COVID-19, ICT and taught. A challenge for engineering professors

COVID-19, TIC y enseñanza. Un desafío para profesores de ingeniería

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Abstract

A study is presented with professors and engineering students at a technological institute in Mexico, on the working conditions derived from social confinement by COVID-19. As well as the benefits that students have observed derived from this virtual or distance study modality. Some findings show that 94% of teachers immediately found a technological alternative, motivated by intensive training (71%) and self-learning (64%). The most used resources: written files (87%), video calls (84%), and chat (78%). The students agreed on its importance, but they appreciated the inclusion of recreational resources. Student problems: access to a sufficient and stable internet service, and stress due to various causes. Half of the teachers also had problems with the internet and the students' absences from virtual classes.

Resumen

Se presenta un estudio con profesores y estudiantes de ingeniería en un instituto tecnológico de México, sobre las condiciones de trabajo derivadas del confinamiento social por el COVID-19. Así también sobre los beneficios observados por los estudiantes derivado de esta modalidad de estudio virtual o a distancia. Algunos hallazgos muestran que 94% de los profesores encontraron de forma inmediata una alternativa tecnológica, motivada por la capacitación intensiva (71%) y el autodidactismo (64%). Los recursos más utilizados: archivos escritos (87%), videollamadas (84%), y chat de (78%). Los estudiantes coincidieron en su importancia, pero agradecieron la inclusión de recursos lúdicos. Problemáticas de los estudiantes: acceso a un servicio de internet suficiente y estable, y estrés por diversas causas. La mitad de los profesores también tuvieron problemas con el internet y las ausencias de los estudiantes a clases virtuales.

COVID-19, Professors, Engineering students, ICT

COVID-19, Profesores, Estudiantes de ingeniería, TIC

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Introduction

The COVID-19 pandemic forced education authorities around the world to declare social confinement. In Mexico, activities in schools were suspended from the second half of March 2020 and instructions were issued to design a strategy to reopen activities, a situation that included all educational levels.

Many professors responsible for engineering courses, especially older ones, before the COVID-19 pandemic, had their didactic strategies based on the blackboard and chalk, notes and questionnaires, paper exercises and laboratory practices with experimental equipment. The use of technology in some cases was unthinkable, not even optional.

The attempt to motivate these teachers to study, analyze, evaluate, and apply another variety of didactic resources and platforms for learning management, related to new technologies, although repeated, had not been successful. Teachers considered the use of mobile devices (MD) in the classroom as a distraction in learning.

However, some teachers did work with strategies that included them, at least for communication, through the most common social networks such as Facebook and WhatsApp. These networks have been studied and classified as potentially positive in learning (Hershkovizt and Forkosh-Barush, 2017; Gómez-del-Castillo, 2017; Ahern, Feller and Nagle, 2016; Amry, 2014; Gavilan, Martínez-Navarro, and Fernández-Flores, 2017).

Likewise, other higher education professors were already working in some institutions, with educational platforms that made it possible to institutionalize learning management and unify efforts for the benefit of communities. Before COVID-19, the best known, due to its free access, was Moodle, although Schoology and Claroline also have their free versions, not to mention those that require licenses such as Blackboard.

Because it is the most widespread, Moodle has been studied more consistently (Rodríguez Correa and Rivadulla López, 2015), but it requires constant training of teachers to maintain contact and motivation of students (Hobbs and Tuzel, 2017; Dahlstrom, 2015) since they involve the development of specialized teaching resources for the virtual or distance modality.

At the beginning of the COVID-19 pandemic, the activities within each of the higher education institutions (HEI), public and private, were reorganized according to their internal situation and that of the environment. As in all areas, the uncertainty of the immediate future was wide, and managers tried to achieve minimal compliance with educational programs. The instructions to adjust the teaching-learning conditions and the school calendar were particularized in higher education institutions in Mexico (Malo Álvarez et al., 2020). The semester ended under emergency conditions.

By the second semester of 2020, the HEI had already deployed an intensive teacher training program, preventing a non-return to face-to-face classes. With this, institutional technological resources were chosen to guarantee a certain uniformity in the educational process, some in free access format and others through the acquisition of a license, but all had a means of communication with the students.

However, the need for a resource with video calls for synchronous communication motivated the use of Zoom platform, Google's Meet, Microsoft's Teams, although others continued their work base in those already mentioned, and even in WhatsApp and Facebook.

Professors, and students of the HEI made a series of decisions regarding their technological equipment, the desktop or laptop computer, the tablet or the smart cell phone that had to support the management of the platform established for this purpose. Some teachers decided to invest in cameras and accessories to record their classes, or the acquisition of a smart board to replace their white board in the classroom.

Also, another need was the connectivity of their device, with a service that would allow them to follow the courses, from the most appropriate place possible, in terms of environmental conditions. Which has been one of the most difficult circumstances for students and teachers of HEI in Mexico, since in almost all families there are several members making use of the internet, in small spaces, which complicates participation with an open camera and microphone.

However, according to Soni (2020), the priority during 2020 was to share: written materials in different editable and non-editable formats, thematic images, and videos available on different platforms, internet pages with adequate content, free simulators for different purposes.

At the same time, a change was necessary in the administrative procedures of the HEI, to address the situations of students and teachers, which affected the regularity of a school year. Significant flexibility in school procedures was warranted.

All this unprecedented process forced by COVID-19, has not been trivial for students according to Di Pietro et al. (2020), since it causes great inequalities in cognitive abilities affecting their motivation and emotional well-being. Psychological problems derived from isolation that affect behavior and their cognitive and non-cognitive abilities have short- and long-term consequences that should be studied.

In this sense, the National Technological Institute of Mexico promoted a virtual space on its website for students and teachers of the different campus to give testimony of their initiatives and efforts to continue the educational process during the COVID-19 pandemic (TecNM, 2020).

A year later, in March 2021 the impact continued, with more than four million higher education students in confinement. Meanwhile, various strategies had been generated at the global level to address this situation. COVID-19 had affected everyone, rich and poor countries alike, but the response was mixed.

These situations common to higher education teachers in the world, excluding those dedicated to the virtual or distance modality, have been recovered from supranational perspectives such as the different guides, recommendations, surveys and reports of: the World Bank (World Bank, 2020. 2021), the International Institute for Higher Education in Latin America and the Caribbean of the United Nations Educational, Scientific and Cultural Organization (IESALC, 2020), the International Association of Universities (Marinoni G., 2020), the Carolina Foundation (Pedró, 2020), the European Union (Di Pietro et al., 2020), the Organization for Economic Cooperation and Development (OECD, 2021), and the Organization of Ibero-American States (Sáinz et al., 2021).

But also, under this need generated by COVID-19, the educational process in HEI has been investigated and reported from different angles and perspectives, some personal, others institutional, inter-institutional, national, and regional. In this sense, Pedró (2020) insisted on the documentation of the "pedagogical changes introduced during the crisis and their impacts; in particular, we must pay attention to the negative effects of emergency distance education, the *Coronateaching* syndrome" (p. 13).

The above, because it had already been shown that the quality of the results in education does not have to do with the presence or absence of technology in schools but with the pedagogy adopted and the conditions in which it is applied in the classroom (Pedró, 2016).

Therefore, a comprehensive diagnosis of the situation should include a review of the professional skills of teachers, but also the infrastructure available in HEI to use technological tools, whether they are computer equipment and mobile devices, programs or applications, and connectivity.

Thus, the main actors of the educational process, students, and teachers, must be characterized, but also their context and antecedents related to the use of Information and Communication Technologies (ICT), Learning and Knowledge Technologies (LKT), and mobile devices (MD) specifically. All within the framework of a defined, conscious, and active pedagogical and didactic strategy.

By the way, a deficiency that has been identified in higher education in various countries (Paredes-Chacín et al., 2020; OECD, 2021; Pedró, 2020).

This work presents a diagnosis on the advancement of teacher training in the use of educational technologies, and in the knowledge and use of active pedagogical and didactic strategies for distance or virtual education. Likewise, the perceptions and experiences of students in this compulsory educational modality, both from the technological point of view and the personal-emotional and socio-family.

Development

This work was carried out with engineering students and professors at a public technological institute (ITCM), located in the south of the state of Tamaulipas, northeast of Mexico. ITCM offers 10 engineering programs and 10 postgraduate programs, with 460 professors, and had an enrollment of 7,955 students as of the second semester of 2020.

The comparison of four studies is presented, two carried out in 2017 before COVID-19, and two in 2021, one year after social isolation. In both cases, the student population, and the academic community of the ITCM were concerned.

During 2017, a questionnaire was applied to 356 engineering students to identify the use of MD during their studies. It was a representative sample of ITCM enrollment, stratified by career and gender, which allowed the identification of students' perceptions and habits related to the use of MD in the classroom, the activities of their teachers, and indications of their correlation with the gender and career of the students.

The other study from 2017 was carried out to make a diagnosis with ITCM professors about their digital, informational, and pedagogical competences, and their attitudes towards ICT. Motivational elements of innovation were also sought in the development of new teaching resources (Tapia Cortes, Cardona Torres and Quintero Salazar, 2017; Dahlstrom, 2015).

Four years later, at the end of the first semester of 2021, and after a year of social confinement derived from the COVID-19 pandemic, a questionnaire was applied to students who had two full school semesters under the virtual education modality.

The above to know the response of the students to the question: How was virtual teaching learning in engineering attended under this emergency of the COVID-19 pandemic? But the situation of the teachers was also investigated, how they faced the emergency, what decisions they made and what didactic strategy they adopted to carry out their teaching work.

In the case of the 2021 studies, descriptive and interpretive analyzes were carried out. The tools used were the Microsoft Forms questionnaires and spreadsheets.

Students and MD before COVID-19

At the institutional level, it seemed that the school was left out of this transformation (Pedró, 2016), since the initiatives to use ICT and LKT were deployed in a personal way, and the projects were assumed as challenges for teachers. In particular, the case of engineering programs in Mexico, only 6.7% of teachers used social networks as an educational resource (Castro Romero, 2014).

The previous study with the ITCM students showed that 84% of the students had a smartphone, 72% had a navigation service (Soto Hernández and Vargas Pérez, 2018) and 23% affirmed that three or more teachers from this period school used the MD for their courses.

However, the main use of MD by students was distributed in 93% to keep communicated through social networks and 50.8% for leisure through entertainment channels; while only 23.6% knew and used educational applications, and 16.6% knew virtual platforms for learning management (Soto Hernández and Vargas Pérez, 2018) or Learning Management System (LMS).

On the other hand, the students were asked about the courses where the teachers used the MD. 35% affirmed that the teachers of Mathematics and of the subjects of the race do it. Those who used it the least were Physics and Chemistry teachers (11%), and Social and Administrative Sciences teachers (13%) (Soto Hernández and Vargas Pérez, 2018).

Certain significant statistical differences were also identified between the abilities of men and women to manage MD. The responses showed that the highest deviation values refer to the handling of symbols to represent gestures (emoji), the Cloud as virtual storage space, and device synchronization. These last two are the ones with the lowest average, but there a positive correlation with the male gender was observed. The handling of emojis is positively correlated with the female gender. The other skills in the use of MD -notifications, facilities, camera, and configuration- presented the same distribution between both genders of students, and between students of different engineering programs (Soto Hernández and Vargas Pérez, 2018).

Teachers and ICT before COVID-19

The exploratory diagnostic study, carried out in 2017 with the teachers, was focused on digital, informational, and pedagogical competences, as well as their attitudes towards the use of ICT. It was concluded that teachers in general have a favorable attitude towards ICT in their teaching work (more than 70%), however "it is also possible to affirm that the opinion of teachers is not reflected in their actions, they could be rather intentionalities" (Saldaña García, 2018, p. 207). Samples of willingness to train and update are not discussed.

These indicators showed that ITCM teachers said they were willing and with positive attitudes towards the use of ICT, however, students only reported a maximum of 35% of teachers in some areas as users. Furthermore, just under a quarter of the students in the sample had three or more teachers who used them for their course, for teaching and learning purposes. The efforts of the academies of mathematics teachers, and of the subjects of the races seemed to be advancing, although not to the extent that they said (35% vs 70%). The rest had really lagged technological advances.

However, if this maximum of 35% is compared with the 6.7% of engineering professors in Mexico reported by Castro Romero (2014), it could be said that the situation at the ITCM is not among the lowest in the country.

Another conclusion of the exploratory study by Saldaña García (2018) is that the strategy for "teacher training is not associated with the development of technologies and therefore with their pedagogical application to improve learning" (p. 208).

Use of ICT during COVID-19

Since March 2020, the generalized conditions in Mexico for working remotely with students were carried out in an otherwise irregular and heterogeneous way to conclude the semester that had started.

However, teacher training processes were also generated at the ITCM, so that all had minimal competence. By September 2020, there was already a license to use Microsoft's Teams platform (LMS), as well as a good number of associated applications that would allow ITCM teachers and students to have a robust infrastructure for learning management. However, the acquisition of technological equipment and the internet service were still in charge of the teacher and the student.

ITCM teacher response in 2020

The great challenge for teachers was the adoption of a pedagogical and didactic strategy with which to deal with for a whole semester. With low digital competence in the vast majority of cases, as already mentioned, the difficult thing has been the recognition of the need for a still small change in the variety of resources, but a large one in their teaching routine.

Faced with the emergency of 2020, the response of teachers was perceived as highly diversified: 1) those who learned to use a tablet with a digital whiteboard, almost emulating a face-to-face session using video calls in the LMS; 2) those who worked at home with a white board and with their cell phone transmitted the development during the video call session, or previously recording it to upload it to their virtual group on the LMS; 3) who referred students to videos on the internet or text files, or learned to use other means to generate content, such as Power Point materials that they recorded with sound and placed them in their virtual groups of the LMS and dedicated some sessions synchronous to answer questions about materials; and finally, 4) those who declared themselves incapable of using ICT and requested the official support of a student to manage the educational materials, such as their own digitized notes, and the virtual groups under their responsibility. Among all of them, some of them generated their own version of Flipped Classroom.

A semester later, all the ITCM teachers had already established a virtual or distance work mode at the beginning of the first school term of 2021, which continued under the instruction of social confinement derived from COVID-19.

However, the intensive and extensive training continued focused on the use of technologies for virtual education, with some specific approaches for a certain strategy or technological resource.

For the students, a certain normality was also reached, they already had the equipment and services that they could acquire, they had already deployed their skills to use the applications that the teachers requested, and they had already organized themselves to attend the tasks.

Some with the bare minimum like a smart cell phone and a basic internet that allowed them to follow video calls. In some cases, with many difficulties when being in suburban or rural areas with very limited internet services, which made it difficult for them to attend two parallel activities (such as the teacher's questions and the use of an application to give an appropriate answer).

In other cases, the economic conditions of the students or their family forced them to work during school hours, for which absences were noted to the detriment of cognitive activity. For others, their own health situation or that of their family members also greatly complicated the learning process and meeting the times established by the teacher for teaching.

To identify the situation of teachers and students, beyond a perception in the immediate environment, the 2021 study presented was carried out.

Methodology

An exploratory, descriptive, and qualitative cross-sectional research was carried out at the end of the first school term of 2021. Two questionnaires were used as instruments in Forms, based on the concerns of the students, obtained from various public and private sources, and the observations made to the work of teachers and campus administrators, during the established period, to achieve a triangulation of data. Internal validity and confirmability (Hernández Sampieri, Fernández-Collado, & Baptista Lucio, 2006) was guaranteed with three researchers who reviewed the categorization and interpretations of the responses.

The external validity was confirmed with the readings and analysis of guidelines, reports, and recommendations in published documents. The questionnaires were designed and validated by seven professors from two different departments, to adjust.

Student survey

The questionnaire for students was integrated with 22 questions to retrieve information about teaching work under the virtual modality; 13 of them were multiple choice, five with a Likert scale, and four open. In addition, questions regarding the students' schoolwork conditions were included.

This questionnaire was distributed mainly through ITCM teachers, at the institutional LMS at the end of the courses. Students must have completed the second semester or up to the seventh semester. They had to use their official account to guarantee their identity, so they were not anonymous responses, but they were voluntary.

259 answered questionnaires were received in July and August 2021, with an average time of 40 minutes. The distribution was 48% women and 52% men, 95% of whom were 18 to 21 years old. The engineering programs they studied: 37% Industrial, 27% Chemical, 9% Business Management, 7% Mechanical, 6% Computer Systems, 5% Petroleum, 3% Environmental, 3% Electrical, 2 % Geosciences, and 1% Electronic.

Teacher survey

The objective of the questionnaire for teachers is to identify the didactic strategy assumed, the training programs, and the problems encountered during the time under confinement by COVID-19. It was made up of 15 items: 10 multiple-choice, three on a Likert scale, and two open questions.

This questionnaire was distributed through the institutional mail to all the teachers at the institute, at the beginning of the second school term of 2021. They also had to answer it from their institutional account to guarantee their identity, which also implied that it was voluntary and identifiable.

101 responses were received (22% from the ITCM academic community) of which 44% were women and 56% men. The age distribution: 95% are 31 years or older, but the most frequent ranges are 27% from 41 to 50 years, and 26% from 61 to 70 years.

The distribution by academic area of the courses attended by the professors who answered the questionnaire: 31% Basic Sciences, 31% Chemical Engineering, 14% Electrical and Electronic Engineering, 13% Economic-Administrative Sciences, 9% Earth Sciences, 8% Systems and Computing, 5% Metalworking, and 4% Industrial Engineering.

Regarding their profile, 18% of the teachers in the sample have a doctorate degree, and 56% have a master's degree. Seniority as a professor at the ITCM is distributed as follows: 37% with 31 or more years of service, 14% with 21 to 30 years, 29% with 10 to 20 years, 17% with less than 10 years, and 13% of professors with a temporary appointment.

Results and discussion

This section presents the situation during the COVID-19 pandemic, both for students and teachers, and compares it with the conditions prior to confinement.

Learning and ICT during COVID-19

After almost a year of effort by the ITCM professors to adapt to the new circumstance of the virtual teaching modality, the applied study among students showed that the MD used by the students for their courses were: 77% smartphone cell phone, 69 % laptop, 11% desktop, 2% tablet. 60% of the students used two or more DM.

The geographical location of the students was associated with their place of origin: 71% were in the ITCM location area; 12% in the north of Veracruz State, 3.5% in the east of San Luis Potosí State, and 3.5% in the center of Tamaulipas State. The latter located in smaller population centers and with less infrastructure facilities. Although 10% were also located in places further away from the ITCM.

About ICT

The essential connectivity for their courses came from: internet service at home (93%), mobile internet from cell phone (37%), internet service from their relatives (13%), internet from neighbors or friends (8%). Only 3% eventually went to a cyber-type pay-per-hour internet service, and another 2% obtained it from a public service available in some places.

The students expressed 82% satisfaction with the virtual modality, using ICT and their MD. In general, its biggest complication was the internet service, especially since the institutional Teams LMS is robust and demands a sustained bandwidth that, in many cases, not both students and teachers had. This meant that 58% of the time students were concerned about the sustainability of communication, and perhaps because of this the need to maintain contact with their teachers through private social networks such as WhatsApp.

However, something congruent with the pre-COVID-19 pandemic investigations is that 88% of the students resorted to videos on YouTube when they had doubts about the contents of their courses, while 67% chose to review their notes located in the institutional LMS, 64% reviewed the videos they had of class sessions or those that their teachers had placed in the LMS, 64% asked their friends from the same group, 61% searched Google, 34% contacted the teacher, and 26% asked another person outside the group.

About learning activities

The activities that students did with their teachers during their courses and that they liked the most are shown in Table 1.

#	Activities	Students
1	Online class recordings	66%
2	Videocalls in *Teams*	59%
3	Communication by *WhatsApp*	56%
4	Exams in *Forms*	46%
5	Teacher presentations	44%
6	Notes from the teacher in *Teams*	43%
7	Team presentations	42%
8	Team exams	35%
9	Work in pairs	28%
10	Internships or projects	28%

Table 1 Activities preferred by students

The general use of the tools associated with the institutional Teams LMS was considered very useful by the students (85%). Some resources were already used and were still present: Geogebra (20%) and Khan Academy (7%), but others broke in such as the digital whiteboard (19%), OneNote (13%) and even greetings and messages using emojis (19 %). New activities for this educational level such as quick tests in Kahoot had 26% of the mentions as attractive to them.

Learning activities were diversified with the Teams platform tools such as: tasks in the spaces for it (22%), research (20%), video production (12%), review of the homework at the beginning of class (12%) and evaluate other teams (8%). In this sense, the students considered that learning through these digital applications had been great (49%) and regular (35%). 7.3% expressed that it had been complicated.

The resources used for learning evaluation, the favorites by the students are presented in table 2. As can be seen, the evaluations through exams or Forms questionnaires and those carried out as a team are the best for them. Although, those short and quick exams in Kahoot, which were hardly used before, today have the recognition of the students.

#	Resource	Students
1	Exams in *Forms*	68%
2	Team exams	57%
3	Internships or projects	47%
4	Portfolio of evidence	36%
5	Quick exams in Kahoot	29%
6	Exams in pairs	25%
7	Problem presentations	23%
8	Personal exam in video call	12%

Table 2 Favorite student assessments

About personal situations

When the students needed help, just over half of them (53%) answered questions on their own, but some asked for help from another person as a friend outside the course (49%). Some never asked for help (20%).

Regarding their personal situation - physical or emotional-, half (49%) of the students felt very stressed, 30% suffered from anxiety at times, 22% suffered from depression, and 28% suffered from COVID-19 infection in them themselves or in their family environment.

Some students had to seek professional help due to stress (9%), and 5% underwent medical treatment for various reasons. Just over a third (36%) who answered the questionnaire stated that they had not had health problems.

Teachers and ICT during COVID-19

The first question asked to the teachers in the applied questionnaire referred to their situation at the beginning of the confinement derived from the COVID-19 pandemic, in March 2020. Some teachers found themselves in crisis and could not face the emergency swiftly, for which reason the conclusion of the school year was completely irregular for them (6%) and their students. However, the majority response (89%) was the continuation of their teaching work in virtual or distance format, with what they had or what they had improvised.

SOTO-HERNÁNDEZ, Ana María, CAMERO-BERRONES, Rosa Gabriela and VARGAS-PÉREZ, Laura Silvia. COVID-19, ICT and taught. A challenge for engineering professors. Journal Computer Technology. 2021

Those immediate responses included working with the LMS they already knew, such as Moodle or Schoology, others took the opportunity and recorded their classes in short videos that were uploaded to YouTube. Still others used applications, software, or simulators that they already had for their courses, although the problem arose that the students sometimes did not have the appropriate equipment. By the second semester of 2020, the teachers had already decided on their new teaching strategy and the technological resources they would use.

About ICT

Most of the teachers used more than one device to connect and attend their courses: 85% did it from a laptop, 26% from a computer. desktop and 26% from a smart cell phone, and only 11% from a tablet.

Teachers reported problems with their internet connection were that it was shared with other family members (33%) or that it was very slow (33%), due to power failures (25%), or because they sometimes had to travel to another place to have access (9%). Almost half (47%) said they had no problems with their internet service.

The teachers answered the doubts of their students basically using the group or individual chat of the institutional LMS (91%), although they also used the WhatsApp social network (58%) and email (54%). However, also 28% used personal telephone communications.

About teaching activities

The resources that teachers used the most during the studied period are presented in Table 3.

Even with all the available technology, the document in non-editable format is the most frequent, distributed by various ways, but it is the priority resource of teachers to share content, available in the files folder of Teams. Also, the non-marginal use of other means such as Zoom or WhatsApp to make video calls, although they had the Teams LMS, can only be explained if the problems of an unstable and weak internet service are considered.

#	Resources	Teachers
1	Non-editable files in Teams	87%
2	Video calls in *Teams*	84%
3	Teams Chat	78%
4	Slides presentations	56%
5	Online class recordings	55%
6	Own notes in images	50%
7	YouTube video links	46%
8	WhatsApp Chat	45%
9	Digital board	39%
10	OneNote App	24%
11	Previous class recordings	12%
12	Khan Academy Activities	10%
13	Activities in GeoGebra	10%
14	Teams Escape Room	9%
15	Video calls by other means	9%

Table 3 Resources used by teachers, always or almost always during the first semester of 2021

Students thanked that the teachers presented their class through slides (56%), or their own notes in digital images (50%), and the digital whiteboard (39%), or use the OneNote application in Teams (24%), and previously recorded class (12%). Although also, 10% carried out activities in Geogebra or assigned Khan Academy tasks, which include written documents, explanatory videos, and exercises to assess progress in students' skills.

Table 4 shows the teachers' strategies for learning evaluation. With a frequency ranging from a few times to always, the evaluation is preponderant over individual work with: practices written in the notebook, virtual exams and written, evidence portfolio, and oral exams. Evaluations on collaborative and cooperative work are mainly with presentations in front of the group, and group exams, although to a lesser extent. Also, 17% used recreational activities such as Kahoot for rapid evaluations, a resource that became attractive to students.

Evaluation strategy	Teachers
Practice in the notebook	77%
Exams in *Forms*	74%
Individual written exam	68%
Team exhibitions	62%
Portfolio of evidence	60%
Individual oral exam	35%
Team exam	32%
Quick test in Kahoot	17%
Exam in pairs	12%
Practice with GeoGebra	11%
Exams in Schoology	10%
Others	23%

Table 4 Assessment applied by teachers, always or sometimes, during the first semester of 2021

Article

In the same table 4, the last evaluation item includes the presentation of practices or projects with programming languages and simulators for various subjects, especially specialties. Also, the use of Moodle or Socrative for exams.

About teacher situations

In other types of problems in the courses, the teachers reported as the most important: apathy of the students (44%), lack of commitment or the work of the students (40%), absence of the students in the video calls (37%), high number of students in the groups (21%), and complications to connect to the LMS (20%).

Although also 37% of the teachers had no problems with their courses during the semester

About teacher training

Finally, in relation to the training received by teachers, Table 5 shows the most important ones. It is worth highlighting the importance of the self-taught character in two-thirds of the teachers, and the valuable support provided and received for the third part of the ITCM academics.

Training received	Teachers
Institutional courses (ITCM)	71%
Self-taught	65%
Microsoft courses	59%
Courses taught by the Instituto National Technological Institute of Mexico	54%
Teams diploma	40%
Advice and personal support from ITCM colleagues	33%
Courses at other institutions	18%

Table 5 Training received by teachers

The institutional effort, and of the central authorities, for the intensive and extensive training of teachers is evident with the wide coverage of the courses associated with the license acquired from the Teams platform. An additional element on this is the inclusion of pedagogical aspects in technological training. Students and teachers agree on the benefits of having video calls for class sessions, and their respective recordings.

The Microsoft courses presented a flexible alternative due to the diversity of routes in terms of the subject and the time required. The diploma on the Teams LMS and other associated applications allowed the rethinking and enrichment of teaching strategies focused on the virtual modality. Evidence of this are the resources such as the Escape Rooms for the collaborative work of the students; and the facilities of conducting research and projects using OneNote, for example.

Gratefulness

ITCMAD-15 Academic Team recognizes the cooperation and support of the professors and students who voluntarily answered the questionnaire to carry out this work.

Likewise, they appreciate the authorities of the National Technological Institute of Mexico for the facilities to access the Teams Diploma which strengthened the experience for the design of the instruments used for this research and the interpretation of the responses.

Conclusions

The health emergency conditions due to COVID-19 forced teachers to use ICT, the majority by themselves (94%). Students and teachers agree on the wide satisfaction they have for the LMS platform that the ITCM has. The above provided certainty in the environment for the teaching work, and if anything, rather the teachers complained about the demand for attention from the students throughout the day and the course.

After analyzing the description of the teachers' responses during this time of the COVID-19 pandemic, it is possible to affirm that, as Pedró (2020) said, *Coronateaching* made its appearance at the ITCM. The return to the lost normality was still waiting, but it is not over yet. However, the positive aspects of improvement could be highlighted in the face of the wide gap in digital, informational, and technological competences of most of the teachers, who were hired for the face-to-face modality.

Students recognize the benefits of having the materials and content for their courses, all in the institutional LMS, a situation that was not guaranteed in the face-to-face mode.

Although the students mention that their teachers do not have the flexibility they would like, and that eventually they even take oral exams in a video call, on the other hand they find the exams in teams or in pairs very suitable.

This irruption of so many resources and strategies to carry out teaching activity has no going backwards. The following years will have to define new didactic models from these compulsory experiences. ITCM will have benefited from initiating a new era with a critical mass of professors with experience in this virtual modality.

One of the pending issues to investigate about this great social experiment that the COVID-19 pandemic became, is the evaluation of the deficit in cognitive and non-cognitive skills of students, mentioned by Di Pietro et al. (2020), it will also be a challenge to investigate it. Probably in a couple of years we will have the conditions to do it.

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