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Virtual Learning During the COVID-19 Pandemic: The Opening for the Implementation of a Blended Learning Modality in the Chemistry Class at High School Level

Lucero Canto Guerrero[1], Julio Rubio Rodríguez[1] & Marco Antonio Carrillo Pacheco[2]

[1] Autonomous University of Queretaro, Mexico

[2] Services Unit for Basic Education in the State of Querétaro, Mexico

Correspondence: Lucero Canto Guerrero, Autonomous University of Queretaro, Mexico, 76010, Tel: 52-442-192-1200. E-mail: lucero.canto@uaq.mx

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Abstract

The pandemic caused by the SARS-COV2 virus, known as COVID-19 brought with it a series of challenges for educational and teaching institutions, since, from one moment to the next, the need for a massive migration from face-to-face education to online education, using educational technological tools, however, is considered that it is necessary to restructure teaching and implement a blended learning model, which is characterized by the integration of various pedagogical and didactic resources in face-to-face and virtual environments to achieve meaningful learning through the construction of knowledge in subjects that are the basis for many careers in the health sciences such as Chemistry. The objective of this study was to analyze the relevance of implementing a hybrid model in education at the high school level in the Chemistry class, through the incorporation of Information and Communication Technologies as educational tools. According to the results, the implementation of a b-learning model is an alternative strategy for the teaching-learning of Chemistry and, at the same time, makes it possible to reduce the health risk that situations such as contagion by COVID-19 or other potentially communicable diseases, since this model allows students to take classes virtually, and simultaneously in person, following contingency measures.

Keywords: High school education, blended learning, Information and Communication Technologies, academic performance, pandemic

1. Introduction

Currently, society is immersed in a time in which the use of Information and Communication Technologies (ICT) have acquired great strength and importance in all social sectors, especially in the educational sector, where it has promoted the development of new teaching methods (Viñals and Cuenca, 2016). The use of ICT brings with it new educational options, between face-to-face (traditional model) and distance, these new tools are transforming teaching-learning systems (Hernández *et al*., 2018). Today, ICT are present in all educational stages (Viola *et al*., 2018) since it allows maintaining contact between the teacher and the students, among classmates, with educational content and resources (Campos *et al.,* 2020), thus stimulating the interest of students in the subject of Chemistry (Villalustre and Del Moral, 2017), which promotes motivation and participation in class (Marín and Muñoz, 2018; Granda *et al*. , 2019). On the other hand, it is important to mention that the concept of the classroom has been substantially transformed, since it does not refer only to the learning space and the teacher, but also to the implementation of virtual platforms through the use of ICT, which allows the development of new teaching-learning models, taking advantage of the skills and abilities of the students, but which require the participation and guidance of the teacher (López *et al*., 2020).

The blended learning (b-learning) is an educational model that combines face-to-face teaching with virtuality, whose purpose is to choose the appropriate media for each educational need and achieve significant knowledge in students (González *et al*., 2017). From this perspective, the teaching of Chemistry with the implementation of a b-learning model with the help of ICT is a growing and important area of study that has even led to questioning the scope, advantages and disadvantages that its implementation may have (Piñero and Canto, 2019; Piñero and Costado, 2020). The objective that has been pursued with the incorporation of ICT and b-learning models is to maintain student attention and achieve learning in accordance with the technological-social context in which they

live and their academic needs, on the other hand, the pandemic by COVID-19 brought with it a turning point in society, especially in the educational field, where from one moment to the next they had to implement these educational tools, which would allow us to continue with the teaching-learning process (Cáceres-Piñaloza, 2020; Pérez and Tramallino, 2020). Due to this context of a global pandemic generated by COVID-19 and its consequent social distancing, where there is no other option than to adapt to virtual education to achieve educational processes, the fact of implementing a b-learning model in which students have digital skills to manage educational resources that are useful in their classes and of benefit. In this way, the present investigation arises, where the objective is to analyze the relevance of implementing a b-learning model in the area of Chemistry that can be used to achieve significant learning in high school students and improve their school performance (Martínez and Garcés, 2020).

2. Theoretical Framework

2.1 Constructionism and the use of ICT

According to constructionism, learning is built from prior knowledge into new knowledge (Ackermann, 2020). In a constructivist model, it has been shown that different factors intervene in academic performance, such as contextual, social, cultural and personal aspects, both cognitive, biological and socio-affective of the student (Barrios and Frías, 2016). With constructionism, ICT allow this step for educational development, however, Mexico is not ready to make this change abruptly since they do not have the economic resources to equip schools with the necessary electronic devices, in addition, it is It is necessary to provide continuous updating courses so that teachers can gradually implement ICT in their educational programs (Seberin, 2010), unfortunately the pandemic led to the premature and hasty implementation of this type of technological tools. In this sense, the implementation of innovative theories such as constructionism and the use of educational technologies, could lay the foundation for a positive development in education in Mexico, but to achieve this requires a joint effort between the government, society and educational institutions and with high participation by the teacher, who must find a way to adapt and update their classes (Hernández and Bautista, 2017; Arancibia *et al*., 2020), taking advantage of the experience acquired during the pandemic, because as mentioned above, the virtual modality arrived unexpectedly and mandatory. According to Papert (1991), constructionism considers that learning is an innate capacity in human beings that allows them to learn through experience, that is, it is a skill that allows the student to learn from practice and through experience. in turn, create graphic representations of their ideas, to later organize them, synthesize the information and relate it to their daily life.

Today society is faced with the possibility of approaching constructionism, which is derived from the theory of constructivism, a theory that states that knowledge "is not a copy of reality, but a construction of the human being", since, the Human beings build knowledge in a personal way, with each graphic representation of their ideas that they already have, and with what they previously built in their relationship with the environment that surrounds them, therefore, it is personal (Sandoval, 2010; Aparicio and Ostos, 2018). Constructionism as a theory and teaching method, takes part of constructivism by stating that the student is responsible for his own learning process, in such a way that he builds his knowledge, in addition, constructionism links this process with the use of technology and particularly the use of electronic devices such as a computer, a laptop, or a smart phone, which can offer this environment so that the student can build their knowledge and relate it to the outside world (Márquez, 2019).

Constructionism is an educational theory that supports the use of ICT, since the devices become learning tools (Lach, 2017). The incorporation of ICT in education has allowed a change in the way of teaching classes; from a traditional model focused on teaching to a model focused on student learning, this last study model allows students during the teaching-learning process to interact, reflect based on the knowledge they are learning achieving, have access to work activities, educational resources such as teaching materials that promote the learning process, as well as evaluation activities at any time and from anywhere, as long as there is an electronic device and an Internet connection (Castro *et al*., 2007). This way of conceiving the teaching-learning process contributes decisively to the formation of an investigative spirit and, consequently, enables the development of the student's creative capacity. Given the incorporation of ICT through constructivism, according to Olmedo and Ferrerons (2017), the student is expected to be someone who:

- Be involved responsibly in your learning.
- Be active all the time.
- Work collaboratively as a team.
- Be able to develop your own ideas and share them with your peers.
- Be creative in problem solving.

- Have new initiatives and be independent.

On the other hand, the constructionist teacher must facilitate, shape and guide learning, investigate and update himself; select and develop educational materials and resources; organize activities and tasks; create a harmonious environment, evaluate objectively, master their subject and motivate their students (Torres and García, 2019).

2.2 Blended Learning Educational Model

Today, the teaching-learning process is not focused on the teacher and in the classroom, currently there are different educational modalities, derived from the incorporation of ICT and the use of virtual platforms. The blended or B-Learning model is one that combines face-to-face and non-face-to-face education, fundamentally taking advantage of the possibilities of technology in learning. This model through the incorporation of ICT can guide learning processes to different areas or fields both in secondary and higher education, focused on any subject such as Chemistry. Mediation with ICT in the b-learning modality is carried out on virtual platforms, institutional web pages, learning management systems (LMS), through virtual forums, email, collaborative work with online tools, virtual meetings, among others (Georgsen, 2014; Piñero and Costado, 2020).

The introduction of ICT in educational institutions has caused an increase in the evolution of learning, and consequently of mixed educational models, which are characterized by allowing the development of cognitive skills, critical thinking and building the knowledge, elements that help the student in making decisions and solving problems of daily life (Lengua *et al*., 2020). On the other hand, the b-learning model focuses on the development of activities in a collaborative way between the students and the teacher, it is flexible, which allows it to be adjusted to the needs of each student and encourages the use of various educational resources that serve as instruments in the teaching-learning process, which promotes the development of critical thinking and decision-making (Maldonado and Etcheverry, 2013; Piñero and Cosatdo, 2020).

2.3 The Importance of Studying Chemistry

The study of sciences, especially Chemistry, contributes to the integral development of the student by promoting the development of attitudes and intellectual habits of great importance in today's society such as reasoning, arguing, checking, discussing, synthesizing, etc.), favors the understanding of phenomena of their daily life, helps to rationally interpret their environment and promotes critical attitudes towards problems of daily life (Chang, 2020). However, the teaching of Chemistry is a very complex activity, since it has been observed that, for high school students, understanding Chemistry implies a greater effort compared to other subjects that make up their curriculum (Ávila *et al.,* 2020; Zouiten 2021). In addition to that, one of the factors that affects the decrease in student interest in Chemistry, if not the main one, is the way of approaching the study of this science; Chemistry courses at all levels are overloaded with theoretical information, oriented towards theory testing and rule following (Galagovsky *et al*., 2003; Morales and Salgado, 2017; Chang, 2020). This causes a total lack of interest in the subject, generating absence in the classroom, which finally culminates in failing the subject. This difficulty means that very few students choose to study a career in health or engineering such as: Chemistry, Medicine, Dentistry, Nutrition, Nursing, Engineering, etc., (Porro, 2007; Frías *et al*., 2016), coupled with the fact that this choice is due to the fact that the Chemistry teacher did not motivate them during their educational process during high school. On the other hand, Chemistry is considered a basic science of great importance in various fields of knowledge and is taught both in high school and at the university level. Being a science that is taught in other careers in addition to Chemistry such as Engineering, Medicine, Dentistry, Physiotherapy, Biology, etc; having great importance in the education and training of students (Nakamatzu, 2012; Rodríguez *et al.,* 2017). The Faculty of Chemistry of the Universidad Autónoma de México (UNAM) considers Chemistry as a science that contributes to the satisfaction of social needs, which is part of the basic culture of the student, providing information and procedures to interact in a well-founded and critical of their natural and social environment (Garritz *et al*., 2011).

Therefore, it is important to develop and implement new strategies to undertake the teaching of Chemistry with the help of ICT (Martínez *et al*., 2018). There is evidence from various studies that analyze the use of ICT and its influence on motivation (Kim and Hall, 2019). In this context, relating the learning process with the use of tools associated with the internet and social networks could constitute an effective alliance to obtain quality learning. Within the characteristics of the use of ICT, it can be highlighted that; Electronic devices allow working with a large amount of variety of information and simultaneously, they are also friendly, accessible and adaptable to the user. The use of ICT encourages a high degree of interdisciplinarity, promotes the development of skills and abilities for the student to search, discriminate, build and simulate information, in addition to testing hypotheses (Centeno and Cubo, 2013). Domingo and Marqués (2011) affirm that "the use of ICT and motivation constitute one of the learning engines, since it encourages the activity of thought", which will make it possible to have a better learning in the subject, since it encourages better performance and performance by the student and greater

audience in the classroom (Certad, 2010; Granda *et al.,* 2019; González, 2021). In this sense, emphasis is placed on the importance of the student to create and build their learning actively.

3. Methodology

The work was carried out at the Escuela de Bachilleres of the Universidad Autónoma de Queretaro (EBA-UAQ), a public high school committed to its function of promoting the integral formation of the student body, with a sense of social responsibility under a sustainable approach, but also to comply with the substantive, linking, research, extension and dissemination of culture. The high school is under a University Educational Model (MEU), which is made up of three fundamental components for University Education whose application includes the High School: the first block covers principles and values, the second has to do with the pedagogical approach and the third, implies adopting a defined position on educational innovation, which are interrelated and focus on the student, who is the protagonist of his university education (EBA-UAQ, 2017). In this sense, the MEU of the Escuela de Bachilleres bases its education on competencies and with a multidisciplinary approach that seeks to implement the use of educational ICT to improve school performance.

A survey was carried out using Google Forms to carry out a diagnosis on the perception of the use of ICT as educational tools in the teaching-learning process, that is, a survey was carried out in order to know the opinion of some key aspects that allows us to understand how students interact with ICT in times of pandemic, which in turn allowed us to know if ICT as educational tools are relevant for the implementation of a mixed model, considering that, derived from the contingency, at this time students are in a 100% virtual model, with the possibility of a return to school. The EBA-UAQ considers a gradual return to classes during 2022, where only a maximum of 50% of the students return in person and the rest continue virtually.

The survey consisted of a series of multiple-choice questions in which their impression on the use of technological resources in the teaching-learning process of Chemistry was questioned. For this stage, 787 students (aged 15 to 18 years) from the EBA-UAQ participated, specifically from the North and South campuses, which are the largest campuses in the state of Queretaro, with an approximate population of 5000 students between both campuses, therefore, the minimum sample size must be 588 students, to ensure a confidence level of 99%, according to the z-score formula.

4. Results

According to Figure 1, the distribution of surveyed students was higher for the North campus, this allows us to observe a better reflection of the student population, since the North campus has 20% more students than the South campus, representing better to the population of students of the EBA-UAQ.

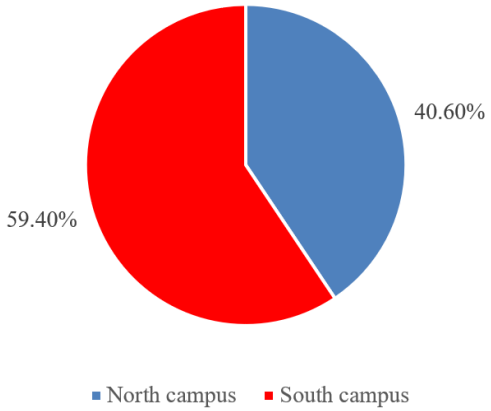
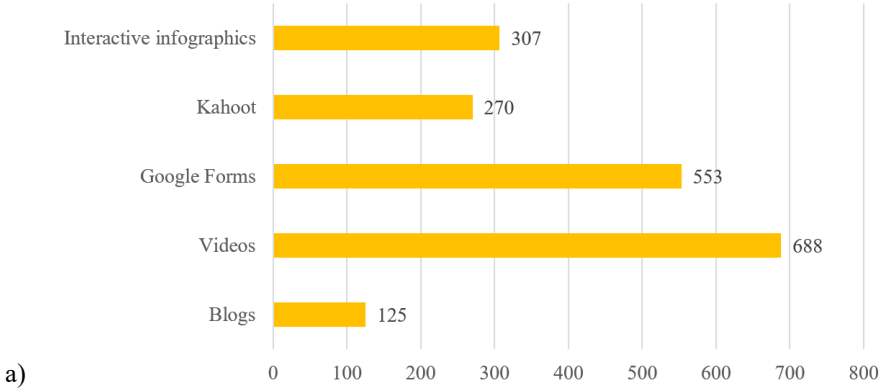


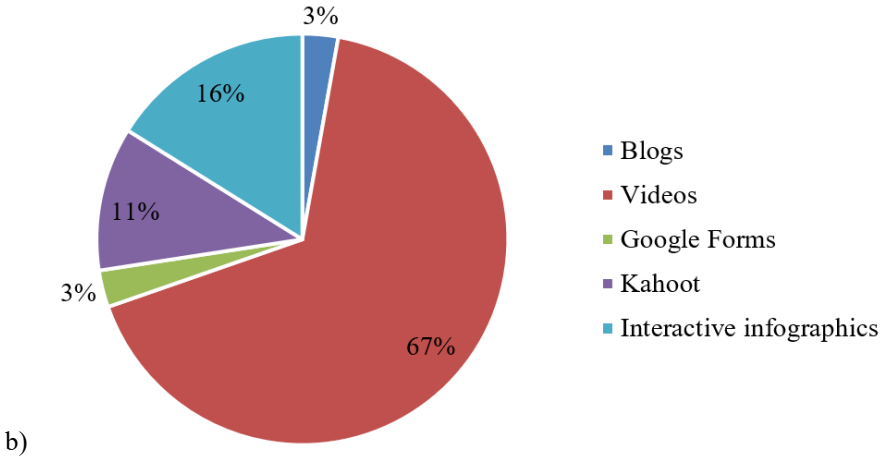
Figure 1. Origin of students by campus

During the pandemic, teachers had to adapt to virtual classes, using various tools to teach their class, for which reason students were asked about the educational tools that their teachers have used when teaching their class during this contingency period and social distancing. Based on the results, it can be seen that students refer to the fact that their teachers have used various ICTs, where the use of videos is positioned as the most used tool with 88.1%, according to Méndez (2018), its use benefits the assimilation of knowledge, which makes them a useful tool for learning the subject of Chemistry and (Figure 2a) and this same tool according to their perception, they consider that it is the one that has provided them the most support for the process of learning (Figure 2b). In the comments section of the survey, the students mention that the videos are a very good tool since it allows them to

repeat the information or procedures as many times as necessary and can be played from any electronic device such as their cell phone.



a)



b)

Figure 2. Use of ICT during the pandemic. a) ICT used by EBA-UAQ teachers; b) Perception of students in the use of ICT as a support for learning

The foregoing is reflected in the study (Figure 3), where students mention that they use the use of educational videos on the Internet as their first source of support, with the YouTube platform being the most consulted by students (Figure 4a). the second source of information consulted by students are web pages with 8.8%, tutoring with another teacher remains the last option for students, these results indicate the digital skills that students have, being technological sources their first options.

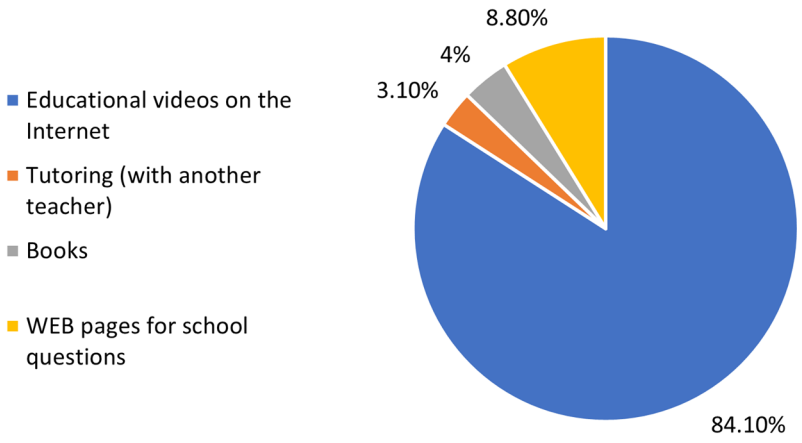


Figure 3. When you do not understand a subject explained by the teacher, what source of information do you go to understand it better?

During the study, the students confirmed the importance of the use of videos, where with an approval of 7-10 and with a total of 84.1% of students, they consider that educational videos allow them to better understand the topics to be studied, in this way it is possible to mention that they approve of the use of videos as a support tool (Figure 4b). Due to the above, it is considered that the development of educational videos on the topics to be reviewed, even though students currently already use this tool as a primary source to resolve their doubts, will allow us to implement a strategy that facilitates the orientation of students in their educational process, and adapt them to our didactic strategy. The development and production of videos with educational content on Chemistry offers us an opportunity, since a large part of the videos that students consult is often of low quality or have erroneous content.

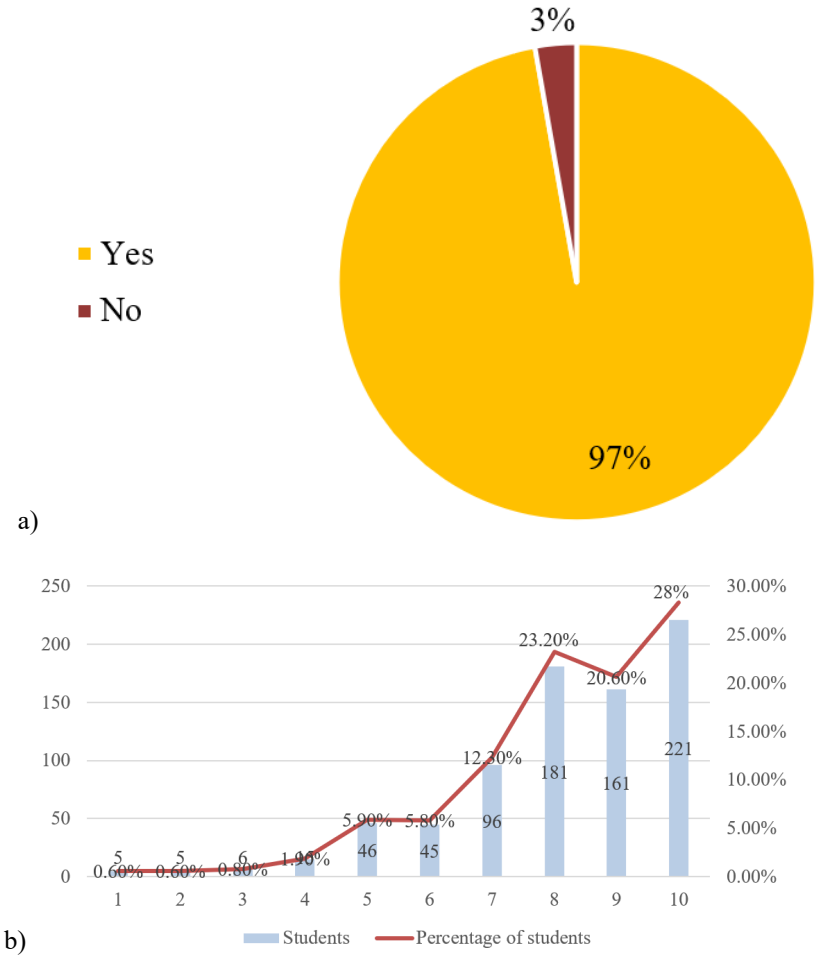


Figure 4. a) Have you ever used a YouTube video to better understand a topic seen in class? b) On a scale of 1-10, do you consider that the use of videos as support in your classes allows you to better understand the topics?

On the other hand, currently due to the vaccination process and the consequent decrease in COVID-19 infections, as well as deaths in the country, it is likely that by 2022 we will gradually return to blended classes. Given this eminent possibility, interestingly the students of the EBA-UAQ consider that the b-learning modality could be the best option to resume their studies and that allows them to understand the topics of the class (Figure 5a).

A problem that is observed for the virtual modality and that could be a challenge for the implementation of the b-learning system, is the access to communication media and devices by students. For which, they were also asked to indicate the equipment they have at home to use for educational purposes, so it can be observed that the majority of students have the tools to be able to face the virtual modality and therefore the b-learning system (Figure 5b).

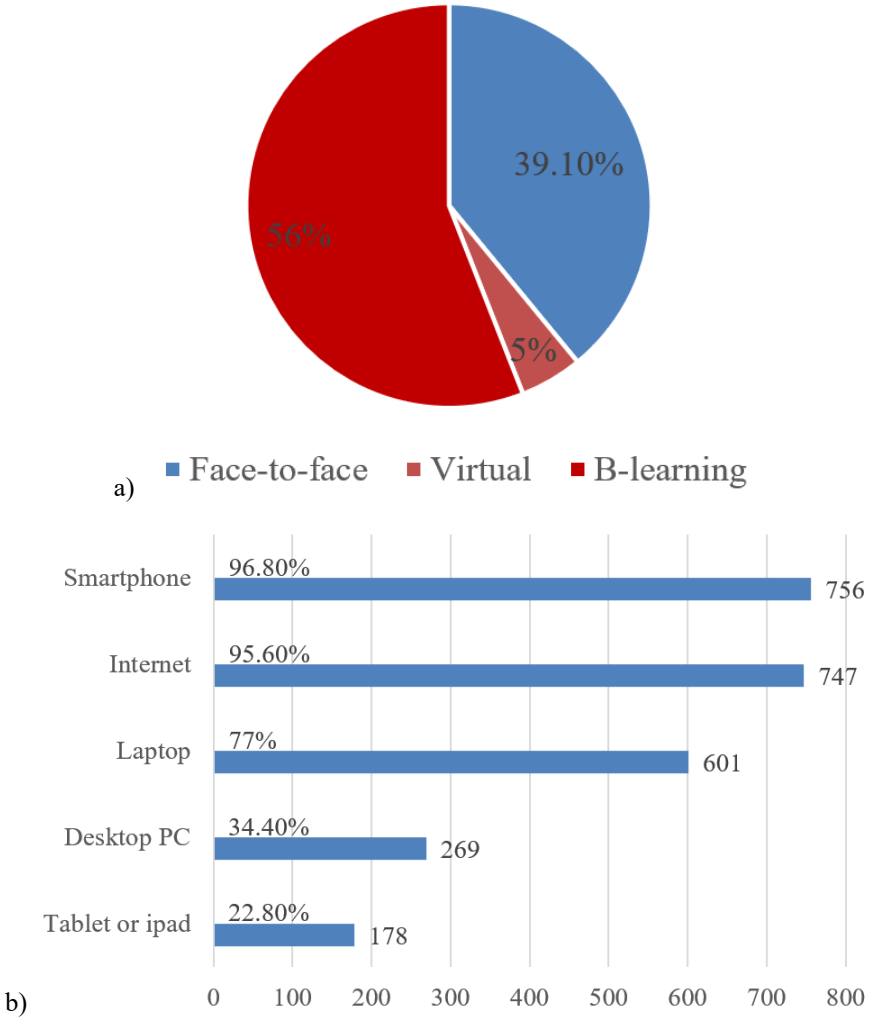


Figure 5. a) What modality do you consider could help you better understand the issues? b) Select the services and equipment you have at home.

5. Discussion

The issue of demotivation and rejection of students towards learning any scientific discipline is a constant concern for teachers (Furió, 2006). Lagowski at the beginning of the sixties, tried to solve this problem through the use of digital technology in the field of education in the United States (Cardellini, 2010). In the 1970s and 1980s, the use of digital technology gradually began to gain interest within teaching (Wilkins, 1975; Wiegers and Smith, 1980). By the nineties Wegner and Montana (1993), evidently made clear the need to incorporate technology in the teaching of Chemistry, so its use was decisive, being an area of opportunities and constant development in the implementation of Chemistry. technology (Evans and Moore, 2011) and that has led to questioning the scope of the use of this tool, as well as its advantages and disadvantages (Williamson, 2011; Pienta, 2015). On the other hand, it has promoted profound changes in the curricular structure of some study plans. The purpose of incorporating these new technologies is to maintain student attention and participation and thus achieve learning in accordance with the technological-social context in which they live (Frías *et al*., 2016).

Interestingly, the students chose the use of educational videos as their main source to resolve their doubts, in this sense Brame (2016) mentions that the use of educational videos has become an important resource that can help in the teaching-learning process, where meta-analysis studies suggest that this technology can increase learning, which makes videos an effective educational tool; mentions that all educational videos must comply with the following aspects: cognitive content, promote student participation and active learning. It is important to ensure that the content of multimedia educational resources such as videos is reliable, to avoid confusing the student, due

to the excess of information that circulates on the web, much of this information is not reliable, on the other hand, guarantee that the student learns in a safer way, which is why it is of the utmost importance that the teacher guide the students in how they should use this tool and that the videos are not the only support in the teaching-learning process.

The B-learning system, as already mentioned, emerged as an option for greater coverage in upper secondary and higher education systems where flexible education alternatives were required to: contribute to the professional development of people immersed in the labor market, develop technological competencies of teachers and collaborative work online, transition of learning processes with recognition of new forms of teaching, incorporate the use of ICT in the teaching-learning process and support equity and equal opportunities of education for people who cannot access face-to-face systems (Coronado, 2017). It is a hybrid model that seeks a balanced relationship between face-to-face hours and virtual hours of each academic program (Guzmán and Escudero, 2016). In this way, classes could be resumed following the contingency measures, support the reduction of infections by COVID-19 and, on the other hand, it could favor and increase the performance of the students, because let us not forget that indisputably, after this long period of absence from face-to-face classes, EBA-UAQ students will face a readaptation process when they return to classes in person, by resuming habits, routines, rules, teamwork, etc. In addition to the fact that the presence encourages coexistence between students that allows a better social and affective development. To achieve a correct adaptation of this modality, it is necessary that students have access to the Internet and possess the technological tools for it, in this sense it can be said that the impact of the mixed and distance modality supported by ICT has been positive, according to According to the National Institute of Statistics and Geography (INEGI), there are currently 84.1 million Internet users in Mexico (Figure 1), which represents 78.3% of the urban population and 50.4% of the rural area. For internet users aged 6 and over; 71.3% correspond to women and 72.7% to men, which indicates an increase of 1.9 percentage points compared to the figure registered in 2019, that is, an increase of 70.1%. On the other hand, according to data from the National Survey on the Availability and Use of Information Technologies in Households (ENDUTIH), the three main means of connecting to the Internet in 2020 were: smart phones (Smartphones), laptops, and television with internet access with 96.0%, 33.7% and 22.2% respectively. According to the above, 9 out of 10 cell phone users have a Smartphone, from which they have the possibility of connecting to the Internet and 44.4 million users have a computer, which represents 38.0% of the total population (ENDUTIH , 2019). Analyzing the behavior of the different age groups of the total population, the age group with the highest demand for Internet use is the group of 18 to 24 years with a participation of 90.5%, followed by the group of 12 to 17 years, with 90.2%. , and in last place, are users from 25 to 34 years old, who registered 87.1%. Among the main activities carried out by internet users in 2020 are to communicate with 93.8%, search for information with 91.0% and access social networks with 89.0%. According to the survey, it is estimated that in 2020 there are 21.8 million households that have Internet access, that is, 60.6% of the national total, either through a fixed or mobile connection, which means an increase of 4.2 percentage points with compared to the year 2019. According to this availability of connectivity, of the population with basic education studies, 59.1% connect to the network, where the cell phone represents the technology with the highest national penetration with 86.5 million users in the country; 44.7 million women and 41.8 million men. Among the population that has this type of cell phone, 94.7% use the network connection functionality (INEGI and ENDUTIH, 2020). In the case of the behavior at the entity level of this same indicator, specifically the state of Querétaro stands out as the third city in the country with the highest proportion of households that have an Internet connection with 82%, while the national average is 52%. It is estimated that there are 573,574 homes, of which 318,332, equivalent to 55.5%, have internet, of the 318,332 homes that have internet in Querétaro, 6.3% are located in rural areas (ENDUTIH, 2018). .

6. Conclusions

Today, the world is controlled by technology, therefore, the skills and competencies that are required to know for the management and mastery of ICT are increasing, which poses a challenge for the acquisition of skills. and thinking strategies that allow reaching significant knowledge. On the other hand, the arrival of the COVID-19 pandemic brought with it a series of challenges in the education sector which, little by little, have been overcome; however, these challenges also offer us the possibility of heading towards a new stage in education, replacing the face-to-face modality with a mixed modality, where subjects that are usually challenging, such as Chemistry, could be addressed with strategies that include the use of educational videos and other technological tools that allow the student to build their own knowledge, and in this way, improve the teaching-learning process. According to the population studied, young people were born in a technological and digital communication era, which allows them to easily adapt to the challenges that arise, such as the SARS-COV2 contingency; however, teachers who belong to different generations creating a heterogeneous population for which they require more training to be able to

know different sources of information and technological tools, requiring adequate training for teachers and administrators that allow the implementation of a B-learning model that can cope with states of emergency such as the one represented by COVID-19 and in this way to be able to offer a quality education for an integral development in high school students.

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