Artículos científicos

Educación a distancia en tiempos de la covid-19, condiciones de infraestructura académica

Distance Education in Times of COVID-19, Conditions of Academic Infrastructure

Educação a distância em tempos de covid-19, condições de infraestrutura acadêmica

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Resumen

En esta investigación se consideró relevante presentar un estudio cuantitativo, transversal y exploratorio-descriptivo sobre las barreras de infraestructura y los problemas que enfrentaron los jóvenes en su formación académica durante el periodo de educación a distancia por la pandemia de covid-19. Específicamente, se analizaron las condiciones de infraestructura tecnológica disponibles en los hogares. La información se obtuvo por medio un cuestionario de 23 preguntas aplicado a 152 estudiantes de una universidad pública del Estado de México. Los resultados muestran que 3 % de la comunidad estudiantil no contaba con equipo de cómputo, mientras que 70 % compartía el equipo con algún miembro de su familia. A pesar de que solo 7 % no contaba con conexión a internet, el resto de los participantes indicaron tener problemas frecuentes con este servicio (bajo ancho de banda, intermitencia o falla con el suministro eléctrico). Aunado a lo anterior, los estudiantes externaron haber tenido problemas frecuentes con las características de sus equipos de cómputo, con los canales de comunicación, el incumplir los horarios establecidos de clases y la actitud de los docentes, así como con el exceso de actividades académicas y el poco tiempo para realizarlas. En conclusión, se establece que la aplicación de la educación a distancia requiere un análisis multidimensional de la problemática de implementación, a fin de asegurar que los estudiantes reciban una educación de calidad.

Palabras clave: covid-19, educación a distancia, infraestructura académica.

Abstract

In this research it was considered relevant to present a quantitative, cross-sectional and exploratory-descriptive study about infrastructure barriers and problems faced by young people during the period of distance education due to the COVID-19 pandemic. Specifically, in this paper we analyzed the conditions of the technological infrastructure available in households. The information was obtained through a 23-question questionnaire applied to 152 students from a public university in the Estado de México, México. The results show that 3 % of the student community doesn't have a personal computer, while 70 % share the computer with a member of their family. Although only 7 % didn't have an internet connection, the rest of the participants had frequent problems with this service (low bandwidth, latency, or power supply). In addition to the above, the students expressed having had frequent problems with the characteristics of their computer equipment, with the

communication channels, the respect of the established class schedules and the attitude of the teachers, as well as with the excess of academic activities and the little time to carry them out. In conclusion, it is established that the application of distance education requires a multidimensional analysis of the implementation problem, to ensure that students receive a quality education.

Keywords: COVID-19, distance education, academic infrastructure.

Resumo

Nesta pesquisa, considerou-se relevante apresentar um estudo quantitativo, transversal e exploratório-descritivo sobre as barreiras de infraestrutura e os problemas enfrentados pelos jovens em sua formação acadêmica durante o período de educação a distância devido à pandemia de covid-19. Especificamente, foram analisadas as condições de infraestrutura tecnológica disponíveis nos domicílios. A informação foi obtida por meio de um questionário de 23 perguntas aplicado a 152 estudantes de uma universidade pública do Estado do México. Os resultados mostram que 3% da comunidade estudantil não possuía equipamentos de informática, enquanto 70% compartilhavam o equipamento com um membro da família. Apesar de apenas 7% não terem ligação à Internet, o resto dos participantes indicaram que tinham problemas frequentes com este serviço (baixa largura de banda, intermitente ou falha de energia). Para além do exposto, os alunos manifestaram ter tido problemas frequentes com as características dos seus equipamentos informáticos, com os canais de comunicação, o incumprimento dos horários de aulas estabelecidos e a atitude dos professores, bem como com o excesso de atividades académicas e pouco tempo para fazê-lo. Em conclusão, estabelece-se que a aplicação da educação a distância requer uma análise multidimensional do problema de implementação, a fim de garantir que os alunos recebam uma educação de qualidade.

Palavras-chave: covid-19, educação a distância, infraestrutura acadêmica.

Introduction

At the beginning of the year 2020, as a result of the sanitary measures that were implemented to prevent the transmission of the 2019 coronavirus disease (covid-19) throughout the world, society was forced to radically modify the way in which it carried out your daily activities. Undoubtedly, these measures notably boosted the use of information and communication technologies (ICTs) to carry out commercial, educational, recreational activities, government procedures, among others. It was a radical change for which people, institutions and society in general were not prepared.

Educational institutions were not exempt from complying with sanitary restrictions (García, 2021); On the contrary, in many countries (including Mexico), academic programs abruptly passed from the face-to-face modality (traditional and more common) to the distance modality, mediated through ICT (Rosario, González, Cruz and Rodríguez, 2020). . This situation, which was initially thought to last a few weeks in Mexico, lasted approximately four semesters.

In the months after the pandemic, researchers from different institutions dedicated themselves to quantifying the consequences of the radical, abrupt and prolonged change that the educational model had (García, 2021; Gazca, 2020; Ponce, Toscano and Silva, 2020; Ruiz, 2020 ; Ruiz et al., 2021), as well as different analyzes of the present and future implications of this educational modality (Segura and Vilchis, 2021). This in order to understand how the actions implemented to prevent the spread of covid-19 would affect people's right to education. Broadly speaking, most of the reported works analyze the effect of the pandemic on one of the following areas:

- The psychological aspects of students and teachers during distance classes (Shah, et al., 2021; Rosario et al., 2020; Saravia, Cazorla and Cedillo, 2020).
- The didactic changes necessary to implement distance education (Area, Bethencourt and Martín, 2020; Navarrete, Manzanilla and Ocaña, 2020; Umaña, 2020).
- The consequences on the academic rates of schools (dropout, completion and graduation rates) (López and Rodríguez, 2020).
- Obstacles and challenges that students had to overcome during this period in order to fulfill their academic training (Miguel, 2020).
- The socio-environmental circumstances in Mexico that surround school education and induce the use and adoption of telematic means (Segura y Vilchis, 2021).

Delving into the quantitative analysis of the problems faced by students throughout the period in which distance education was applied massively can serve as a basis for defining action strategies and protocols that are applied in the event that, in In the future, it is necessary to switch to hybrid or distance educational modalities due to the emergence of new variants of the virus, due to other pandemics or even because it is desired to implement study programs under this modality.

In this sense, the objective of the present work is, on the one hand, to analyze the conditions of technological infrastructure that the students had to face the academic activities related to their professional training in a distance study modality and, on the other hand, to know the problems that limited their learning in this modality, from the students' voice.

Method

Design of the investigation

A quantitative, cross-sectional and exploratory-descriptive study was carried out. This with the intention that the information obtained from the study would allow an overview of the technological conditions that a sample of university students had during the covid-19 pandemic.

Participants

The study was carried out with the participation of the students of the Computer Engineering program that is taught at a public university in the State of Mexico, which is located in an urban area, in the center of the country, adjacent to the City of from Mexico. The sample was non-probabilistic and for convenience with a total of 152 students (28% women, 72% men), with ages ranging from 18 to 36 years (Mage = 21.6, SDage = 2.69).

The distribution of students who participated by answering the questionnaire was: 22% in the second semester, 21% in the fourth semester, 21% in the sixth semester, 17% in the eighth semester, and 19% in the tenth semester. All participants had access to an informed consent document, which they had to accept before having access to the research instrument. It is important to highlight that, due to the conditions of the program, in the 2021-A period there were only groups of even semesters.

Instrument

To fulfill the proposed purpose, a 23-item questionnaire was developed, divided into five dimensions (figure 1). The first dimension allows knowing the demographic characteristics of the sample; the second dimension explores in a general way what technological equipment the participants have; in the third dimension, students are asked about their perception of the Internet service; In the fourth dimension, the participants can choose one or several options according to the academic management, videoconferencing and storage platforms they handle and select the best one to be able to face the online learning activities; and finally, the fifth dimension is composed of an open question where students can express what problems they have faced during the distance education period. It should be noted that the part of the instrument that measures the perception of the Internet service proved to have an acceptable internal consistency. ($\alpha = 0.78$).

Figure 1. Questionnaire: Available technology and conditions for online academic work

Datos sociodemográficos								
Matrícula:								
Edad:								
Sexo:						**Mujer**		**Hombre**
¿Qué semestre cursas actualmente?:								
Segundo		**Cuarto**		**Sexto**		**Octavo**	**Décimo**	
¿Te encuentras cursando tus materias en línea?							**Sí**	**No**
Equipamiento tecnológico								
¿Cuentas con computadora para la realización de las actividades académicas del siguiente semestre?							**Sí**	**No**
¿Con cuantas personas compartes la computadora?								
Ninguna	**1**	**2**		**3**	**4**	**5**	**o más**	
¿Cuentas con un teléfono inteligente para realizar las actividades académicas para el siguiente semestre?							**Sí**	**No**
¿En tu casa cuentas con conexión de Internet fija?							**Sí**	**No**
¿Cuentas con conexión de datos a través de tu teléfono?							**Sí**	**No**
¿Con cuantas personas compartes el teléfono inteligente?								
Ninguna	**1**	**2**		**3**	**4**	**5**	**o más**	
Plataformas de gestión académica, videoconferencia y almacenamiento								
¿Cuáles de estás plataformas de trabajo académico conoces y manejas?								
Google Classroom		**Google suite**		**Moodle**	**Ms Teams**	**Edmodo**	**Otra**	
¿Cuál plataforma de trabajo académico consideras que es la mejor?								
Google Classroom		**Google suite**		**Moodle**	**Ms Teams**	**Edmodo**	**Ninguna**	

¿Cuáles de las siguientes plataformas para videoconferencia conoces y manejas?							
Zoom	**Google Hangouts**	**Skype**	**Meet**	**WhatsApp**	**Moodle**	**Ms Teams**	**Otra**
¿Cuál plataforma para videoconferencias consideras que es la mejor?							
Zoom	**Google Hangouts**	**Skype**	**Meet**	**WhatsApp**	**Moodle**	**Ms Teams**	**Otra**

¿Cuáles de las siguientes plataformas de almacenamiento usas?				
Google Drive	**Dropbox**	**OneDrive**	**Otra**	**Ninguna**
¿Cuál plataforma de almacenamiento consideras que es la mejor?				
Google Drive	**Dropbox**	**OneDrive**	**Otra**	**Ninguna**

Percepción del servicio de Internet		
¿Consideras que es adecuada la velocidad de la conexión de Internet con que cuentas en tu casa para tomar clases por videoconferencia?	**Sí**	**No**
¿Consideras que es adecuada la velocidad de la conexión de Internet con que cuentas en tu casa para descargar material bibliográfico?	**Sí**	**No**
¿Consideras que es adecuada la velocidad de la conexión de Internet con que cuentas en tu casa para visualizar videos en Internet?	**Sí**	**No**
¿Consideras que es adecuada la velocidad de la conexión de Internet con que cuentas en tu casa para subir documentos electrónicos al Internet?	**Sí**	**No**
¿Consideras que es adecuada la velocidad de la conexión de Internet con que cuentas en tu casa para subir videos al Internet?	**Sí**	**No**
Problemáticas que surgieron durante las clases a distancia		
¿Menciona cuáles son los problemas principales a los que te enfrentaste en el semestre durante las clases a distancia?		

Source: self made

Process

Students were invited to participate in the study voluntarily. The application of the questionnaire was carried out through a digital platform (Google Forms) during the month of February 2021. The time to answer the questions ranged between 5 and 10 minutes.

Results

Conditions of technological infrastructure

Because the development of academic activities in the distance education modality requires the use of a personal computer, the question was included as part of the instrument: Do you have a computer to carry out academic activities? The responses indicated that, even though the vast majority of the student community has a computer (97%), there is 3% that do not have this fundamental tool in their training. Of the participants who do not have a computer, 25% are women and 75% are men.

Despite the fact that most students have a computer, 70% share this technological resource with other members of their family, a situation that notably limits their use and enjoyment. Only 30% of the students have a computer exclusively for their personal use, 26% of the participants share the computer with one person, 26% with two, 13% with three, 4% with four and 1% share the use of the equipment computing with five or more people, respectively.

To analyze the connectivity conditions of the Internet service, the participants were asked: "Do you have a fixed Internet connection at home?" The result obtained shows that 93% have a fixed internet connection in their homes; only 7% reported not having this service, of which 36% are women and 64% men.

Internet service perception

With the idea of knowing in greater depth the quality of the Internet service of the student community, they were asked if they considered that the connection was adequate to: a) take classes by videoconference, b) download bibliographic material from the Internet, c) watch videos on the Internet, d) upload electronic documents to the Internet and e) upload videos to the Internet. These options were considered because they represent some of the essential academic activities that take place in the distance learning process.

The results indicate that almost half (49%) of the participants consider that the speed they have is not adequate for uploading videos to the Internet (figure 2). In addition, 3 out of 10 students highlight that the classes taken through videoconferences are affected by the connectivity conditions of their contracted service. While downloading bibliographic material, viewing videos on the Internet and uploading electronic documents did not turn out to be a problem for most of the students.

Figure 2. Perception of Internet service available for academic activities
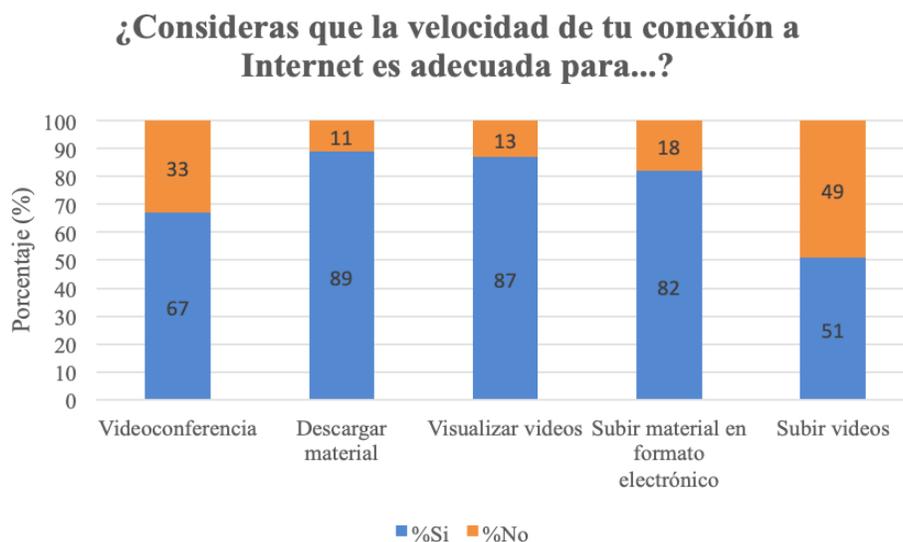
Source: self made

The use of smartphones is often considered an alternative for attending classes remotely (Céspedes-Tamayo, Salomón-Vila and Augello-Díaz, 2021). For this reason, the conditions of the university community in this aspect were analyzed. From the answers it was obtained that 93% of the university community has a smartphone. Unlike computers, 80% say the phone is for personal use, while 20% share the phone with family members. While only 30% of those surveyed have a data connection plan on their phone and 70% do not have this service.

Digital platforms for the management of academic activities, videoconferences and cloud storage

This section presents the results corresponding to the platforms that the students handle and that they consider the best for managing academic work, conducting videoconferences and for cloud storage (table 1).

Regarding the academic management platforms, the respondents reported that the ones they use the most are: Microsoft Teams, Moodle, Google Classroom and Edmodo. Microsoft Teams (83%) is the platform they consider to be the best for this purpose.

Regarding the platforms used by students to hold videoconferences, the results show that the most used are Microsoft Teams, Zoom, WhatsApp, Meet and Skype, mainly. In the case of the analyzed community, 71.3% consider that the best platform to hold videoconferences is Microsoft Teams, followed by Zoom (13.1%).

While the cloud storage platforms most used by students are: Google Drive and OneDrive. Here Google Drive is the preferred storage platform (72.1%), followed by OneDrive (22.1%).

Table 1. Digital tools used by students during remote classes

Plataformas para la gestión de actividades	%	Plataformas para realizar videoconferencias	%	Plataformas para el almacenamiento en la nube	%
Microsoft Teams	100	Microsoft Teams	93.4	Google Drive	81.1
Moodle	70.5	Zoom	85	OneDrive	53.3
Google Classroom	64.8	WhatsApp	66.4	Dropbox	9
Edmodo	27	Meet	61.5	Otras	4.4
Google Suite	9	Skype	58.2	Ninguna	6.6
Otras	2.4	Moodle	21.3		
		Google Hangouts	16.4		
		Otras	3.3		

Source: self made

Main problems that arise when taking distance classes

This dimension of the questionnaire focused on finding out, from the point of view of the students, what were the main problems they faced during the distance learning period. Depending on the topic to which the referred problem was related, the responses were classified as shown in Table 2.

Table 2. Problems faced by the analyzed student community, during the period of distance education carried out as a consequence of covid-19

Problemas a los que se enfrentó la comunidad universitaria durante el periodo de educación a distancia.	Frecuencia Absoluta
1. Problemas con el internet:	*74*
1.1. Conexión de internet lenta	19
1.2. Fallas o intermitencia en el internet	44
1.3. Problemas con el suministro eléctrico	11
2. Problemas con los docentes:	*44*
2.1. Problemas por falta de canales de comunicación adecuados estudiantes-docentes	14
2.2. Problemas por la actitud de los docentes	9
2.3. Problemas con horarios de clases (respeto a los horarios, cambios de horarios, inasistencia, etc.)	7
2.4. Actividades académicas excesivas y falta de tiempo para realizarlas	14
3. Infraestructura académica disponible:	*34*
3.1. Problemas con las características del equipo de cómputo	21
3.2. Compartir equipo de cómputo con familiares para realizar actividades académicas	4
3.3. Problemas con periféricos (por ejemplo, cámara y micrófono).	4
3.4. Falta de recursos bibliográficos	1
3.5. Falta de un espacio adecuado para tomar clases	4
4. Deficiencias en las habilidades necesarias para gestionar el autoaprendizaje:	*24*
4.1. Deficiencias en el aprendizaje autodidacta-autogestionado	19
4.2. Deficiencia en la administración de los tiempos de las actividades a distancia	5
5. Trabajar por necesidades económicas	*14*
6. Problemas con la plataforma Microsoft Teams	*3*
7. Complicaciones en las interacciones sociales	*3*
8. Falta de actividades prácticas	*2*

9. Problemas con la estructura de las materias	*1*
10. Estrés por las actividades a distancia	*1*

Source: self made

As can be seen (table 2), in order of incidence, the five problems that students most frequently faced during this type of education were: 1) problems with the internet connection, 2) communication problems or with the attitude of teachers, 3) problems of available academic infrastructure, 4) deficiencies in the skills necessary to manage self-learning and 5) the need to work for economic reasons.

Regarding the first incidence, the problem of the internet connection (figure 3) that the students have not only has to do with speed, but also with problems with the electrical supply and failures or intermittence in it. service.

Figure 3. Distribution of common problems with the internet connection


Source: self made

In second place, in incidence, the students expressed that there were problems with the teachers (figure 4); the lack of adequate communication channels and the excessive workload were the main problems, followed by the attitude of the teachers and, finally, they report having presented other inconveniences due to the fact that the class schedules assigned to the subjects were not respected.

Figure 4. Frequent problems with teachers

Problemas con los docentes

- ■ Problemas por falta de canales de comunicación adecuados estudiantes-docentes
- ■ Problemas por la actitud de los docentes
- ■ Problemas con horarios de clases (respeto a los horarios, cambios de horarios, inasistencia, etc.)
- ■ Actividades académicas excesivas y tiempo para realizarlas
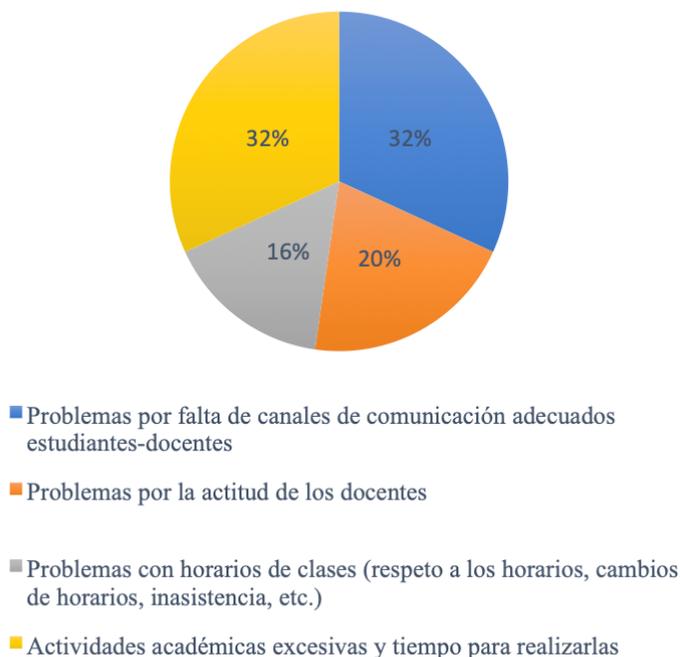
Source: self made

Regarding incident three, which refers to the available academic infrastructure and includes problems related to computer equipment, peripherals and spaces and furniture so that students can have adequate academic development, it can be seen in figure 5 that the most frequent problem faced by students was not having computer equipment with the necessary technical characteristics to face the academic activities of the Computer Engineering career. Second, problems related to sharing computer equipment with other members of the family were found; problems with peripherals such as the camera, microphone or keyboard and the lack of an ergonomic workspace so that they could work without distractions.

Figure 5. Frequent problems with the academic infrastructure of students

Problemas con la infraestructura académica disponible

- Problemas con las características del equipo de cómputo
- Compartir equipo de cómputo con familiares para realizar actividades académicas
- Problemas con periféricos (cámara, micrófono, etc.)
- Falta de recursos bibliográficos
- Falta de un espacio adecuado para tomar clases
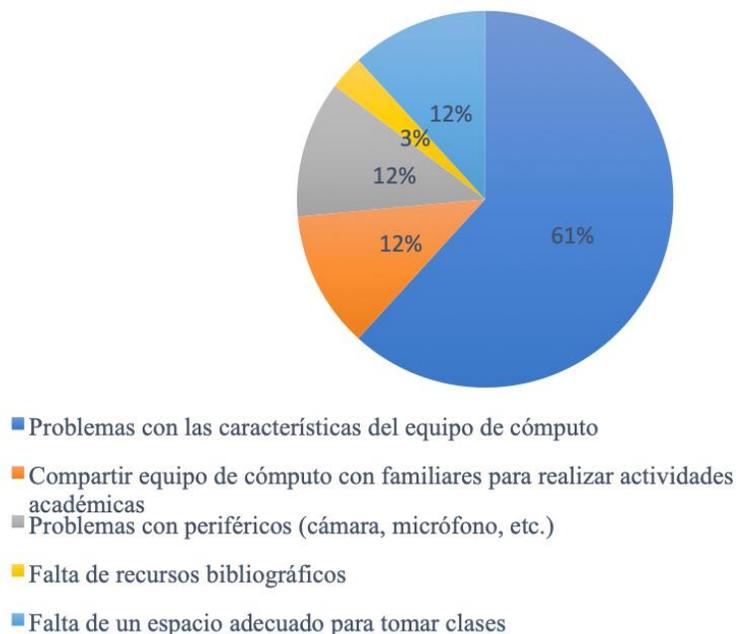
Source: self made

Regarding the following incidents, 24 participants expressed that during the distance education period they faced problems related to the administration of their work time and poor skills to manage their self-learning (table 2).

Discussion

Currently, there are more and more examples that confirm that economic activity based on technological developments is the key to the accelerated growth of countries. Today more than ever, the true wealth of nations lies in the creative and creative capacity of their society. For this reason, it is easy to see that the development of towns is a direct function of the scientific and technological development of the people who make them up (Sanz and Serano 2017).

Taking into account the above, fostering creative technological ecosystems is essential for the progress of economies, but this requires that society be provided with quality education. Hence the importance of considering education as one of the fundamental rights of people that promotes the development of both individuals and countries (Umaña, 2020). This responsibility to guarantee, favor and promote the right to education, from an equality perspective, which allows people to develop the necessary skills to build a dignified and full

life, falls on the State (Sanz and Serano, 2017). . Therefore, it is in the different education systems where the actions focused on the fulfillment of the right in question are implemented.

Parallel to the function of providing quality education, schools fulfill the task of reducing the existing contextual differences between the student community, promoting conditions of sufficiency and equality that allow students to face the academic challenges of the courses of study. training. In this way, by making its own infrastructure (laboratories, libraries, work areas) and equipment (computers, laboratory equipment) available to students, the school fulfills a homogenizing function that, on many occasions, passed unnoticed in the pre-covid era. The abrupt change to the distance education modality made it difficult for educational institutions to fulfill this task, that is, they sent the student community to face the academic activities of their respective study programs at home.

Since the beginning of social distancing, different government and educational entities identified not having an Internet connection at home as one of the main limitations (Ponce et al., 2020; Umaña, 2020), something that was not found in this research so markedly, since only 7% of the students surveyed do not have such a service; the bandwidth of the connection (internet speed), the intermittence of the service due to different circumstances, as well as the failures in the electrical service were more obvious problems, with higher levels of incidence, which coincides with the research by Rosario et al. . (2020), where most of the participants indicated having had problems with the internet service to carry out their academic tasks online. In addition, due to these same problems, a third of the students had complications attending the synchronous classes.

In the particular case of study programs related to the area of technology, an additional aspect to consider is the characteristics of the computer equipment that families have, since at least in this research three out of five students did not have an adequate equipment to carry out the academic activities of a career such as computer engineering, since it requires the use of programming languages, simulators and other tools that require equipment with superior characteristics. Faced with this, what is the alternative? What can be done? How can a student learn the topics if they do not have the necessary computer equipment to put into practice the theoretical knowledge analyzed in the course?

Due to the high penetration of the use of smartphones in today's society, it is easy to assume that these devices can be used as an alternative to the computer in the distance learning process. However, although the majority of the surveyed community has a smartphone, only one in three has contracted the data service, in addition to the fact that there

is a specialized package that cannot be installed or executed on these devices. Therefore, it can be considered that smartphones can only be used in a complementary way to carry out some academic activities such as attending synchronous sessions, viewing bibliographic or multimedia material, creating and editing video, etc.

The change in the educational model took both students and teachers by surprise. This transition was not and is not trivial. Teachers with many years of experience in face-to-face education had to teach classes in a practically unknown modality, without the necessary conditions and with the work, family and health pressures typical of the time. Reasons why this research considers that many of the students may have had the following problems: lack of adequate communication channels with teachers, excess of academic activities or lack of sufficient time to carry them out, and problems respecting class schedules by the teachers.

Likewise, it is important to consider that the communication and coordination of academic activities must flow from the educational authorities, through the teachers to the students and vice versa. These communication channels will allow the community to know the objectives and the actions that are implemented for the fulfillment of the quality objectives of the educational programs. Likewise, it will allow to know the barriers that hinder the efficient academic performance and the implementation of the necessary preventive or corrective actions. It is not enough to leave the implementation of actions focused on the fulfillment of the teaching activity to the individual free will of the teachers. The implementation of a distance quality program requires the coordination of all the elements that participate in the development from a collegiate perspective.

Conclusions

As conclusions, various situations are proposed that must be considered for the implementation of the distance modality in educational programs under the circumstances of the covid-19 pandemic and that could also be taken into account in the event that the centers educators make the decision to continue working under this modality. It is very important to consider that the internet service available to the members of the student community is very diverse, so it is essential to establish mechanisms that allow students to view the content of synchronous sessions asynchronously. In this way, technological limitations or equipment availability do not definitively limit the learning process.

In addition, institutions should carry out work focused on identifying students with technological infrastructure problems and implementing the necessary actions to provide

access to services and equipment. Connectivity scholarships, computer equipment loans from institutions, agreements for the acquisition of equipment and peripherals are some of the actions that should be explored to try to solve these conditions. Another alternative is to establish schedules for the use of computer laboratories and school facilities, all of this done under specific access controls that do not put the community's health at high risk.

In addition to the above, it is important to take into account the limitations of the bandwidth of the internet connection that the community presents, so the development of videos as a school task has to be analyzed by the teacher, in order to weigh the academic benefit provided by this tool against the difficulties that students may face during the delivery of the work.

Finally, it is essential to consider establishing (bidirectional) means and institutional communication protocols between the different actors that participate in the educational process (students, teachers and education administrators), so that the community is aware of the progress, achievements and problems for that, through a reflective manner, preventive and corrective actions are implemented that favor the fulfillment of educational objectives.

Future lines of research

This research has its limitations, since the aspect of how the bandwidth of the Internet connection is affected by the simultaneous work of several members of a family was not analyzed, nor was the type of telephone and data connection service they have. students and how they are currently using these to carry out the academic activities that arise as part of their studies.

In addition to the above, the available infrastructure with which the teachers faced remote work was not considered, nor was the perception they have of their internet service or the problems they face with remote work.

Therefore, in future research of this nature, all the above aspects could be taken into account in larger samples, in order to have even more detailed data from both parties (students and teachers) and thus be able to generalize the results. to propose some teaching strategies that have a positive impact on the education of students.

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