, mobile phones, tablets, etc. In addition, they constitute an educational innovation that has contributed positively to improving the understanding of concepts, student motivation and the acquisition of basic skills in science and technology (Fernández-Enríquez and Delgado-Martín, 2020). An example of this is the study carried out with higher education students from Spain, who obtained better academic averages thanks to the use of the Wikipedia platform. (Meseguer-Artola *et al.*, 2020).

### **Access to web pages**

The use of the Web has been increasing due to the easy access to information that in many cases is produced or disseminated by teachers in certain virtual environments (Lowenthal *et al.*, 2016). This has been very useful for students in times of confinement, as it is a significant tool to continue their training.

However, it should be noted that web pages can include multitasking (digital activities simultaneously), which can have a negative effect on the average grade of students (Alghamdi *et al.*, 2020).

Even so, web pages are a valuable resource for sharing information through Google Drive, Scribd, Box, Dropbox and OneDrive or Facebook, a social network used to teach face-to-face courses. (Yot-Domínguez y Marcelo, 2017).

### **Digital board**

The use of the digital whiteboard in education has increased over the years to favor the learning process. For this reason, various educational institutions have an educational technology area, in charge of managing the use and implementation of educational technology. These services are varied and one of them is the creation of digital classrooms that contain technologies that facilitate and support the learning process. In the Faculty of Education of the University of Seville, a study was carried out to visualize the use by teachers

of the interactive whiteboard. The results were positive because the teachers considered that it was very useful to promote the active participation of the student (Toledo Morales and Sánchez García, 2013).

In fact, it was considered that the digital whiteboard has made the learning process more interesting and friendly, since it facilitates the understanding of the topics (Montoya de la Cruz, 2014). In addition, it has been shown that with the digital whiteboard the time for teaching is used in 55% (Cala *et al.*, 2018).

### **Directed questions**

Directed questions encourage the acquisition of learning, as it invites the student to previously carry out research, consultation and analysis of information. This stimulates reflection in the student, as well as being critical and analytical, so active participation is achieved. (Kane *et al.*, 2016).

### **Access to videos**

In the Faculty of Economic and Business Sciences of the University of Seville (Spain), ICTs were integrated into teaching activities to develop new learning environments based on the use of multimedia (instructional videos) with which it was possible to improve the academic performance of students. students (Expósito *et al.*, 2020). However, due to the covid-19 pandemic, online education for public universities and teachers was a problem, as they did not have time to prepare educational and attractive videos for students. (Sobaih *et al.*, 2020).

### **Teachers and students**

The covid-19 pandemic generated mandatory social isolation. This represented a significant challenge for both teachers and students because they did not have the skills and knowledge to use educational technologies. In fact, in a study by Sobaih *et al.* (2020) it was shown that many teachers only knew how to use Google Classroom and Zoom, and that they developed their teaching resources in Power Point. The students, for their part, preferred WhatsApp and Facebook because they were the tools they knew the most (Rapanta *et al.*, 2020).



In short, it can be ensured that the aforementioned technological resources have been the most used, to a greater or lesser extent, to continue academic activities during the pandemic period. For this reason, this research attempts to identify the academic performance of university students at the end of the educational transition that was experienced.

## **Objective and hypothesis**

The objective of the research was to identify the factors that influenced the academic performance of university students who attended the January-June 2020 school year in the distance modality due to the health contingency due to covid-19.

The established hypothesis was the following: the information and communication technologies used as tools in distance learning helped to have a higher academic performance.

## **Materials and methods**

### **Participants and sample**

Students enrolled during the January-June 2020 school year in the academic programs of Computer Engineering, Computer Science, Industrial Engineering and Industrial Administration of the Interdisciplinary Professional Unit of Engineering and Social and Administrative Sciences (UPIICSA) of the National Polytechnic Institute (IPN). The sample size was 247 students from a population of 12,000 students, who switched from the face-to-face modality to the distance modality due to the health contingency due to covid-19.

### **Instrument**

A survey was designed to find out the impact that abruptly switching from the face-to-face modality to the online and/or distance modality had on students. The survey was structured through the Google platform. General aspects of education were included, such as the number of subjects taken at a distance, semester, subjects, grade point average, technological resources, and learning strategies used by teachers and students. Table 1 shows the questions generated.

**Table 1.** Structured Survey Questions

No.	Pregunta	Opciones de respuesta
1	Programa en el que te encuentras inscrito	Respuesta abierta
2	Número de asignaturas cursadas a distancia	Respuesta abierta
3	Tecnologías y medios de comunicación utilizados por el profesor	Classroom, videoconferencia, mensajes, chat.
4	Recursos didácticos digitales que fueron utilizados en clase en línea y a distancia	Acceso a páginas web, videos, pizarra digital, comparte recursos.
5	El acceso a la tecnología utilizada fue...	Respuesta abierta
6	¿Cómo fue la comunicación con el profesor y con el equipo de trabajo?	Respuesta abierta
7	¿Las actividades de aprendizaje apoyaron en tu aprendizaje?	Sí, no, parcialmente
8	¿Qué estrategias de enseñanza aprendizaje utilizadas por el profesor(a) te fueron de mayor utilidad?	Preguntas dirigidas, participación en el chat.
9	El promedio de calificaciones, antes de la contingencia sanitaria fue...	Respuesta abierta
10	¿El promedio de calificaciones aumentó al final de ciclo escolar después de la contingencia? Indica cuál fue.	Respuesta abierta
11	¿El ciclo escolar con la modalidad a distancia permitió el logro de los objetivos?	Sí, no, parcialmente
12	¿Cómo consideras la evaluación que obtuviste al final del curso?	Muy buena, buena, regular, mala, muy mala
13	¿En qué porcentaje disminuyó su promedio?	Respuesta abierta
14	¿Las actividades realizadas a distancia te permitieron aumentar tu promedio?	Sí, no, parcialmente
15	¿En qué porcentaje aumentó tu promedio?	Respuesta abierta

Source: self made

### Analysis of data

For the analysis of the data, the answers were downloaded in an Excel file. In the same way, the SPSS software, version 22, was used to correlate data on academic performance "Average grades" (dependent variable), and with the independent variables

Classroom, messages, videoconference, teaching resources, access web pages, access to videos, directed questions, participation in chat, digital whiteboard, objectives met and evaluation (table 2). These variables were used to develop a predictive model related to academic performance.

**Table 2.** Study variables to develop a predictive model of academic performance

Variable	Descripción	Tipo de variable
Promedio (Y)	Promedio de calificaciones del alumno, medido en porcentaje de aumento del promedio	Numérica
Classroom (X <sub>1</sub> )	Plataforma educativa que es gratuita y desarrollada por Google	Binaria (1=Sí, 0=No)
Mensajes (X <sub>2</sub> )	Mensajes internos enviados por el profesor al alumno a través de una plataforma	
Videoconferencia (X <sub>3</sub> )	Videoconferencia utilizada por el profesor para impartir las clases a los alumnos en plataformas educativas	
Recursos didácticos (X <sub>4</sub> )	Recursos didácticos instalados en la computadora del profesor que presenta en la plataforma educativa a los alumnos	
Acceso a páginas web (X <sub>5</sub> )	Acceso a páginas web de los temas en las plataformas educativas	
Acceso a videos (X <sub>6</sub> )	Acceso a videos en las plataformas educativas	
Preguntas dirigidas (X <sub>7</sub> )	Preguntas dirigidas de parte del profesor a los alumnos a través de plataformas educativas	
Participación en chat (X <sub>8</sub> )	Participación en chat sobre temas de la clase en las plataformas educativas	
Pizarra digital (X <sub>9</sub> )	Pizarra digital en la que el profesor elabora los apuntes	
Objetivos cumplidos (X <sub>10</sub> )	Se refiere a la consideración de las competencias alcanzadas por el alumno, según objetivos planteados en la materia de forma presencial al inicio del curso	
Evaluación (X <sub>11</sub> )	Percepción del alumno en la evaluación del curso en la modalidad a distancia	Escala 1 = Muy mala, 2 = mala, 3 = Regular, 4 = Buena, 5 = Excelente

Source: self made

## Model

We have the theoretical model on the increase in the average with the variables set out in table 2, and said model is described in equation 1.

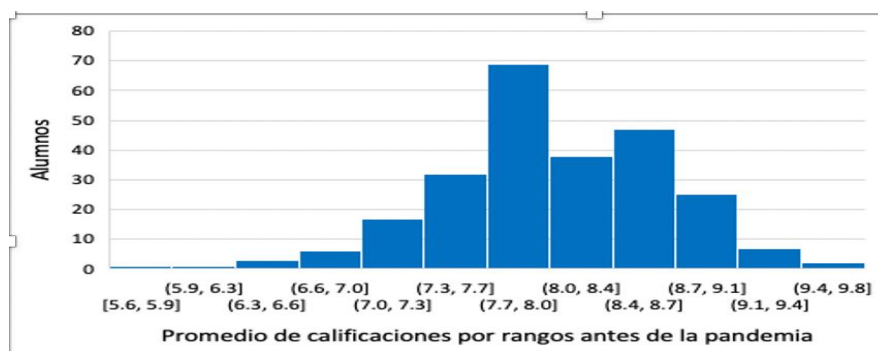
$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{11} X_{11} + u \quad (1)$$

## Results

The sample corresponded to 247 students from the Interdisciplinary Professional Unit of Engineering and Social and Administrative Sciences (UPIICSA) of the National Polytechnic Institute (IPN). It was carried out in the following study programs: Industrial Administration (59), Computer Science (81), Computer Engineering (92) and Industrial Engineering (15). The semesters in which they were enrolled correspond to the second (3), third (39), fourth (28), fifth (18), sixth (60), seventh (35) and eighth (65).

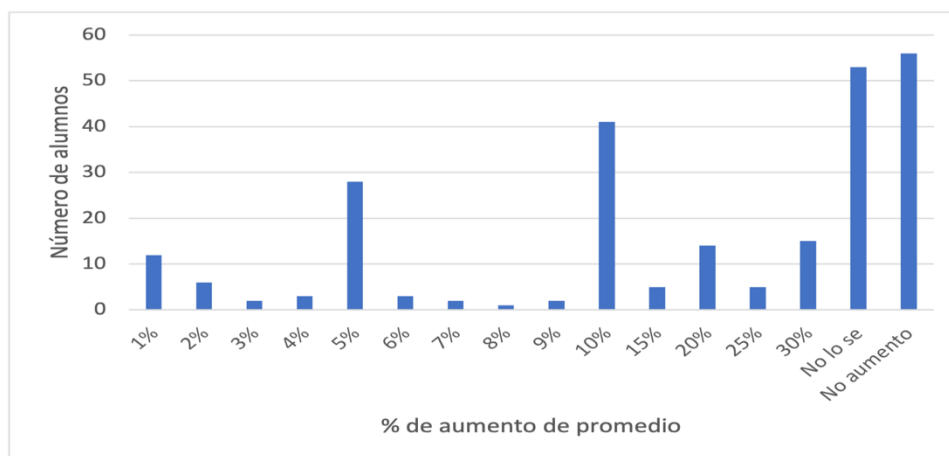
The average of the students before the pandemic fluctuates between 5.3 and 9.54. Likewise, it can be seen that 69 students have an average between 7.7 and 8.0, which is presented in Figure 1. Likewise, at the end of the semester during the pandemic (June 2020), it was identified that the students increased their average grades from 1 % up to 30%, being the most representative 10% with 41 students (figure 2).

**Figure 1.** Average grades distributed by ranks before the pandemic



Source: self made

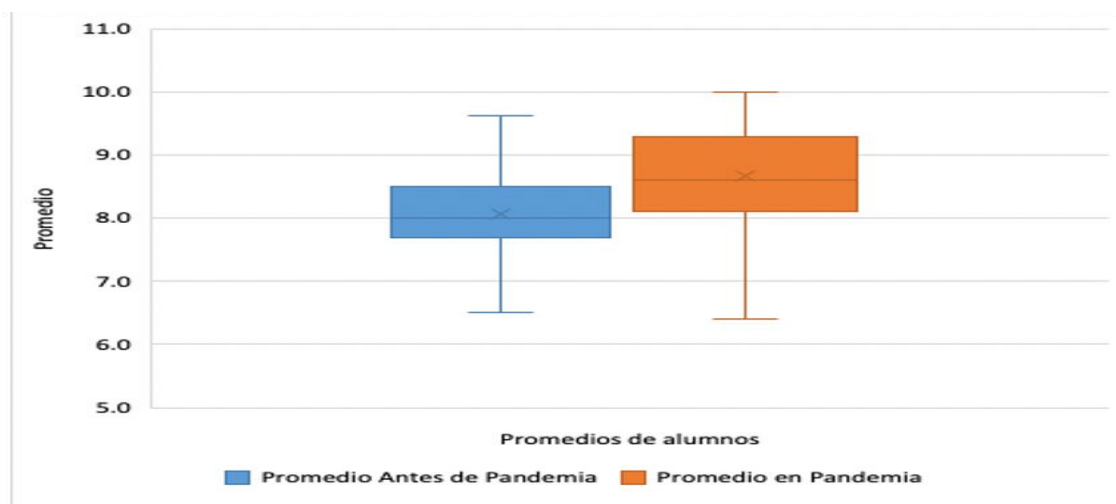
**Figure 2.** Percent increase in grade point average



Source: self made

When analyzing the data of the average that the students had before the pandemic and the average that they obtained at the end of the semester with the pandemic, a very significant increase in the average at the end of the semester is perceived, since of the 247 students, 139 declared which increased its average (figure 3).

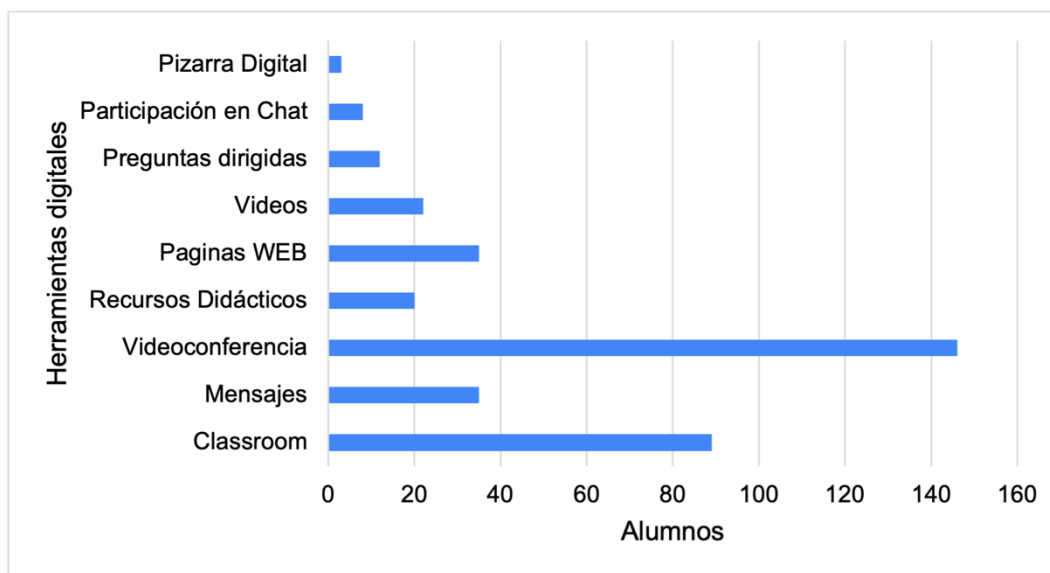
**Figure 3.** Academic average of students before and during the pandemic



Source: self made

Figure 4 shows the digital tools and teaching resources used by the students during the pandemic semester. The most used communication tool was the videoconference, followed by Classroom. Regarding resources, access to web pages and videos were the most used, while the least used was the digital whiteboard.

**Figure 4.** Digital tools used by students



Source: self made

Table 3 presents the results of the predictive model that was raised in equation 1, whose dependent variable is the grade point average.

**Table 3.** Results of the predictive model (academic performance)

	<i>Coeficiente</i>	<i>Desv. Típica</i>	<i>Estadístico t</i>	<i>Valor p</i>	
Const	0.304	0.052	5.863	<0.0001	***
Classroom	0.015	0.007	2.2349	0.0264	**
Mensajes	-0.023	0.009	-2.550	0.0114	**
Videoconferencia	0.238	0.049	4.8637	<0.0001	***
Recursos didácticos	0.248	0.050	4.9625	<0.0001	***
Acceso páginas Web	0.238	0.049	4.8144	<0.0001	***
Acceso a videos	0.234	0.050	4.6804	<0.0001	***
Preguntas dirigidas	0.228	0.051	4.5032	<0.0001	***
Participación en Chat	0.187	0.052	3.6222	0.0004	***
Pizarra Digital	0.268	0.057	4.7400	<0.0001	***
Objetivos cumplidos	0.009	0.005	1.7900	0.0747	*
Evaluación	0.009	0.005	1.8759	0.0619	*

Source: Own elaboration, predictive model, obtained from the one proposed in equation 1

F = 4.93 p-valor = 0.0000

The predictive model raised in equation 1, with the results of table 3, is raised in equation 3.

$$Y=0.304+0.015(\textit{Classroom})-0.023(\textit{Mensajes})+0.238(\textit{Videoconferencia})+0.248(\textit{Recursos didácticos})+0.238(\textit{Acceso a páginas Web})+0.234(\textit{Acceso a videos})+0.228(\textit{Preguntas dirigidas})+0.187(\textit{Participación en Chat})+0.268(\textit{Pizarra digital})+0.009(\textit{Objetivos cumplidos})+0.009(\textit{Evaluación}) \textbf{(2)}$$

The validity of the model was carried out with the test of  $F = 4.93$  with  $p\text{-value} = 0.000$ ; likewise, it presents adequate coefficients and also adequate  $t$  values. Therefore, statistically the increase in the average presented a positive trend.

## Discusions

The study analyzed the technological and academic variables that were used to predict the academic performance of university students. The main findings indicate that technological tools such as Classroom, videoconference, didactic resources, access to web pages, access to videos, directed questions, participation in chat and digital whiteboard have a positive effect, that is, they manage to increase the academic performance of students. university students in 0.015, 0.238, 0.248, 0.238, 0.234, 0.228, 0.187 and 0.268, respectively. Instead, the messages have a negative impact of 0.023 on the students' grades.

These findings present quantitative aspects that help make educational decisions, which is contrasted with Quimis et al. (2021) and Shampa (2016), who only present a literature review. Similarly, the work of Basilaia and Kvavadze (2020), who only presents descriptive data, such as percentages and averages of the number of internet connections by computer or mobile device, as well as the average time of classes by video and audio conferences. The same happens with Cala et al. (2018), who analyze the impact of the use of digital whiteboards on teaching and learning in a university and only present descriptive aspects of percentages before a classification of a lot, a little or nothing. Likewise, Bui et al. (2020) only present a correlation of variables on online learning.

In this research, it was identified that the Google Classroom technological variable was used as the main tool to teach online classes. This is similar to previous studies that have shown success in managing the learning process by making teaching resources available and defining learning activities that supported online sessions (Bhat et al., 2018; Iftakhar, 2015; Kumar and Bervell, 2019; Lage et al., 2000; Sobaih et al., 2020). Similarly, videoconferences have also been used in previous research with favorable opinions (Bui et al., 2020), as they indicate that there is greater participation (Lenkaitis, 2020), although some universities have

also presented results with negative ratings ( Roth et al., 2020). The accessible and free tool that was in demand is Google Hangouts, which coincides with the study by Moszkowicz et al. (2020). The review of other research confirms that our results are significant for making educational policy decisions regarding the use, selection and adoption of ICT in universities. Regarding the didactic resources, which in this research have a good impact (0.248), they agree with other inquiries that refer to the fact that the variety and availability of resources, as well as their access on various platforms and equipment, indicate that the understanding of the topics and motivates students (Fernández-Enríquez and Delgado-Martín, 2020) and helps to increase their average by 0.72 (Meseguer-Artola et al., 2020).

In this research, access to web pages was included because they allowed easy access and distribution of information. Likewise, they are used as interaction in a social blog (Lowenthal et al., 2016), which is useful in this time of pandemic, in addition to helping them search for and analyze information to carry out learning activities (Yot- Dominguez and Marcelo, 2017). Regarding the variable "Guided questions", it proved to be a teaching strategy that helped the student reflect on what was investigated, since active and critical participation was encouraged, which coincides with Suwono et al. (2019).

Regarding access to videos, an important effect was found to increase academic performance, which agrees with Expósito et al. (2020), although it should be noted that in other public universities it was not convenient, since there was not enough time to prepare educational videos (Sobaih et al., 2020).

As for the digital whiteboard, it was decided to include it in the predictive model because at the University of Otavalo in Ecuador, 48% of teachers estimate that by presenting attractive work on the interactive whiteboard, the student's attention increases (Cala et al. al., 2018; Montoya de la Cruz, 2014; Toledo Morales and Sánchez García, 2013), so in this research an impact on academic performance of (0.268) was found.

In this study, it turned out that the variable messages on platforms does not help predict better performance because students look for other types of messages on other platforms to communicate, such as Messenger or WhatsApp.



## Conclusions

In the sample of 247 university students from the Computer Engineering, Computer Science, Industrial Engineering and Industrial Administration study programs who were enrolled in the face-to-face model in the January-June 2020 school year at UPIICSA and who derived from the emergency due to the covid-19 pandemic took distance classes, the predictive model found that the Classroom platform, videoconferences, teaching resources, access to web pages, access to videos and the digital whiteboard have a positive impact so that students have an increase in academic performance, which was measured through the grade point average.

In addition, in the didactic aspect, the teachers, to give continuity and follow-up to the learning, implemented the strategy of directed questions through the chats available in different technological tools.

Finally, the research makes it clear that the use of technologies and didactic aspects used responsibly by teachers and students are a good option to improve learning, which will be reflected in academic performance. For this reason, it is important to raise awareness in the educational community that has not taken advantage of the use of technology to start this task. To achieve this, it is necessary to promote public policies in education that support the institutions in this initiative.

## Future lines of research

The results obtained offer the opportunity to delve into good practices for the adoption of technology with a view to favoring the online, hybrid or distance learning process, and therefore contributing to academic performance.

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