Measurement of the Adaptability of Practical Learning Units to the Non-School Modality

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Abstract

More than a year after the changes established in higher education in Mexico in terms of the way of teaching and learning, which arise from the spread of the COVID-19 virus throughout the world, it is necessary to evaluate students and teachers on their adaptation to change, to monitor their ability to adapt to the challenges presented by the non-school modality. In this case, for the practical subjects of the Design and Manufacturing branch of the specialty area of the Industrial Engineering Administrator educational program, since some of these require a physical space and student-facilitator interaction, for example, man-machine and man-tool. A measurement instrument was designed which allowed us to know the level of adaptability of students and teachers in the practical learning units, results were obtained indicating the main challenges of both interest groups, analyzing the results, proposing recommendations and suggestions to improve the teaching, and learning process. The results are presented while the return to face-to-face classes is normalized. Considering that people's health and well-being is the most important thing, the use of interactive software was proposed for these practical subjects, it could be the use of immersive videos, video games and / or augmented reality programs.

Keywords
Practical Subjects, Non-School Modality, Engineering, Adaptability, COVID-19

1. Introduction
Traditionally, classes at the undergraduate level have been held in person; In the last decade, the curriculum of studying the degrees in a non-face-to-face way began to be developed, making use of the online platforms that are at hands reach, although more than 70% of the universities worldwide did not have that plan in development. Currently, changes in the ways of learning have been accelerated using online platforms to develop classes, all due to the health contingency of COVID-19 in the world.

As a result of COVID-19, universities have tried to adapt in the most effective way possible so that students fully benefit from online classes, avoiding risking their lives and that of their families, because, due to Mexico's healthcare system, face-to-face classes were prohibited because they did not want an agglomeration to exist, and the universities were not a source of infection. More than a year after the start of social distancing restrictions in Mexico, the need arises to evaluate the adaptability of educational institutions and their performance to establish optimal online classes so that they are beneficial for students and are carried out as expected with the educational program of each of the subjects. Above all, when it comes to practical subjects, particularly the Design and Manufacturing branch of the specialty area of the Industrial Engineering Administrator educational program, as there are many in the Engineering branch and which are affected by the impediment to being in face-to-face in laboratories, factories, business visits, etc.

1.1 Objectives

The objective of this research is to obtain a broad and clear picture of how the practical classes have been adapted in the digital format, the achievements, the barriers, and to study the adaptability shown by the students and teachers, who have modified the way of operating the teaching-learning process to face this new global situation.

2. Literature Review

According to the research, The Outbreak of the COVID-19 Pandemic and its Social Impact on Education: Were Engineering Teachers Ready to Teach Online?, Víctor Revilla-Cuesta, Marta Skaf, Juan Manuel Varona, Vanesa Ortega López (2021) "the students considered that the explanations of theoretical concepts were more successful during the F2F (Face to Face) teaching, except in the basic units of the course taught in the first years of engineering careers. The reduced learning autonomy of newly enrolled students increased the concern about the explanation of this type of concepts among teachers".

One of the factors that have become problematic is the excess of information and documentation of the knowledge imparted by teachers. This is considered impractical since the students do not finish analyzing the information as they perceive it as a burden, in addition to the fact that the time in front of the computer ends up being a visual fatigue and causes physical and mental fatigue for the students, and the teachers.

How have you tried to improve this situation? Well, according to an analysis The effect of games and simulations on higher education: a systematic literature review, an article by Dimitrios Vlachopoulos, Agoritsa Makri (2017), shows that "the results indicate that games and / or simulations have a positive impact on learning objectives. Researchers identify three learning outcomes when integrating games into the learning process: cognitive, behavioral, and affective. In addition, the authors consolidate evidence for the benefit of academics and higher education professionals interested in the efficient use of games and simulations for educational purposes ". It was established that, as far as possible, implementing 3D programs and simulations helps the cognitive scope of the student to expand, which allows a greater acquisition of knowledge. Furthermore, the research entitled Augmented reality as a tool to enhance interest, adaptability, reflection, and semantics in English language classes by Michael Reyes, Zara Núñez (2020) adds that "the inclusion of ICT in the classroom finds its justification in the strengthening the teaching-learning relationship by including aspects of reality with the support of multimedia tools. This allows students to develop not only basic concepts, but also critical and reflective construction skills that place the student beyond linear learning ".

The fact that the classes are completely through the internet allows students to connect from any electronic device. The study called Peer interaction teaching-learning approaches for effective engagement of students in virtual classroom, by S. Rajalingam, S. Kanagamalliga, N. Karuppiah, Julius Caesar Puoza (2021) conducted on students and staff members of different faculties and universities of engineering in India, Ghana, West Africa, considered engineering disciplines such as Electrical and Electronic Engineering, Mechanical Engineering, Civil Engineering, and Computer Engineering and stated the following: "The use of smartphones and laptops prepares the student to adapt to the e-learning methodology. E-learning during this COVID-19 is stressful as all stakeholders faced an unexpected transition. 25.8% of technical problems, 21.1% of home environment disturbances, and 15.5% of digital literacy is considered as notable challenges to be solved for the adaptability of virtual learning. Access to courses from anywhere and at any time (38.1%) is considered the best benefit in e-learning methodologies. "

3. Methods

The present study was carried out under the methodological approach of the quantitative approach through a descriptive investigation. The research design can be defined as a non-experimental, transactional and descriptive design, from which the measurement instrument design technique was taken through a survey to measure the adaptability of students and teachers, in the face of the change caused by the pandemic that promoted giving way to the online modality, focused mainly on the practical learning units of the fifth and sixth semester of the Industrial Engineer Administrator educational program, which is part of the Design and Manufacturing area of the specialty area of the program taught in the Universidad Autónoma de Nuevo León.

To achieve the objective of this research, a review was first carried out on the practical learning units offered in the career of Industrial Engineer Administrator of the Faculty of Chemical Sciences, later it was necessary to select the area (basic or specialty) and the types of units (mandatory or electives) to determine the participants (students and teachers) who would form our object of study. Two measurement instruments were designed that allow us to collect

data, an instrument applicable to students of the Industrial Engineering career who are taking or have taken the practical learning units, Computer-aided Design (CAD), Machines and Tools, Manufacturing computer-assisted (CAM) during the semesters August 2020-January 2021 and during the current semester February-June 2021, and another applicable instrument for teachers who teach in these learning units during these same semesters that were taught entirely online.

In the academic curriculum of Industrial Engineering and Administration of 2012, it was decided to choose the electives of the specialty area of Design and Manufacturing, which were mentioned previously (CAD, CAM and Machines and Tools) because they are the subjects that are have specialized software for each one, for example, CAD (Computer Aided Design) has Creo Parametric software, which requires a license that the University grants to students so that they can use it within the faculty facilities, for On the other hand, the optional Machines and Tools and Computer Aided Manufacturing is required to be present in the laboratories to make the parts that the teacher orders as evidence, using the CNC lathe together with the codes that would be displayed from the class where the different codes would be taught. that are managed, however, because of the health contingency experienced by COVID-19, the analysis to visualize taking the electives of the area of design and specialized manufacturing through the non-school modality.

4. Data Collection

In Table 1, a table will be displayed with more detailed information on the electives that are the object of this study.

Table 1. Informative table of elective courses

COURSE	PLAN	SEMESTER	CREDITS	SOFTWARES REQUIRED
CAD- Computer Aided Design	2012	5to	3	Creo Parametric
MACHINES AND TOOLS	2012	5to	3	N/A
CAM- Computer Aided Manufacture	2012	6to	2	EdgeCam

First, considering that the previous semester and this semester were taught in non-school mode, the number of students who took these units during the semester August 2020 - January 2021 was obtained, as well as the total number of students belonging to the current semester February - June 2021. Similarly, we were able to obtain the number of professors who taught in these units during the past semester and the current semester.

Subsequently, a measurement instrument was developed, one for the students that covers 24 closed questions and 2 open questions, ranging from general to specific research information. The other, for teachers, covers a total of 20 closed questions and 1 open question, equally constituted from the general to the specific. The students' questions include, from gender, age, semester, if they have access to the internet and their own device to take the virtual classes, as well as questions with a Likert scale to know how they rate the learning of the practical classes, which they consider should be improve in virtual classes, among others. The measurement instrument applied to teachers includes questions such as: age, gender, if they have access to the internet and their own device to teach virtual classes, and in the same way, questions with a Likert scale to know how they rate their adaptation to teaching online, which they consider preparing the material and transform the practical class to virtual mode, among others.

Considering a population of 411 students, the formula for calculating the sample size was taken as a reference. Regarding teachers, the entire population was considered, that is, the 8 teachers who teach the optional practical learning units in the specialty area.

Considering the results of the formula, the measurement instrument was applied in total to 78 students as a sample size for the application of the surveys, taking as a reference a very extended formula that guides the calculation of the sample size for global data, being:

$$n = \frac{k^2 * p * q * N}{[e^2(N-1)] + k^2 * p * q}$$

* Equation 1

Where:
N: It is the size of the population or universe (total number of possible respondents).
k: It is a constant that depends on the level of confidence that we assign. The confidence level indicates the probability that the results of our investigation are true: 95% confidence is the same as saying that we can be wrong with a probability of 5%. The summary can be seen in Table 2:

Table 2. Valores K y sus niveles de confianza

K	1.15	1.28	1.44	1.65	1.96	2	2.58
Confidence level	75%	80%	85%	90%	95%	95.5%	99%

e: It is the desired sampling error. The sampling error is the difference that may exist between the result that we obtain by asking a sample of the population and the one that we would obtain if we asked the total of it.
p: It is the proportion of individuals who have the study characteristic in the population. This data is generally unknown, and it is usually assumed that p = q = 0.5, which is the safest option.
q: It is the proportion of individuals who do not have this characteristic, that is, it is 1-p.
n: It is the size of the sample (number of people surveyed who are going to participate).

Therefore, the calculation of the sample size in students was obtained as follows, where:

N = 411 (total population of IIA students who took these learning units during the semesters of study)
K = 95% = 1.96 (confidence that students answer)
e = 10% p = 0.5 q = 0.5
Solving the equation, we have n = 78 students.

The measurement instrument was created in the Microsoft Forms application and once the sample size of the students was obtained, we set about submitting them. The measurement instrument applicable to teachers was sent through their university emails. While the student measurement instrument was distributed with the help of the teachers of each subject through the Microsoft Teams groups. The application time was 15 days, and a total of 124 responses were obtained from the students.
Once the data collection was finished, an analysis of the information was carried out with the descriptive analysis technique, where we considered the percentages and graphs provided by the Microsoft Forms platform.

5. Results and Discussion

After the application of the measurement instrument was concluded, results were obtained from a total of 124 students and 4 professors of the Industrial Engineer Administrator career of the Faculty of Chemical Sciences at the Autonomous University of Nuevo León, in order to know the adaptability of practical learning units in online mode.
The participating student population was divided into a total of 75 women and 49 men, among which 98% belong to the age range of 19 to 25 years.
While 25% of the students study the subjects during the August 2020- January 2021 period, 75% are currently studying during the February- June 2021 period and are presented distributed by subject in Table 3:

Table 3. Distribution of students by subject based on the period studied.

Period	CAD	CAM	Machines and Tools	Totals
August 2020-January 2021	17	13	1	31
February-June 2021	29	41	23	88
Total	46	54	24	124
Percentage	37.10%	43.55%	19.35%	100%

The participating teacher population was divided into a total of 25% women and 75% men, among which 75% belong to the age range of 31 to 40 years.
In this case, the population is made up of 3 professors who teach Computer Aided Design (CAD), 3 professors who teach Machines and Tools and 2 professors who teach Computer Aided Manufacturing (CAM). The information of the total population was obtained, we only managed to collect the data of 4 teachers. Next, Table 4 shows the distribution of the teacher population by subject:

Table 4. Distribution of the teacher population by subject.

Gender	CAD	CAM	Machines and Tools	Totales
Female	1	0	0	1
Male	2	1	0	3
Totals	3	1	0	4
Percentage	75%	25%	0%	100%

The next part of the measurement instrument collects information on the appropriate conditions, both for a student to take their classes virtually, and for teachers to teach; as they are: having their own device, access, and internet connection, having Technological skills and the right platform. When analyzing the results, 48% of the student population considers that it is "Very accessible" to have their own device to take to virtual classes and 38% that it is "Accessible". On the other hand, only 25% of the teachers consider that it is "moderately accessible" to have their own device. The device that is most used is the laptop, this result comes from both teachers and students.

Like the results about the accessibility of having their own device, students and teachers were asked about how accessible it was to have access and internet connection, the results were again positive since the students consider it to be "Very accessible" or "Accessible"; while the teachers' survey yielded similar results.

Regarding the technological capabilities of the respondents, 39% of the students consider themselves “Very capable” and 56% consider themselves “Capable”. Teachers on the other hand, only 25% of the teachers consider themselves "Capable" and another 25% consider themselves "Moderately capable"

Both teachers and students are "satisfied" with the platform used online.

On the other hand, the sudden change to online mode generated various challenges that need to be addressed; The participants were asked to mark the following challenges from highest to lowest, according to their level of importance: connection problems, student-teacher interaction, low knowledge of technologies, lack of motivation, understanding of content and time management; where 1 is the greatest challenge and 6 is the least. The results are shown in Figure 1.

5.1 Numerical Results

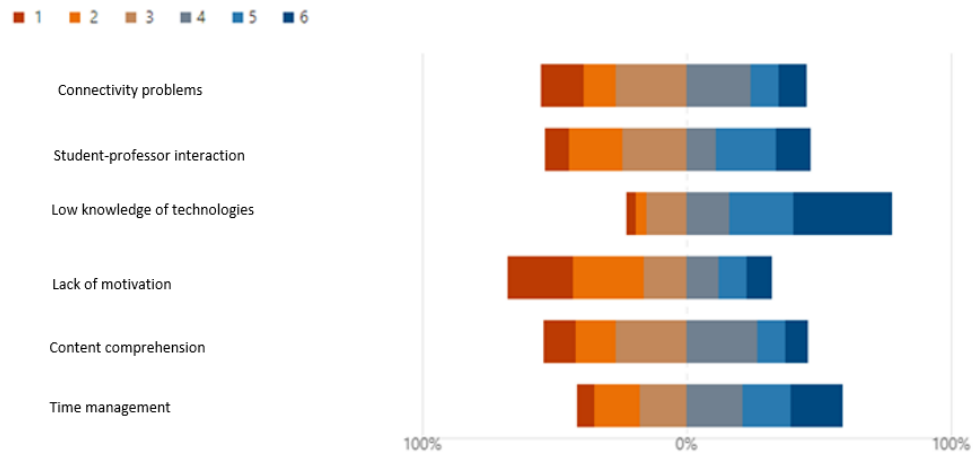

Figure 1. Student Graph on the challenges in the process of transition from face-to-face classes to online classes.

Students considered "lack of motivation" as the biggest challenge in changing modality to virtual mode of practical classes and to "Low knowledge of technologies" as the lesser challenge to face. In turn, the teachers considered the biggest challenge the "student-teacher interaction" and. As the least of these "problems connecting" This information is shown in Figure 2.

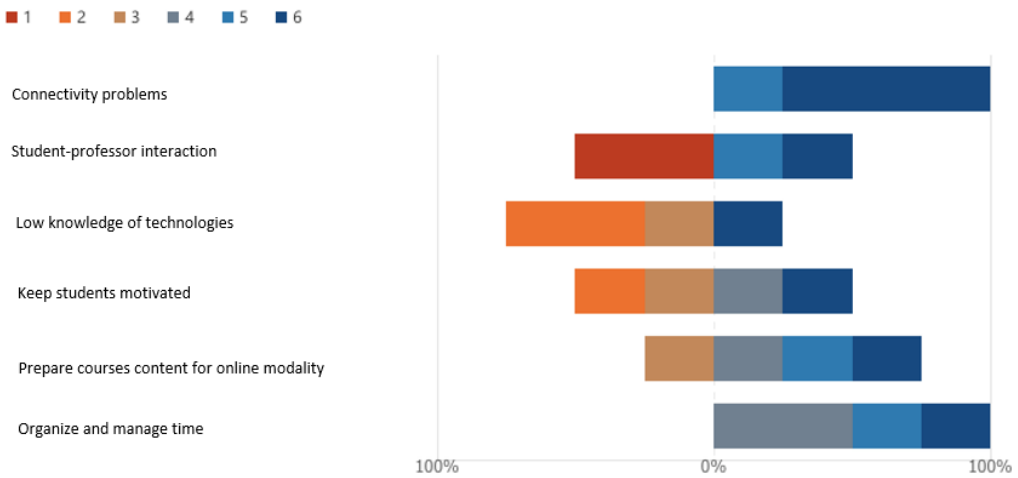

Figure 2. Graph of teachers on the challenges in the process of transition from face-to-face classes to online classes

Faced with the statement "I am satisfied and consider practical classes better compared to face-to-face classes" the students presented a great diversity in their results and it is shown in Figure 3

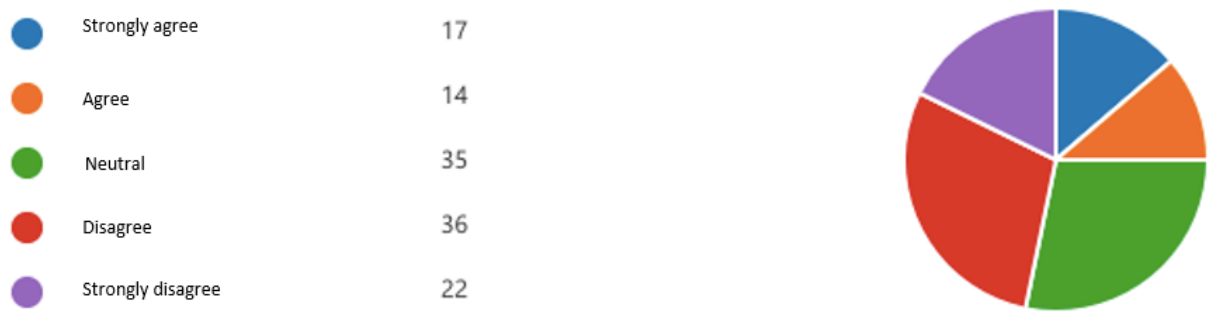

Figure 3. Graph of students on the preference between face-to-face classes and virtual classes.

By observing these results, we can infer that student continue to consider face-to-face classes essential for practical subjects.

Virtual education has certain benefits that motivate students to consider it as an option that they would like to choose. We introduce students to some of the important benefits of virtual classes and the results are shown in Figure 4:

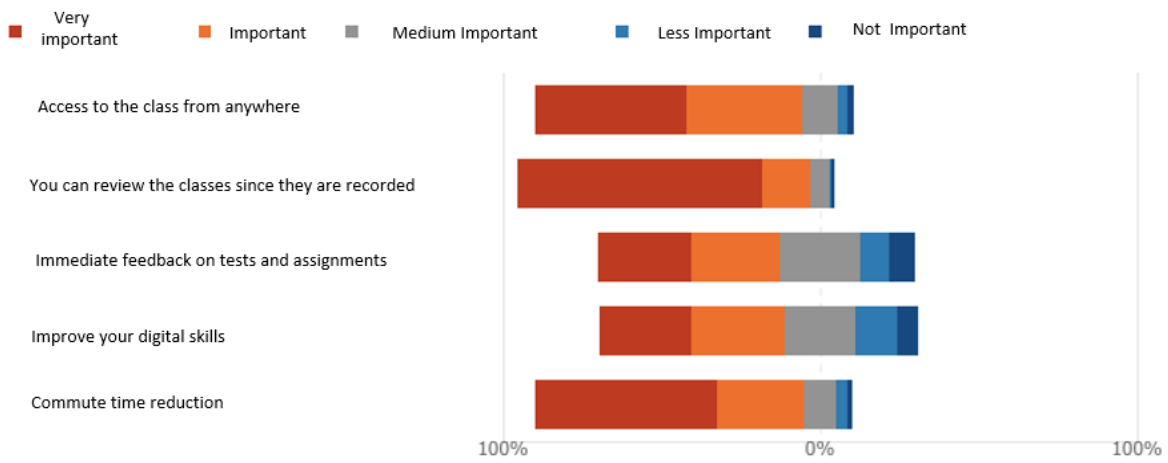

Figure 4. Graph of students on the benefits of virtual classes.

The students consider that “being able to review the classes, they are already recorded” is the most important benefit, followed by “saving time in transfers”. For their part, the teachers responded freely and when classifying their responses, “time management” stands out, since in addition to saving time on transfers, they feel that they have greater control over their personal time.

As we have mentioned, the pandemic shocked the entire world and forced both students and teachers to experience online education. To find out how this experience has been, students and teachers were asked how they would rate the experience of taking practical classes online; 42% of the students who consider they have had a “Good” experience and 31% confirm that their experience has been “Fair”. Meanwhile, the teachers consider that they have had an experience between "Excellent" and "Good".

42% of the students consider that the explanation they have received of the practical subjects is "Good" and 34% consider it "Fair". For its part, it is important to know the adaptation of teachers to online classes, so we asked teachers how they consider the training provided, we found that 50% consider it to have been "Good". Similarly, the teachers consider that their adaptation to the online modality has been "Good".

For teachers to be able to adapt the subject and provide the appropriate material to their students, various aspects must be considered, such as: Agenda, Calendar, Technological resources, Teaching didactics; The teachers were asked to determine which of these aspects they consider the most important in preparing their classes. The results are shown in Figure 5.

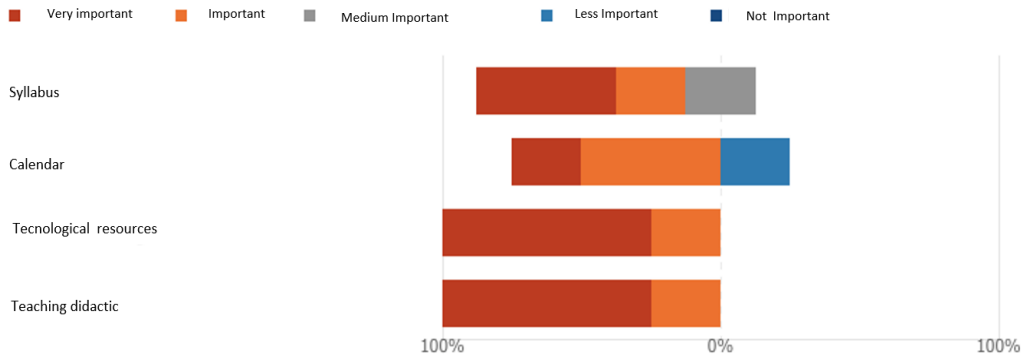

Figure 5. Graph of professors on the aspects to consider preparing the virtual practical classes.

Teachers consider both "technological resources" as the "Didactic teaching" as important points to prepare their practical classes for the virtual mode. We can infer that these aspects are important since 32% of the students consider the material provided by the teachers “Very useful” and 50% consider it “useful”.

The tools that teachers use to teach practical classes virtually shown in Figure 6:

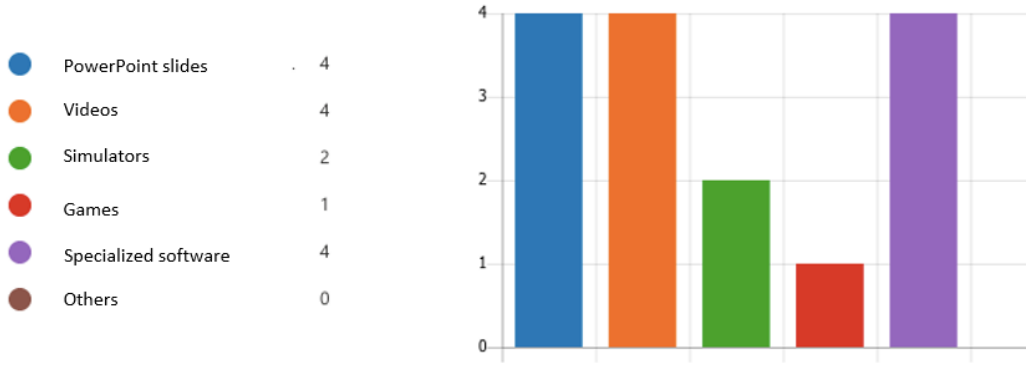

Figure 6: Graph of the tools / resources used by teachers.

While 37% of the students consider “Effective” the learning of the practical units, another 35% consider it “Moderately effective”. According to these results on the effectiveness of learning, in the same way, students are considered "Capable" and "Moderately capable" of implementing what they have learned in a virtual way in real life.

In general, students are "satisfied" with the teaching methods applied by teachers.
For there to be optimal learning, there must be good communication between teacher-student, since the student must feel motivated by the teacher and know that both parties seek to actively participate in the teaching-learning process. Although both students and teachers consider that they have had a "good" interaction during their stay in the virtual mode; for their part, teachers admit that it has been between "Regular" and "Difficult" to evaluate their students. In addition, the 4 teachers participating in the measurement instrument differed in their responses to the question about their perception to capture the student's attention and this is reflected in Figure 7.

Figure 7. Teachers graph on the perception to retain the student's attention.

Although the results of online teaching of practical subjects are favorable, there are still aspects where work must be done. The students were asked what they would like to improve in their practical classes, from the most important to the least important, and the results obtained show us that it is important for the students to improve motivation, as well as for the classes to be more dynamic and attentive. to improve teaching methods. In addition, they were asked about the strategies they would like the teachers to implement in order of importance, with specialized software and simulators being the most important, followed by explanatory videos.

5.3 Proposed Improvements

Although there are institutions that managed some online courses since before the pandemic, the unexpected situation of migrating the courses to the non-school modality, provoked both in students and teachers, a process of gradual adaptation for all in the institutions with an effective response but rather an emergency response and although it has been a year since the schools taught their programs entirely online, they have had more opportunity to know and adapt to the new normal although there is still uncertainty about the future of the classes in virtual mode. Seeking to know if a future is contemplated for online teaching, the teachers were asked if they consider it likely that the online modality will remain as part of the program, to which they consider that there is a possibility that it will remain this way. For their part, the students were also asked whether, if an adequate program of practical classes were designed in a virtual way, they would consider taking it in this modality, 68% answered yes. Giving continuity to the question and opening a possible future investigation, it was decided to allow the students to freely express that they consider that said program should contain; After analyzing the responses, the following classification was made:

- Class time management: Only 6.45% of students consider that it is heavy to spend so many hours in a row in front of the computer, it becomes tedious and even the class can become boring and the student's attention is lost. As well as time must be managed in such a way that it is possible to see the total of topics established during the course.
- Dynamic material: 25% of the students hope that a balance will be achieved between the theoretical part and the practical part to lighten the class load, they want the classes to have explanatory videos, examples or games that motivate the participation of the students. students and in this way enrich their learning by participating actively and not just observing the teacher.
- Working conditions at home: On the other hand, 24.19% of the students think that, if the online class format is maintained, it is necessary to take into consideration that not all students have the same conditions to take the classes, therefore Example: when taking a practical class where it is necessary to work with software, perhaps not all computers have the ability to download it. The software used is expected to be easy to understand.
- Role of the teacher: A total of 30.65% of students consider that teachers should actively participate in seeking the learning of each of their students, since not all learn in the same way, students expect that learning methods are used flexible and have their views taken into consideration. In addition, they seek effective and efficient communication between the student and the teacher, and they also want teachers to seek to motivate students.

Meanwhile, 10.48% insist that face-to-face classes are necessary, since they consider that it is not the same to learn virtually and that the experience generated in the laboratories is necessary.

Finally, we decided to know which subject they recommend taking virtually, the results are shown in Table 5

distributed by gender:

Table 5. Distribution of materials recommended by gender.

Gender	CAD	CAM	Machine and Tools
Female	61	31	18
Male	41	27	14
Totals	102	58	32

6. Conclusion

After analyzing the results, we conclude that the online mode for hands-on learning units is complicated but not impossible. Various suggestions and proposals for improvement aimed at facilitating adaptation in the teaching-learning process of university teachers and students for better academic development are also considered, always ensuring the health and well-being of all during this pandemic.

For example, in some practical matters a type of software, a program augmented reality, video games, among others, in order to meet the challenge of not performing physical practices that incurs the art could be used, whether the Immersive case Videos as in the case of matter Machines and Tools, where you work with lathe spindle, saw, etc., and fundamental part is the use of the 5 senses to better understand the use of these objects.

It will always be a challenge to face what is not contemplated, in this case it was the COVID-19 pandemic. The fact that students and teachers prefer face-to-face classes and that both have gone through a process to adapt to this unexpected change could be considered as the common denominator between both groups. But also, the fact that they all demonstrate the ability to innovate themselves by not allowing themselves to be defeated by the adversities that occur in the non-presential modality, in this case, in the branch of Engineering. Despite the little or low interaction, it has been possible to specify the teaching of these practical subjects without the need to risk health, the entire class being online.

Finally, readers are encouraged to continue acquiring knowledge of emerging technologies and to develop interpersonal skills, which have been rare and necessary throughout this pandemic. Without the certainty, it is visualized that the non-face-to-face modality will be implemented in the future of higher education. With all this, we are confident that humans will continue to adapt to the coming changes that occur in a new educational normally.

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Biographies

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