*Artículos científicos*

# ¿Cómo cambió la enseñanza-aprendizaje de las asignaturas prácticas en el área de tecnologías de la información con la covid-19?

*How Did the Teaching and Learning of Practical Courses in Information Technology Change with COVID-19?*

*Como o ensino-aprendizagem de disciplinas práticas da área de tecnologia da informação mudou com a covid-19?*

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## Resumen

**Introducción:** Durante la contingencia sanitaria por covid-19, la educación migró hacia ambientes virtuales que permitieron el aislamiento social necesario para evitar la propagación del virus. Para todos hubo un periodo de adaptación a la nueva modalidad. Sin embargo, los docentes y alumnos con asignaturas de laboratorio enfrentaron un reto todavía mayor: el de abordar contenidos prácticos desde la virtualidad, es decir, sin estar físicamente presentes en un laboratorio. **Objetivo:** El presente artículo se sitúa en este contexto con el objetivo de lograr un acercamiento a la caracterización de la enseñanza y aprendizaje de las asignaturas prácticas universitarias en el área de tecnologías en los tiempos de covid-19. **Método:** Se presenta el estudio de caso de una universidad pública mexicana (que por confidencialidad se denominará UNX) en la carrera de licenciatura en Tecnologías de la Información, en donde el trabajo de laboratorio de *hardware* y *software* está implícito en la mayoría de las asignaturas. En esta investigación se realizaron entrevistas en profundidad a cinco profesores y se aplicaron cuestionarios con preguntas abiertas a seis alumnos universitarios del área de tecnologías de la información. Durante el semestre de primavera 2020, los cinco profesores impartieron materias cuyos contenidos implicaban prácticas de laboratorio. Los seis alumnos cursaron esas mismas materias con estos docentes. Ni alumnos ni profesores conocían que la investigación abarcaría ambas perspectivas. En las entrevistas con los docentes se abordaron los siguientes aspectos: contenidos, labor docente, alumnos, dinámica de la clase y modalidad en línea. Los cuestionarios con los alumnos solamente se abordaron los últimos tres aspectos. Para el procesamiento de los datos se utilizó el *software* MAXQDA versión 20. **Resultados:** A pesar de que la mayor parte de los contenidos se pudo cubrir con éxito, hubo temas prácticos que pudieron profundizarse más, y otros que no se abordaron. La comunicación entre profesores y alumnos fue fluida y explícita. Los docentes encontraron muy conveniente la modalidad en línea y coincidieron en que preferirían impartir sus clases de esta manera aun en escenarios futuros, libres de pandemia. En este sentido, aceptaron que su experiencia docente en línea podría mejorar, para lo cual deberían incrementar su planeación y diversificar los formatos de sus sesiones y materiales de clase. Por su parte, los estudiantes coincidieron en que la forma de evaluar y la comunicación con los docentes fueron buenas. Sin embargo, reconocieron áreas de oportunidad y concluyeron que no les gustaría tomar sus clases completamente en línea cuando termine la contingencia por covid-19. **Conclusiones:** La docencia universitaria de las asignaturas prácticas en el área de tecnologías en los tiempos

del covid-19 se realizó de manera virtual en un ambiente de buena comunicación entre docentes y alumnos. Los contenidos, materiales didácticos y forma de impartirlos tuvieron que adaptarse. Tanto alumnos como docentes reconocen que fue una buena experiencia, pero que es susceptible de mejorar todavía más a través del compromiso personal y colectivo de todos los actores involucrados.

**Palabras clave:** aprendizaje en línea, asignaturas de enseñanza profesional, enseñanza superior, epidemia.

## Abstract

**Introduction**: During the health contingency due to COVID-19, education migrated to virtual environments that allowed the necessary social isolation to prevent the spread of the virus. There was a period of adaptation to the new modality for everyone. However, professors and students with lab courses faced an even greater challenge: that of addressing practical content from virtual scenarios, that is, without being physically present in a laboratory. **Objective**: This paper is developed in this context with the objective of achieving an approach to the characterization of the teaching and learning of university practical courses in technologies in the times of COVID-19. **Method:** A case study of a Public Mexican University (named UNX, for confidentiality purposes) and its bachelor's degree in Information Technology, where the hardware and software laboratory work is implicit in most courses is presented. In this research, in-depth interviews were conducted with five professors, and questionnaires with open questions were applied to six university students in Information Technology. During Spring 2020, the five professors taught subjects whose contents involved laboratory practices. The six students studied the same courses with these professors. Neither students nor professors knew that the research would encompass both perspectives. In the interviews with the professors, the following aspects were addressed: course content, teaching work, students, class dynamics and 'online' mode. In the questionnaires with the students, only the last three aspects were addressed. For data processing, MAXQDA version 20 software was used. **Results:** Even though most of the content was covered successfully, there were practical topics that could be deepened further and others that were not addressed. Communication between professors and students was fluid and explicit. The professors found the online mode very convenient and agreed that they would prefer to teach their classes in this way even in future scenarios, free of

pandemics. They accepted that their online teaching experience could improve, for which they should increase their planning and diversify the formats of their sessions and class materials. Students agreed that the evaluations and communication with the professors were good. However, they identified some areas of opportunity and concluded that they would not like to take their classes completely online when the COVID19 contingency ends. **Conclusions:** The university teaching of practical courses in technologies in the times of COVID-19 was carried out virtually in an environment of good communication between professors and students. The contents, learning materials, and the way of teaching had to be adapted. Both students and professors recognize that it was a good experience, but that it is susceptible to further improvement through the personal and collective commitment of all the actors involved.

**Keywords:** electronic learning, vocational training subjects, higher education, epidemics.

## Resumo

Introdução: Durante a contingência de saúde devido ao covid-19, a educação migrou para ambientes virtuais que permitiam o isolamento social necessário para prevenir a propagação do vírus. Para todos houve um período de adaptação à nova modalidade. Porém, professores e alunos com disciplinas de laboratório enfrentaram um desafio ainda maior: o de abordar conteúdos práticos a partir da virtualidade, ou seja, sem estar fisicamente presente em um laboratório. Objetivo: Este artigo se situa neste contexto com o objetivo de abordar a caracterização do ensino e da aprendizagem de disciplinas universitárias práticas na área de tecnologias na época de covid-19. Método: O estudo de caso de uma universidade pública mexicana (que se chamará UNX devido ao sigilo) é apresentado no curso de Bacharelado em Tecnologia da Informação, onde o trabalho do laboratório de hardware e software está implícito na maioria das disciplinas . Nesta pesquisa, foram realizadas entrevistas em profundidade com cinco docentes e aplicados questionários com questões abertas a seis universitários da área de tecnologia da informação. Durante o semestre da primavera de 2020, os cinco professores ministraram disciplinas cujos conteúdos envolviam práticas laboratoriais. Os seis alunos estudaram as mesmas matérias com esses professores. Nem os alunos nem os professores sabiam que a pesquisa abarcaria ambas as perspectivas. Nas entrevistas com os professores foram abordados os seguintes aspectos: conteúdo, trabalho docente, alunos, dinâmica das aulas e modalidade online. Os questionários com os alunos

abordaram apenas os três últimos aspectos. Para o processamento dos dados, foi utilizado o software MAXQDA versão 20. Resultados: Apesar de a maior parte dos conteúdos ter sido abordada com sucesso, houve tópicos práticos que puderam ser explorados mais a fundo e outros que não foram abordados. A comunicação entre professores e alunos era fluida e explícita. Os professores acharam a modalidade online muito conveniente e concordaram que prefeririam ministrar suas aulas dessa forma mesmo em cenários futuros, livres de pandemias. Nesse sentido, aceitaram que sua experiência de ensino online pudesse melhorar, para o que deveriam aumentar seu planejamento e diversificar os formatos de suas sessões e materiais didáticos. Por sua vez, os alunos concordaram que a forma de avaliação e comunicação com os professores foi boa. No entanto, eles reconheceram áreas de oportunidade e concluíram que não gostariam de ter suas aulas totalmente online quando a contingência covid-19 terminar. Conclusões: O ensino universitário de disciplinas práticas na área de tecnologias na época de covid-19 era realizado virtualmente em ambiente de boa comunicação entre professores e alunos. Os conteúdos, materiais didáticos e a forma de transmissão tiveram que ser adaptados. Alunos e professores reconhecem que foi uma boa experiência, mas que pode ser aprimorada por meio do comprometimento pessoal e coletivo de todos os atores envolvidos.

## Introduction

Covid-19 arrived in Mexico in the middle of a school period that seemed normal in its course. However, the consequent health contingency decreed by the authorities on March 14, 2020 forced educational institutions to suspend face-to-face activities, which caused them to have little time to prepare and react. The principals and administrators had to make emergency adaptations in the school calendars and in the strategies to continue with academic life. Likewise, teachers had to adapt their classroom lectures to virtual media with varying levels of difficulty and faced the challenges and stress of working from home in the midst of a pandemic. The students, for their part, were not exempt from facing the challenges of studying from home.

In this scenario of changes, sudden adjustments and new ways of working, the internet emerged as the central element of communication that made it possible for teaching to not be paused indefinitely. Online classes were adopted as the most suitable alternative to continue educational activities. This is how various platforms and modalities began to be implemented in an emergency technological plan that implied serious challenges for institutions, teachers and students of all educational levels. In the specific case of a Mexican public university (which will be called UNX due to confidentiality), there was freedom to use any platform or digital medium at each of its locations. Specifically, in Faculty X Microsoft Teams was adopted as an official learning and communication tool. By explicit direction from the management, the regular class sessions should be held online and live at the official times that had been assigned at the beginning of the semester, when the possible appearance of a pandemic was not yet in sight. This meant that students and teachers would continue to meet on the usual days and times, but now virtually through Microsoft Teams.

Although Office 365 and its tools had been available to students and teachers for free for some time, few of them had used Microsoft Teams. Just in February 2020, an online diploma course had been started for teachers from several universities in which its use was promoted. Several teachers from UNX were studying it when the contingency began. However, his skills remained at the beginning levels. The groups of students that these teachers attended at the university had also had some contact with Microsoft Teams, since the teachers had begun to put into practice what they had learned to fulfill the tasks that the diploma required of them.

At the beginning of the contingency, classes were suspended for a week at UNX with the aim of giving intensive face-to-face Microsoft Teams workshops aimed at all faculty teachers. In these training sessions, the basic topics of team building, chat use, start, end and recording of live sessions were addressed, as well as scheduling of sessions on the calendar and file sharing. That is how the following week all classes were resumed online through Microsoft Teams.

For teachers and students there was an adaptation period and a learning curve to the new modality. However, those who taught or took practical subjects had an even greater challenge: that of addressing practical content without being physically present in a laboratory. Perhaps the most representative case of this scenario at UNX is in the Information Technology degree, since laboratory work is implicit in most of the subjects of this educational program.

This article, therefore, is situated precisely in this context with the aim of achieving an approach to the characterization of university teaching of practical subjects in the area of technologies in the times of covid-19.

Microsoft Teams is a technological platform included in Office 365 in which virtual class teams and discussion channels can be created. It is also possible to assign and review tasks, apply exams, share educational resources such as documents in various formats, videos, tutorials and presentations. One of the main advantages of this platform is that it allows students and teachers to interact virtually in real time. In addition, the sessions can be recorded in the Stream application to be consulted later. This platform offers functionalities that are of great help for the academic environment, as it favors ubiquity in the teaching-learning process. Teams works on desktops and laptops, as well as cell phones and tablets with Android or iOs operating systems.

Students have been found to have adopted Microsoft Teams quickly despite concerns that the opposite would occur (Hodgson and Hagan, 2020). There is also reference in the literature that Microsoft Teams has been implemented to revitalize the training of working students. This is because it has been found that, when using it, students are more productive and informed and that their lives have been facilitated by having the tools they require (Belvin, 2018). Teams has also been used to share educational resources online (Halstead-Nussloch, Dickson, Greer, Siddiqui, and Tumuluri, 2019) and to bring the face-to-face campus experience to online classes (Owens, Weismann, and Suskin, 2019). On the other hand, during the pandemic, Microsoft Teams has been used for educational purposes (Pather et al., 2020; Sinha, Sharma and Cullen, 2020; Tofade and Daftary, 2020) and for telemedicine (Ghosh, Gupta and Misra, 2020; Price et al., 2020).

According to the work of Haleem, Javaid, Vaishya, and Deshmukh (2020), covid-19 is giving new importance to several areas of academic research. Some of them are social phenomena, the emergence of a new workplace and a new work culture, as well as the information technology revolution. In this last area, Haleem et al. (2020) highlight new ways of learning, online classes and the use of virtual laboratories through video and other support materials.

Medical education has been identified as an eminently practical and face-to-face area that has been affected by the health contingency of covid-19 (Ferrario et al., 2020; Panesar et al., 2020). In this sense, Ferrario et al. (2020) provide four recommendations that, when generalized, could well be useful for any other area of practical knowledge: 1) safety comes

first, so the presence of non-essential personnel, as well as physical contact, should be reduced, 2 ) strengthen the use of technologies through online classes, recordings, video conferences, weekly extracurricular clubs and simulators, 3) motivate students to use their free time to read, study and increase their academic production with the daily support of their tutors or teachers, and 4) provide psychological support to students.

Ping, Fudong, and Zheng (2020) highlight some problems that arise in the online modality as a substitute for face-to-face education in times of covid-19: it is difficult for teachers to know if students are paying attention or loafing. Some students may not be able to ask questions if they don't understand something, and students also require self-discipline, which can be difficult for them to achieve. In this way, Ping, Fudong and Zheng (2020) propose problem-based learning as an effective method for online teaching, especially at the university level and in the area of technologies. There are three stages to this approach: autonomous student learning, live virtual encounters, and online exercises. The central idea is to teach using problems and questions. In this process, the teacher can guide the students, jointly solve problems with them, or let them solve them themselves.

For Feng, Yu, Hu and Fan (2020), teachers, in addition to facing the challenges of knowing how to use the new software to teach their classes, have to convert their learning materials into electronic versions and adjust the pace of the class. All this without taking into account the stress that the lack of response from students when interacting with them can cause them. On the other hand, they point out that, as online teaching is completely different from face-to-face teaching, universities must establish strategies to support this process. For example, it is advisable to have a team for supervision, support, quality and control of online classes. Likewise, it is important to choose an efficient platform with the necessary functionalities to provide virtual education. Teachers also need to be trained to make the most of the platform used, design learning plans, and adopt diversified and flexible methods to organize teaching. Finally, these authors point out that it is important to analyze the results of the experience and carry out the evaluations and derived actions that are pertinent.

For its part, after analyzing the effects of covid-19 in daily activities, Cerf (2020) mentions that the internet and the Web, videoconferences, collaboration tools, email and social networks are the main means for business, social interaction and entertainment during the pandemic. Subsequently, it is questioned whether in post-COVID-19 society, distance work and academic activities will become more common and even preferred by people instead of face-to-face ones.

It is clear that the appearance of covid-19 has modified much of human activity and has given way to new interactions that need to be studied. It is also true that there are many questions that have arisen and remain to be answered. Specifically, in the educational field, it is relevant to know how the teaching-learning processes have been carried out during the pandemic. In this way, it will be possible to better understand them and prepare future scenarios where the areas of opportunity that are detected can be strengthened.

This article, therefore, presents an investigation carried out with the objective of achieving an approach to the characterization of the teaching and learning of practical university subjects in the area of information technologies in the times of covid-19. The rest of this document is organized as follows: the method followed is presented below, the results and their discussion are subsequently shown, and finally the conclusions and future work are addressed.

# Method

## Type of study

A qualitative approach was used where in-depth interviews were conducted with five university professors in the area of information technology. During the spring semester 2020, the five taught subjects whose contents involved laboratory practices. Six students from this same area also participated, taking these same subjects with the teachers interviewed.

First, each of the participating professors was contacted to schedule an individual and virtual appointment through the Microsoft Teams platform. At the time of the meeting, each one was explained the purpose of the interview and their authorization to be part of this study was requested. The five interviews with the teachers were recorded and produced video material of 198.20 minutes in total. The six participating students were contacted through WhatsApp and / or through Microsoft Teams, and they were explained what their participation would consist of. Once they accepted, they were provided a link to a questionnaire containing open questions, which they answered through the Google Forms platform. In some cases, the students were contacted again by WhatsApp or by Teams to clarify or expand some answers.

**Profile of the interviewees and the practical subjects in which they participated during the health contingency**

Five teachers participated, who were identified with the codes D1 to D5. Table 1 shows the practical subjects and the contents that each one taught during the spring semester of 2020.

**Tabla 1.** Perfil de los profesores participantes y de las asignaturas prácticas que impartieron

| Docentes entrevistados | Antigüedad (en años) como docente en la UNX | Asignaturas con contenidos prácticos de laboratorio impartidas en el semestre de primavera 2020 | Contenidos prácticos de laboratorio que aborda la asignatura |
|---|---|---|---|
| D1 | 19 | Fundamentos de la informática y metodología de la programación | Programación por lotes (Batch) |
| | | Seguridad e integridad de redes | *Software* de encriptación, estenografía y otras herramientas de seguridad. |
| | | Sistemas operativos cliente | Virtual Box para instalar los sistemas operativos |
| | | Implantación y configuración de redes | Práctica con *routers*, antenas y Cisco Packet Tracer |
| D2 | 19 | Diseño de base de datos | Microsoft Access |
| D3 | 1 | Programación intermedia | C# |
| D4 | 1 | Programación intermedia-avanzada | Angular |
| | | Desarrollo de bases de datos avanzado | Benchmark |
| D5 | 24 | Mantenimiento de equipo de cómputo | Prácticas de ensamble, diagnóstico y mantenimiento de *hardware* |

Fuente: Elaboración propia

Six students also took part, taking exactly the same subjects taught by the teachers interviewed. The students were identified with the codes E1 to E6. Table 2 shows their profiles.

**Tabla 2.** Perfil de los estudiantes participantes

| Estudiantes entrevistados | Semestre que cursaron durante primavera 2020 | Asignaturas con contenidos prácticos de laboratorio que cursaron en el semestre de primavera 2020 |
|---|---|---|
| E1 | 1 | Fundamentos de la informática y metodología de la programación |
| E2 | 2 | Mantenimiento de equipo de cómputo |
| E3 | 3 | Sistemas operativos cliente <br> Programación intermedia |
| E4 | 4 | Diseño de base de datos <br> Programación intermedia-avanzada |
| E5 | 6 | Implantación y configuración de redes <br> Desarrollo de bases de datos avanzado |
| E6 | 8 | Seguridad e integridad de redes |

Fuente: Elaboración propia

## The interview

The interview with the teachers addressed all the aspects that are presented in table 3. The open questions that the students answered only included items 3, 4 and 5 of this same table.

**Tabla 3.** Aspectos relacionados con la contingencia por covid-19 abordados en las entrevistas

| Tema | Aspectos investigados |
|---|---|
| 1. Contenidos | Ajustes al contenido de las asignaturas en alcance y en profundidad. |
| 2. Profesores y su labor docente | Entorno del profesor, retos que enfrentaron los docentes, sentimiento ante las clases en línea. |
| 3. Dinámica de la clase | Dinámica de las sesiones y de las evaluaciones. |
| 4. Alumnos | Comunicación maestro-alumno, solución de dudas, retos que enfrentaron los alumnos. |
| 5. Modalidad en línea | Ventajas y desventajas de las asignaturas prácticas en línea, disposición para seguir impartiendo/cursando clase de esta manera y formas de mejorar la experiencia vivida. |

Fuente: Elaboración propia

The duration in minutes of the interviews with each teacher was as follows: D1 (40.03), D2 (47.29), D3 (35.58), D4 (31.25) y D5 (44.05).

## Analysis of data

The interviews with the teachers were entered and transcribed in the MaxQDA 20 software, where the corresponding codings were carried out and categories were extracted through which the results are presented. Student responses to open-ended questions were also entered into MaxQDA 20 in Microsoft Word documents. A summary table was created in the software to collect the central points. This summary was exported to Excel and used to structure the responses obtained.

# Results

## Contents

The teachers used PowerPoint presentations (D1, D2, D4), electronic books (D2, D3, D5), videos (D2, D4, D5) and internet sites (D3) as didactic material during the contingency. Although in some subjects the time was perfectly enough to meet the objectives - databases (D5), database design (D2), network security and integrity (D1), network implementation (D1) -, in other subjects it was adjustments are necessary according to each subject (table 4).

**Tabla 4.** Asignaturas y ajustes realizados en sus contenidos durante la contingencia sanitaria

| Asignatura | Ajustes |
|---|---|
| Fundamentos de la informática y metodología de la programación | Se comenzaron los temas, pero faltó profundizar más. |
| Sistemas operativos cliente | Faltó práctica de Linux. Se cubrió el tema teóricamente. |
| Programación intermedia | Faltó práctica en el acceso a base de datos con C#. Se cubrió el tema superficialmente. |
| Programación intermedia avanzada | Faltó práctica en el tema de conexiones a bases de datos. |
| Mantenimiento de equipo de cómputo | Faltó hacer prácticas de laboratorio, instalación y mantenimiento. No se abordó el tema de dispositivos de comunicación. |

Fuente: Elaboración propia

In this regard, D4 commented that "I removed one exam and unified it with another (…). I also used the week before the online classes started for the students to install the software we were going to use ". D2 expressed: "I thought that maybe we would not have enough time. But (due to) having the classes online (…) we were not interrupted on class days. In person, there is always an event or activity that students have to attend and that delays the program. On this occasion, on the contrary, we had most of the sessions. There was no interruption in class days (…). We had the opportunity to do more exercises".

## Teachers and their teaching work

### What was the environment like for the teachers who taught practical subjects?

All the teachers interviewed had a computer and a cell phone while working from home. Although Microsoft Teams can run on both devices, teachers always used their computer to join their virtual sessions. The cell phone was used mainly to respond to the chat messages that the students sent them after the class session. Only one of the teachers (D1) used the cell phone to enter his session due to a connection problem. However, he only did it to commission a task, so he quickly logged out. The five teachers interviewed had internet at home with the following speeds: 1, 10, 20, 25 and 40 Mb, and none reported serious problems with their connection. They only reported having technical problems related to the internet or accessing the platform on a maximum of two occasions. In order to fulfill his teaching, no professor faced serious challenges due to his family environment. However, two of them had to organize their time and space with their children to carry out their teaching (D2, D5). This was because the children of these teachers also took classes online at the same time that they taught their class from home. The other three teachers already had a space adapted to work.

### What challenges did the teachers face and how did they solve them?

One of the main teaching challenges was related to the students. On this, D4 commented:

> At first I was uncertain. I was concerned because through a small survey I asked my students which modality they preferred and almost 100% answered "face-to-face". Talking to them, they told me that the teachers asked them for more work online, that they didn't let them rest. I was worried that they would

stick with that image from online classes. I would tell them, "This is a contingency process and there are many areas of opportunity." The teachers did not coordinate and there were things that were not discussed. It was a challenge for me not to have the visibility of how we were all working. I was worried about the reaction of the kids (…). Another challenge was answering questions through chat. There was a time when they wrote to me all the time.

D3 also cared about the students:

The first challenge was to get the boys' attention. When I'm in the living room (physically) I'm seeing who at least gives you a glance, who's downstairs. Online how am I going to understand that they are absorbing what I am commenting on? It was very difficult to let go of that responsibility, because it is an adventure. Another challenge was finding a way that empathy did not become an accomplice of irresponsibility. I had an experience with a student who told me: "Professor, I'm going to go to lunch, but I'll be back right now." Another student told me: "(At my job) they changed my schedule due to the contingency. I come in at seven and I go out at three and I can't connect to class. '".

D2 also commented:

Sometimes I couldn't tell if the student was understanding what I wanted to say. Although you can share the screen and almost take it by the hand, there are some distractors that the boys have and cannot capture (…). At the time of teaching and being connected with the boys, at first there was a little bit that they wanted to take it to play.

D2 also referred to the technical and time problems:

Another situation was the difficulty when evaluating or reviewing the exams. They sent it to me in a version that I couldn't open. The platform was taking too long to load tests and student work. The fact that the boys complained that they couldn't send him out there was very recurrent. Also the times. For the practical exam there is a certain time and with these situations you could not adjust to that time.

For D1, the main challenge was the preparation of the topics:

> It was a challenge to adjust the contents. The new songs were not prepared to give them virtually (…). I explained a topic to them in person and we put it into practice (…). Online I had to create new content and adapt others, (…) since I was not going to be accompanying them (the students).

For D5, his main challenge was the realization of hardware practices: "Practices (equipment maintenance) we could not do much. We address questions, observations, and reminders. We couldn't do anything practical. "

Teachers faced these challenges with their creativity and the use of the Microsoft Teams tool, through which they could interact with students either in virtual sessions or through chat. D4 had "to set a schedule for attending to students." One strategy that D3 implemented was "to involve students, committing them to participate and taking lists at different times". For D2 it was very important to "be tolerant" and implemented an alternative strategy of sending tasks "by chat or by e-mail" when there were problems with the platform. He also "established rules with the students" and configured the virtual class sessions "so that the students could not take their classmates out or were playing". For its part, D5 showed them "photos or videos (…) about pieces of hardware and procedures with them". D1 used "simulator software" and "prepared some new learning materials".

## How did the teachers feel about the challenge of teaching practical subjects online?

Uncertainty was the common sentiment among teachers. For D4 "at first it was a challenge due to the preparation of the material, which was ready to be exhibited in person (…). I felt a bit lost for not knowing how my students were progressing (…). Then I felt very comfortable. I saw it as an opportunity to do a real practice of what I had learned from Teams ". D5 agreed: "At first, not knowing the platform (made me feel) uncertain, with ignorance. Then happy to live the experience ". For D3 also "it was a challenge, an uncertainty about the situation, for the students". D2 was "mortified by the pandemic and also concerned that at first the students took a bit of play on the online sessions."

## Dynamic

### What were the class sessions like?

The teachers said that their online classes mainly involved theoretical elements and practical demonstrations. The "desktop sharing" functionality was used to explain step-by-step procedures. Table 5 summarizes the subjects and the dynamics of their sessions.

**Tabla 5.** Asignaturas y su dinámica en las sesiones de clase de acuerdo con los docentes

| Asignatura | Dinámica |
|---|---|
| Fundamentos de la informática y metodología de la programación | "Exponía un tema introductorio, se planteaba un problema para que lo diseñaran, lo resolvieran y lo implementaran durante la sesión. Ellos iban enviando los archivos y se les daba retroalimentación". |
| Implementación de redes | "Utilizaba presentaciones Power Point como apoyo (…) para reforzar la teoría. Las prácticas se llevaron a cabo a través de un simulador de redes en donde los alumnos veían la forma de agregar y configurar dispositivos. Durante la sesión, replicaban la actividad y aclaraban dudas en el momento". |
| Seguridad e integridad de redes | "Explicaba un tema, se les mostraba un *software* para descargar y hacer una práctica. Ellos lo replicaban (…). Si había un ejercicio para entregar, ellos lo resolvían y lo enviaban a través de la herramienta Teams". |
| Sistemas operativos cliente | "Usamos un *software* de virtualización. Yo les explicaba a través de demostraciones y ellos lo replicaban". |
| Bases de datos | "Se les dejaba un proyecto para desarrollar, se iban revisando avances, se hacían ejercicios prácticos y se daban explicaciones acerca de los resultados obtenidos y el procedimiento aplicado (…). Había videotutoriales y demostraciones en vivo". |
| Programación intermedia | "Se exponía un tema o la técnica de manera teórica. Luego explicaba un diagrama de flujo, la codificación y se dejaban problemas propuestos (…), los alumnos hacían presentaciones del trabajo individual". |
| Programación intermedia avanzada | "Dejaba unos minutos de tolerancia al inicio de la sesión, luego pasaba lista y hacía una presentación teórica y después la práctica (…). Compartía el escritorio (…). Había mucha demostración, pero alternaba lo teórico y lo práctico". |
| Mantenimiento de equipo de cómputo | "Se hacían presentaciones en Power Point por parte de alumnos o del maestro. Posteriormente se les dejaban tareas para hacer o videos demostrativos para ver". |

Fuente: Elaboración propia

The students agreed with what was stated by the teachers. "First they explained to us with slides or documents, then they put us through practices and exercises to carry out and then send them to qualify" (E1). "Through the shared screen we could follow the exercises

that the teacher taught us" (E3). "The class was explained and we were assigned different exercises that we had to develop" (E5).

## How was the evaluation of the course?

For the dynamics of the assessment, D2 applied multiple-choice theoretical exams and practical exams. Both had to be answered during the class session and the students had a short time to answer them. For D3, the evaluations were practical and consisted of the development of a program in a maximum of one hour, within the class session. D4 also took theoretical exams, but, on the contrary, the students answered them outside of class time. D4 redesigned its exams so that the questions were not so obvious in their answer, but instead showed applied cases that required some reasoning. D5 evaluated the course only with the activities carried out throughout the course. He decided this because before the contingency started, the group had already solved an exam.

The students, for their part, expressed that the evaluation of their practical subjects was good and that it did not vary compared to the face-to-face modality. "Practically (it was) in the same way as in the face-to-face mode" (E1). "It was a good evaluation, since both class work, homework and, of course, exams were taken into account" (E2). "It went pretty well for me. The way of evaluating the face-to-face did not vary much "(E6).

## Students

### How was the teacher-student communication?

The five teachers interviewed agreed that communication through Teams was good, "quite fluid" (D1), "very open, I was always available to them (…), I insisted a lot that they communicate" (D3), " very fluent, (the students were) explicit in their messages, their confidence increased and they had no limits "(D4)," excellent and with the confidence to say if they have doubts or needs "(D5). D2 deepened: "(The students) sent me many messages and I answered them at the same time, even until late at night."

The students also agreed that communication with their teachers was good: "(The teachers) were aware that we could understand things" (E2). "(The communication was) good. It's something more personal and confident, so I think it's great "(E3). "(The communication was) good, normal, more personal compared to when it is face-to-face" (E4).

## How were the students' doubts resolved?

During the class sessions there was feedback on the practices (D1), but also solution of doubts (D3, D4), which could be expressed by chat or through the microphone (D4, D5). Another means of solving doubts was through the "screen sharing" functionality, "they shared their desk and debate was opened to the whole class" (D3), "(I) shared my screen and did the procedure step by step (…); if they did not capture, they shared their screen and I was telling them the procedure step by step "(D2). Doubts could arise in class or outside of it. However, they were manifested and fixed mainly through the Teams tool. "In the Advanced Database they asked many questions (…). There are recorded sessions where almost all the time they are questions (…). In the case of programming, they hardly asked during class and then they sent me all their doubts by chat, exceptionally by WhatsApp "(D4). "The students did not use email. They preferred the chat. The solution of doubts outside of class was through chat "(D1). In addition to the isolated questions, D2 and D4 gave more extensive counseling sessions. "I gave a student personalized advice and I dedicated a lot of time to her" (D4). "I gave two virtual sessions for special advice through Teams" (D2).

The students highlighted that the Teams chat was very useful to express and clarify their doubts (E3, E4, E5, E6). Furthermore, not everything was asked of the teacher: "I didn't go to them (the teachers) so much. I preferred to search for information through my means, on the internet, to answer my questions "(E2).

## What challenges did the students face?

The teachers agreed that the main challenges faced by the students were the lack of computers to join the sessions and do the practices, as well as the lack of internet connection. "In the group of fundamentals of computer science and programming methodology (of the first semester) there were always many connectivity problems and many students did not have laptops. Others connected through mobile phones "(D1). "Many students did not have a microphone" (D4, D5). Family or work situations were also a challenge for some students. "The wife of a student had a baby and she had to be absent for some sessions" (D4). "Some students who worked in the afternoon had to attend their work in the morning, because due to the contingency they changed their schedule" (D3, D4).

For their part, the students reported mostly technical problems: "Sometimes the internet didn't work well and it got very slow and affected the communication I had with the

teacher. In other cases, the computer took a long time to upload the exercises "(E1). "Sometimes the internet was cut off and the session practically closed for me" (E2). "The platform did not work as it should and sometimes my camera did not." (E4). "I had connection problems" (E5). "I was without internet for several days, so I missed several classes. Fortunately, I was able to talk to the teachers about it and it did not happen to adults "(E6).

# Online mode

## What advantages do teachers perceive over teaching practical subjects online?

The five teachers expressed their opinions on the advantages they perceive from the online modality. This question was open and no answer was suggested. Table 6 summarizes everyone's comments.

**Tabla 6.** Ventajas de la modalidad en línea que fueron percibidas por los docentes

| Ventajas percibidas | D1 | D2 | D3 | D4 | D5 |
|---|---|---|---|---|---|
| Me resulta más práctico / cómodo | ✓ | | | ✓ | |
| No hay necesidad de trasladarse físicamente al campus | ✓ | | | ✓ | |
| Es posible estar más al pendiente de la comunicación con los alumnos | | ✓ | | | ✓ |
| Sin tantos distractores como en las sesiones presenciales | | ✓ | ✓ | ✓ | |
| Se ahorra tiempo | | | ✓ | | |
| Es posible usar más herramientas tecnológicas | | | ✓ | | ✓ |
| Es más conveniente para complementar la docencia con otras actividades personales | | | | ✓ | |
| Es posible grabar las sesiones y verlas posteriormente | | | | ✓ | |
| Se comparte contenido digital con mayor facilidad | | | | ✓ | ✓ |

Fuente: Elaboración propia

## How satisfied are the students with the online modality?

The students were very measured in their responses and showed an average level of satisfaction. None were highly satisfied or dissatisfied. Some comments were: "The class teaching was adequate" (E2). "Regarding the classes, I have no complaints. Only a little unsatisfied by the problems of the application "(E4). "The normal. It was a good experience "(E3). "I would say normal. It was not something spectacular or disappointing "(E5). "Satisfied. Just enough. It was a new experience, but until then "(E6).

**What are the perceived disadvantages of teaching practical subjects online?**

The common response from teachers was that the main disadvantage is that it requires internet access and at least one computer to connect. It was reflected on the fact that some students do not have economic resources to acquire the necessary equipment (D3) and on the inability of local internet providers to offer continuous high-speed access in different geographical areas, especially when there are many connected users (D3 , D4). Also, two interviewees specifically commented on the disadvantages of having to teach online classes without anticipating it well in advance. In this regard, D4 highlighted the apathy that students may have for taking classes online when they were originally planned to be face-to-face. D5 highlighted that the surprising start of online classes prevented teachers from having prior preparation both in their training and in the use of technological learning tools.

Some students agreed on the technical aspects: "The biggest disadvantage was with the internet, since I was left without a connection for several days and could not enter classes, then I would lose exhibitions or be late in work and sometimes it was difficult for me to understand" (E6 ). "Sometimes the audio failed and since I couldn't hear well, I fell asleep" (E4). Others specifically commented on attention: "Not all (the students) paid attention (to the class) or did not learn at all" (E1). "Willpower is required much more, since being at home one is distracted by practically anything and stops paying attention to what the teacher is teaching" (E2).

**Would teachers be willing to continue teaching online and students to continue taking their subjects online when the pandemic is over?**

The five teachers interviewed said that they would be willing to teach practical subjects online, even if there was no longer a contingency, having prepared content (D1, D4, D5) and video materials (D5), as well as time to prepare them (D1, D4) . D3 said this modality "would help manage large groups at the university." For D2 "it could be complex to match the schedules of virtual and face-to-face subjects (…) if the format of the virtual subjects implied connecting live at certain times (as on this occasion)". He referred to this because on the physical campus of the university a good internet connection and a space with privacy are resources that are not easily available at any time.

The case of the students was different. Most of the interviewees would opt for the face-to-face modality (E4, E6). "Although the Microsoft Teams tool offers very good tools

for both students and teachers, honestly, if it were up to my decision, I prefer to continue with the face-to-face format" (E1). "I continue to favor the face-to-face modality" (E5). E2 commented: "Yes, I would take my classes online, although it is not a secret to say that if the platform corrected its errors it would be much more comfortable" (E2) and for E3 "it is indifferent to take them one way or another".

## How could you improve the experience?

For teachers, it is possible to improve the online teaching experience they had during the contingency. Some aspects that could be improved are the content presentation format (D1), evaluation (D1), class interactivity (D4), planning (D4, D5), student perceptions (D2) and teacher preparation (D3).

In this regard, D5 comments: "I would like to make the classes more interactive. There are tools (…). It would be to put more competitions, online games to keep them more entertained (...), and also give them all the planning from day one and have all the activities in Teams, so that they have the visibility of what the course will be from the first day and that they can be seeing their grades (…) and that they do not feel so lost (…). I also need to get more creative so that the exams are more challenging for them. "

D4 agrees that planning is important: "Making a good work plan and not being up and running from day to day or thinking about what to do for the next day." For D3, teacher preparation is relevant:

> I am looking for resources to help me grow to be able to teach these practical subjects in a virtual way, create learning spaces that adapt to the needs of these practical subjects. Yes, it is important to prepare (…) not only in technology, but on how to discern to deliver knowledge to a student that you are not in front of.

D1 also comments:

> In the evaluation part (…) the tool we were using did not seem to me the best (…). I would like to use other tools or methods to evaluate. I have taken many classes online and I have liked many of the methodologies and tools and I am left with that desire to implement them for my classes. I would like to record my sessions, but well done. Even prepare a stage (…), that there would be a space in the faculty, like a kind of recording studio in which it would be more

professional to record my sessions. I think it could have better quality in the virtual sessions ".

For the students, there were three main aspects that could improve their online experience: a) solve technical and platform problems (E2, E3, E4), b) have more dynamic and interactive classes (E5, E6), and c ) provide more training for teachers to get more out of the online mode and the platform (E1). In this regard, E6 elaborated: "I would like them to make the classes more dynamic (…). Despite the fact that the practical subjects would have to be of this style, if the class is not adapted to this modality, it ends up being like one more theoretical class ".

## Discussion

The teachers interviewed expressed that although they were able to conclude the semester satisfactorily, in some cases there were topics that could have been studied further. This was especially the case with the final and more elaborate topics of the course. On the other hand, although the videos and simulators were very useful, in some cases they were not enough to replace the real components. Such is the case with hardware and networking practices.

During the class period in the health contingency, one of the teachers' biggest concerns was the students. In this sense, they were concerned with how their students felt, how they could ensure that they had their attention during the sessions, and how they could know that they were understanding the issues. In addition, they were puzzled by their little experience with the platform and the uncertainty of the situation. To cope with this virtual teaching period, the teachers had to adapt content that was designed to be taught in person and they had to be empathetic and flexible in their criteria.

The sessions took place live. During the class time, there were theoretical presentations by teachers and students, presentations, books and electronic documents were used. The practice was carried out through demonstrations that the students reproduced. In this sense, the most useful functionalities of Microsoft Teams were "share the desktop" and "record session". All the classes were recorded and the students could consult them later. Some teachers also shared video tutorials with specific content for students to see outside of class. The evaluations were carried out in a variety of ways. There were theoretical and practical exams, live, with a time limit, or to be answered outside of class.

Teachers reported that communication with their students was very fluid and open. The platform helped a lot in this process, as it provided the necessary elements to answer through chat, even from the cell phone, which was perceived as very convenient. During the class sessions, doubts could also be resolved out loud, or through the microphone. On the other hand, although it is true that some students faced family and work challenges, there were more who at some point had problems related to the availability of technological resources such as computer equipment or internet connection.

The teachers were happy with the experience of having taught online classes. They found several advantages to working this way. For example: as it is not in person on the university campus, there are not so many interruptions or class suspensions due to other events, it is more comfortable, without physical transfers, communication with students is better, due to the nature of this modality, more is used technology, and it is easier to share digital resources with students. However, all agreed that the main disadvantage is the need to have available technological resources. They also all said that they would agree to teach courses online even if the contingency was over. In this sense, the teachers stated that they would like to improve the presentation format of their classes, adding more interactivity, recording good quality and well-planned videos. They also said that evaluations could be improved by incorporating other methods or techniques. They also expressed that it would be appropriate to carry out more planning and content dosing.

The students, for their part, perceived the communication with their teachers and the evaluation of their subjects very positively. They recognized that they mainly faced technical problems and although they were satisfied with the online experience, they prefer the face-to-face mode. Students also accepted that there are distractors at home that can cause them to lose focus and not pay due attention to the class. Regarding the dynamics of the sessions, they stated that they would like a greater number of interactive activities to be included.
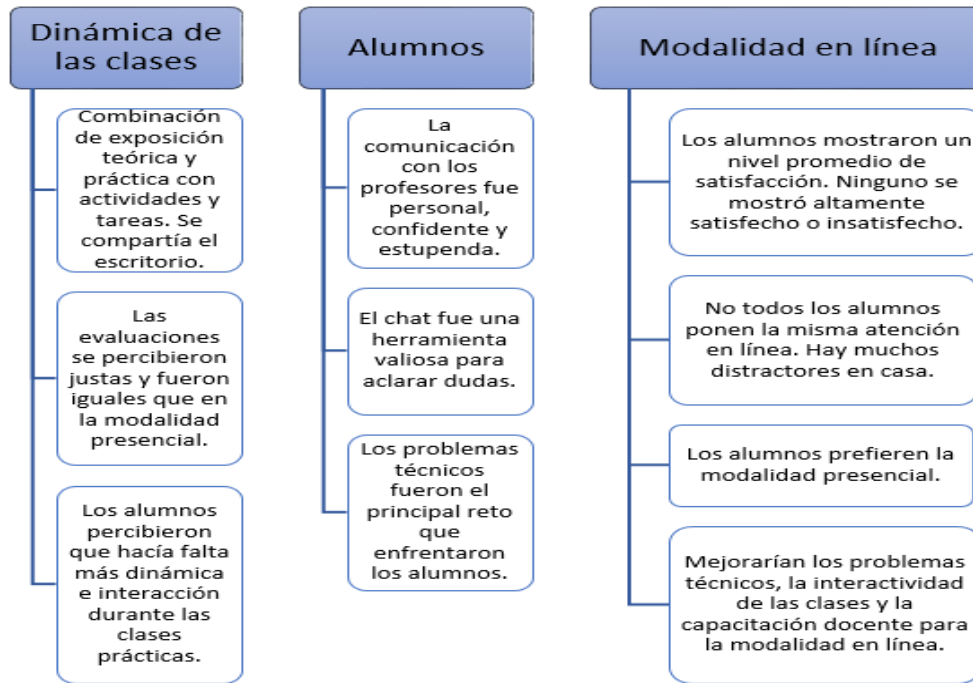
Figure 1 shows the most important facts reported by teachers, and figure 2 the most important aspects expressed by students.

**Figura 1.** Resumen de las respuestas de los docentes



Fuente: Elaboración propia

**Figura 2.** Resumen de las respuestas de los alumnos



Fuente: Elaboración propia

## Limitations and delimitations

This research was limited to five teachers from UNX who teach practical subjects in the educational program of the Information Technology degree and six students from these same courses. The questions were oriented only to the health contingency time in which they had to teach their subjects online. That is, from March 17 to May 17, 2020.

## Contrast of the findings with the analyzed literature

Our findings agree with Sinha et al. (2020) in relation to the usefulness of the Microsoft Teams platform, which was well valued by teachers and students. On the other hand, the challenges mentioned by teachers and students are similar to the problems presented by Feng et al. (2020) and by Ping et al. (2020). The teaching approaches adopted by the teachers also coincide with the problem-based learning model proposed by the latter authors. Finally, we find that the questions raised by Cerf (2020) are well founded. In this regard, our results suggest that in a future post-COVID-19 stage, online education would be preferred by teachers.

# Conclusions

In this research, it was found that, in university classes in virtual mode, Microsoft Teams really makes possible fully connected teaching, effective communication with students, as well as receiving and evaluating assignments. It also makes it easy to share content. However, it represents only a means through which the teaching-learning processes are developed. The teacher is responsible for designing, uploading, organizing and explaining the learning materials.

In addition, in practical subjects, teachers and students face the challenge of covering topics that they would address in person in a laboratory. To achieve this goal, teachers use live demonstrations, video tutorials, simulators, and even theoretical explanations on practical procedures. In the present investigation, it was found that Microsoft Teams is a very useful tool in this regard, since it allows sharing the screen, videotaping sessions and answering questions through audio or chat. However, it is not a substitute for good teaching organization or good course design. The teachers recognized that, despite the fact that most of the content could be covered successfully, in most subjects there were topics that could be deepened and that there were practices that were not carried out. This occurred in subjects

such as connections to databases in programming and operating systems such as Linux, which have a higher level of difficulty, which are located at the end of the activity schedule, or in those whose nature implies physical practices. Such is the case with the installation and maintenance of hardware and networks.

On the other hand, although it is known that technological platforms tend to promote distancing and individual work, both teachers and students commented that communication was fluid, private, explicit and rich in content. Likewise, despite the uncertainties, concerns and problems, the teachers found notable advantages of the online modality and agreed that they would prefer to teach their classes in this way in future scenarios, without a pandemic. This if the University and the study program allow it.

Faced with this enthusiasm, the teachers reflected objectively on the areas of opportunity that could improve the teaching-learning experiences. In this sense, they concluded that the process would imply more work on their part by having to increase their planning and diversify the formats of their sessions and class materials. For their part, the students were simply satisfied with the experience of the online modality, but they were in favor of the face-to-face modality. In this way, the present investigation allowed characterizing the teaching-learning of practical subjects in the area of information technology through a case study in the context of the UNX.

## Future lines of research

As future work, a follow-up investigation in the immediate subsequent period, that is, autumn 2020, would be useful, with the aim of describing the differential in the experiences between the two semesters of 2020. This is because before starting the autumn period 2020, teachers received training sessions of more than 30 hours aimed at creating virtual environments and learning objects. Additionally, the Microsoft Teams platform was updated with several new features, and students had time to prepare with better computers and more robust internet connections. On the other hand, technology in education during the post-pandemic era is a phenomenon that remains to be studied in order to characterize its adoption and appropriation, as well as the perceptions, trends and institutional changes derived from mandatory virtuality due to the COVID-19.

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