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# Gains from the transition from face-to-face to digital/online modality to improve education in emergency

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Education during emergencies demands attention from both institutions and governments, as the incidence of disasters and crises continues to increase worldwide due to various challenges that threaten humanity, including climate change, terrorism, food and water scarcity, energy crises, poverty, and inequality. Emergency remote teaching (ERT) is a critical factor in providing academic opportunities, building resilience, and promoting recovery for affected individuals. This research examines the challenges associated with transitioning from face-to-face to online/digital lessons, according to the perceptions of 105 professors in a Mexican private university, 2 months after mandatory online/digital teaching was implemented. By analyzing data collected through a survey using statistical and data mining techniques, we identified factors that should be considered when designing future education in emergency situations. The study found that while most professors positively evaluated their performance in ERT, they still preferred face-to-face teaching due to the lack of personal interaction and distractions. Professors adapted to ERT with technological training provided by the institution, but reported an increase in workload and the importance of the balance between job responsibilities and family issues. The study also revealed that professors' performance in ERT depended on the conditions of their teaching space at home. Furthermore, the study suggested the need for the development of an improved assessment framework for online evaluation methods, and integration of the most effective online and face-to-face teaching strategies for everyday academic contexts. The sudden change in education modality represented a fantastic opportunity to introduce teaching-learning-evaluating strategies and technologies while forcing institutions to evolve into the digital environment. Therefore, every education stakeholder should identify and implement best practices of the online and face-to-face modalities to improve future education in emergencies.

## KEYWORDS

faculty perceptions, professors' performance, digital education, educational innovation, higher education, remote education in pandemic

## 1. Introduction

The incidence of disasters and emergencies is increasing globally, ranging from pandemics to wars. These challenges pose a significant threat to humanity, including climate change, terrorism, food and water scarcity, energy crises, poverty, and inequality (United Nations, 2022). The rapid advancement of technology has highlighted the relevance of acquiring knowledge and its practical application as a critical means of addressing these challenges, mitigating disasters, and reducing their impact. In light of this, providing education during emergency situations is of utmost importance for both present and future generations.

Delivering education in emergency situations is crucial for providing educational opportunities and support to those affected by crises. In natural disasters, conflicts, epidemics, and other difficulties, education helps students by providing a sense of stability and assists them in mitigating the long-term effects of the emergency. Furthermore, education can also foster resilience and promote recovery for the future (Torani et al., 2019). It is noteworthy, however, that the success of education relies not only on institutions but primarily in educators, who are themselves susceptible to the trauma and stress associated with emergencies.

Amid the COVID-19 pandemic, lockdown represented a unique challenge to educators, as they were the only group of professionals who had no other option but to work remotely (Allen et al., 2020). Many employees in other sectors had the option of not leaving their working places or returning to their workplaces under safety protocols. However, professors, teachers, and instructors did not have this option since most governments around the Globe implemented social distance and closing of all educational facilities (UNESCO Office Santiago and Regional Bureau for Education in Latin America and the Caribbean, Economic Commission for Latin America and the Caribbean, 2020). In March 2020, Mexico announced the suspension of all academic activities and closure of schools in all levels. This decision suddenly replaced face-to-face education with distance education through several formats and platforms, with or without the use of technology (UNESCO Office Santiago and Regional Bureau for Education in Latin America and the Caribbean, Economic Commission for Latin America and the Caribbean, 2020; Area and Adell, 2021).

This study investigated professors' perception 2 months after the urgent implementation of online classes. The research question that guided this analysis was: how did faculty perceive their academic performance during the transition of their teaching to digital modality? The first purpose was to disseminate among the teaching community how other colleagues experienced this transition. This would help identify common challenges, learn from our peers, and create a sense of community among faculty members. The second purpose was to allow educational institutions, decision-makers, and policymakers to identify the best strategies to support faculty and ensure not only continuity during emergencies but also academic quality in any circumstances. The second purpose of the study was to identify the best strategies to support faculty and ensure academic quality in any circumstances. This is particularly important, as future emergencies could include a range of crises such as wars, climate change consequences, water, and food shortages, among others. In fact, according to Duke Global Health Institute (Penn, 2021), large pandemics are even more likely to happen than previously thought.

## 2. Theoretical framework

Due to the pandemic that affected the Globe in 2020, schools, colleges, and universities had to close their doors. As a response, this triggered the deployment of distance education modalities through a variety of formats and platforms (UNESCO Office Santiago and Regional Bureau for Education in Latin America and the Caribbean, Economic Commission for Latin America and the Caribbean, 2020). Some educational institutions were able to quickly transfer their face-to-face classes to online or digital classes despite having little time to prepare (Huang et al., 2020). In many other educational institutions in Latin America, due to the digital divide or the lack of economic and technological resources (Ferri et al., 2020) some other distance education modality was implemented, e.g., through open television broadcast. In worst-case scenarios, some institutions stopped providing school services and attention to students all together (Torras Virgili, 2021).

Educational institutions faced a crisis in 2020 as communities and governments continued to make difficult decisions about education during COVID-19 pandemic (Allen et al., 2020; Flack et al., 2020). Examples of these decisions include the use of video conferencing for ensuring the delivery of education including lecturing, learning activities, and assessment; the use of video conferencing for faculty collaboration and academic collaborative work; the fostering of learning management systems (LMS) to create learning environments for the tracking of academic performance of students (Bond et al., 2021); the creation of web repositories for digital learning materials; the development and proliferation of apps and software to facilitate the creation of videos, infographics, animated videos, podcast, and other multimedia content; the production and distribution of TV programs with learning content (nationally and locally); reduced-price agreements with telecommunications and digital companies to provide their services for educational purposes; and the organization of conferences, academic and training activities as webinars, and other online activities (Area and Adell, 2021).

The educational environment changed radically; it was forced to reinvent its learning, teaching, and evaluation processes. According to Miguel Román (2020) and Alcántara Santuario (2020), the shift to online education was a difficult and drastic adjustment for educational institutions. This global crisis triggered a rethinking of educational service delivery at all levels (Instituto Internacional de la UNESCO para la Educación Superior en América Latina y el Caribe, 2020). The intensive use of all kinds of platforms and resources technology to ensure continuity of learning is the boldest experimenting the field of educational technology, although unexpected and unplanned.

To learn from this crisis, while overcoming it, it was necessary to analyze the challenges involved, especially for online education. Topics like the attention to students, the use of educational technologies to support the teaching process and the well-being and needs of teachers and professors, needed to be analyzed. According to Sánchez Mendiola et al. (2020) teachers left the traditional classroom, to which they have been accustomed for decades, to become forced users of the technological tools that exist to interact at a distance between themselves and their students, while dealing with the pressures of confinement and its economic, health, and emotional consequences. In this address, See et al. (2020) affirmed that the workload of teachers is directly related to their well-being, besides; Hayes et al. (2020) reported that working from home can cause greater stress.

For Miguel Román (2020), successfully dealing with this educational crisis implied that both teachers and students develop self-learning, autonomy, and socio-emotional skills. The challenge was not easy, so it is important to recognize that many teachers and professors, along with their institutions and students, found ways to innovate. The foregoing led education to a renewal; Flack et al. (2020) recognized and celebrated the great work that all stakeholders in education did. However, every innovation in education must be analyzed and validated. We must provide strong evidence of true improvement in each innovation, its circumstances and even identify their limitations; or, conversely, identify those innovations that create more problems than solutions (Moreno, 2021).

The definition of Emergency Remote Teaching (ERT) clearly states that it is a method of teaching meant to be used only in emergency situations. Due to the magnitude of the COVID-19 Pandemic, we do not have a historical point of comparison to either the short term or long-term impacts of this online methodology on both students and professors, therefore, the need to have as much information on these impacts becomes clear (Ezra et al., 2021; Stewart, 2021).

In fact, multiple studies have been published concerning the impact on both the teaching and learning process (Allen et al., 2020; Ferri et al., 2020; Instituto Internacional de la UNESCO para la Educación Superior en América Latina y el Caribe, 2020), as well as on the development, health, and well-being of students (Area and Adell, 2021; Camacho-Zuñiga et al., 2021). However, it was important to find out how well-prepared every educational stakeholder was for the online modality. Concerning teachers and professors, it is recommended to train them in ERT (Trust and Whalen, 2020), especially after identifying several areas of opportunity amid education during COVID-19 lockdown (Alcántara Santuario, 2020; UNESCO Office Santiago and Regional Bureau for Education in Latin America and the Caribbean, Economic Commission for Latin America and the Caribbean, 2020). This makes our analysis relevant, since it specifically focuses on professors' perspective—on how they perceived their online teaching performance, focusing attention into opportunities for learning, innovation, and improvements in higher education during an emergency.

## 3. Methodology

### 3.1. Data collection

The private Mexican university studied here had successful experiences in online instruction before the COVID-19 lockdown, such as distance programs with synchronous and asynchronous courses. These courses were implemented in Mexico City after the earthquake in 2017. This allowed the training of 14,000 professors in a fast, pertinent, and concrete way, in relation to the use of platforms such as Zoom or Microsoft Teams and the fundamental strategies for online teaching. The university began remote online instruction on Monday, March 23, 2020, providing technical support and monitoring to the professors.

The faculty perspective on the mandatory transition from face-to-face modality to online modality after the COVID-19 breakout in

Mexico was analyzed through a sample of 105 professors. Faculty from the Schools of Humanities, Engineering, Business, Architecture and Social Sciences and Government were invited via institutional email to answer a survey between April and May 2020. They were informed of the purpose of the study, their optional participation, and the confidentiality of their answers. Participants' adscription corresponded to Campi in the cities of Toluca, Puebla, and Mexico City in Mexico (all located in the south-center of Mexico). Their age range was 25–64 years with 1–43 years of teaching experience. Among the participants, 61 identified as males and 44 as females and all of them held a masters and/or doctorate degree.

The participants of this research experienced online modality during the COVID-19 emergency, as a teaching and learning situation in which undergraduates were in a distance learning situation and not face-to-face with their professors. Undergraduates and professors interacted synchronously through videoconferencing technology and professors used a LMS as an aid for planning, informing, sharing, and evaluating learning.

### 3.2. Survey

We collected data through an online survey, powered by Google Forms, which included 10 closed-ended and four open-ended questions written in Spanish. At the beginning of this survey, participants informed about their degrees, years of teaching experience, and general socio/demographic aspects. The core questions focused on their perspective of the transition from the face-to-face modality to the online modality. The closed-ended questions under analysis in this research are shown in Table 1. The open-ended questions under analysis are: (9) Taking into consideration your teaching activities, what are the fundamental differences that you find between the two teaching experiences: face-to-face lectures and online lectures? (10) Regarding students' performance, what is the main difference between face-to-face lectures and online lectures? (13) What is the main advantage in online lectures? (14) What is the main disadvantage in online lectures? Questions 4, 11, and 16 were topics of a different publication.

### 3.3. Analysis

Data gathered from closed-ended questions were analyzed using descriptive and inferential statistics as well as data mining (*k*-means clustering); while that from open-ended questions was analyzed using text mining. Spearman's rank correlation coefficient (Null hypothesis: there exists no correlation between variables, Alternative hypothesis: there exists correlation between variables, level of significance 0.05) was evaluated for different variables assessment of the online modality (Tables 2–4) using Minitab Ver 19.2020.2.0.

K-means clustering is a machine unsupervised learning tool used to find relevant information beneath the data; it provides an insight of data that needs to be explained by the experimenter (Essa and Mojarad, 2022). Its implementation required transforming categorical data into numerical data (0–4). It was executed with 11 features (degree, online teaching evaluation, perceived change in workload, time to adapt to the online modality, perceived online teaching

**TABLE 1** Closed-ended questions for faculty participants about the mandatory transition from face-to-face modality to online modality after COVID-19 lockdown in Mexico.

Question	Options				
1. At home, how is your workspace to deliver online lessons? Is it isolated, illuminated and free from distractions and noise?	0. I do not have a specific space for my lecture	1	2	3	4. It is a bright, isolated and distraction-free space
2. Taking into consideration your experience in the online modality, how do you evaluate the following aspects? (See Figure 1)	Very bad	Bad		Good	Excellent
3. Taking into consideration your previous answers, in which of the two modalities do you perceive the following characteristics are better? (See Figure 2)	Definitely face-to-face modality	A little better in face-to-face modality	Equivalent in both	A little better in the online modality	Definitely online modality
5. Taking into consideration a subject that you deliver regularly in presence, for each hour of lecture, how much time did you dedicate to your preparation?	Less than 1 h	Between 1 and 2 h	Between 2 and 3 h	More than 3 h	I have no arguments to answer
6. Taking into consideration a subject that you regularly deliver in face-to-face, and that you are delivering in the online modality, for each hour of lecturing, how much time do you dedicate now to its preparation?	Less than 1 h	Between 1 and 2 h	Between 2 and 3 h	More than 3 h	I have no arguments to answer
7. How quickly did you adapt to the change of face-to-face modality to online modality?	I have not adapted	Slowly		Moderate-ly Fast	I adapted quickly
8. Which type of lecturing do you like the most: Face-to-face modality or online modality?	Definitely face-to-face modality	A little more face-to-face modality	It is indistinct to me	A little more online modality	Definitely online modality
12. Compared to a face-to-face lecture, how has your workload changed?	It decreased a lot	It decreased a little	It has stayed the same	It increased a little	It increased a lot
15. When your online lessons end, you say goodbye to your alumni and close your Zoom, how satisfied do you feel with your teaching?	0 Not satisfied at all	1	2	3	4 Extremely satisfied
17. How much harmony is there between your family issues and your job responsibilities working from home?	0 Very little	1	2	3	4 A lot

Numbering reflects actual order in the survey.

performance, school, harmony between job and family issues, teaching experience, satisfaction of their own online teaching performance, working space quality, and gender) without dimensionality reduction. Finally, its performance was evaluated through silhouette coefficient.

Answers to the open-ended questions were cleaned (correct spelling; removing accent mark, stop words and plurals; unifying synonyms; and replacing verbs by their infinitive) prior to the text analysis performed using Voyant Tools (Sinclair and Rockwell, 2016).

## 4. Results

From an overall perspective, after 5–6 weeks of mandatory closure of face-to-face instruction, faculty evaluated the online modality positively. Figure 1 reports the frequency of answers to assess the characteristics of the online modality through a heatmap (higher frequency corresponds to higher intensity and vice versa). It is noteworthy that “Good” got the highest frequency for every analyzed characteristic of the online teaching modality, which evidences a

	very bad	bad	good	excellent
Your own performance	0	6	70	29
Undergraduates' participation	3	16	72	14
Undergraduates' fulfillment in assignments	2	3	61	39
Integrity during evaluation	4	21	64	16
Undergraduates' learning	1	13	72	19
Quality in undergraduates' contribution	0	24	57	24
Undergraduates' punctuality and attendance	2	6	57	40
Fluidity in sessions	0	3	66	36
Professor-undergraduate interaction	3	13	54	35
Interaction between undergraduates	5	29	55	16
Syllabus and contents coverage	1	8	48	48
Undergraduates' attitudes towards learning	1	16	66	22
Assessment effectivity	2	18	69	16
Innovation in lectures	1	15	59	30

FIGURE 1

Frequency in professors' responses ( $n=105$ ) to the question: "Taking into consideration your experience in the online modality, how do you evaluate the following aspects?" after mandatory shift from face-to-face instruction to online/digital instruction during COVID-19 quarantine. Higher intensity corresponds to higher frequency.

growth in professors' competencies far beyond the sudden shift from face-to-face modality during the COVID-19 emergency and the challenges that came with it.

Concerning the attribute of "excellent," professors mentioned coverage of the syllabus, undergraduate's punctuality and attendance, fulfillment in assignments, and fluidity of the sessions in the online modality with the highest frequency. Participants evaluated syllabus and contents coverage as excellent, which corresponds with the perception of fluidity during the lessons and the fulfillment of assignments. These results might be related to the multiple tools and sources of learning available for the undergraduates in the World Wide Web, especially during the global pandemic; learners can review and try out different didactic sources, such as class recordings, blogs, videos, papers, textbooks, notes, etc. On the other hand, participants evaluated punctuality of their alumni as excellent, which reflected the ease of access to the classroom in its virtual mode.

Under professors' perception, the most mentioned challenges of online/digital teaching were identified as the interaction between undergraduates, quality in their contribution/participation, integrity during evaluation, and assessment effectiveness. The first two were related to social interactions in the online modality; these aspects were fundamental for the teaching and learning process since social relevance has been highlighted as an intrinsic motivation to learn (Ryan and Deci, 2000; Savelsbergh et al., 2016). The last two challenges were related to assessment and evaluation, which were rated as "bad" under the participants perspective. This result has several implications, which will be discussed later.

After comparing the teaching-learning process, respondents assessed face-to-face modality equivalents with online/digital modality in eight out of 14 analyzed characteristics. Figure 2 shows a heatmap of the frequency in professors' response to the question: "Considering your previous answers, in which of the two modalities

do you perceive the following characteristics are better?" after mandatory interruption of face-to-face instruction during the COVID-19 quarantine. Participants evaluated both modalities' equivalents in undergraduates' fulfillment in assignments, achievement of learning content, undergraduates' punctuality and attendance and fluidity during sessions. They preferred the face-to-face modality over the online/digital modality in four factors; in decreasing order of frequency, they mentioned: (1) interaction between undergraduates, (2) undergraduates' participation, (3) integrity during evaluation, and (4) personal interaction with undergraduates. In contrast, online modality was definitely preferred over face-to-face modality due to the innovation involved in lectures. In the answers to Question 8, "Which type of lecturing do you like the most: Face-to-face modality or online modality?," 21.9% of the participants preferred online lectures over face-to-face lectures, 19.0% of the participants had no preference for any of the modalities, while 59.0% of the participants liked the face-to-face modality better than the online modality. This discrepancy between specific characteristics and overall evaluation might be a consequence of those facts and issues that fall outside of the analysis.

How professors assessed their own performance during the start of the COVID-19 emergency in online modality was correlated with most of the variables analyzed herein, but higher correlations were found to relate to undergraduates' participation and the quality of their contributions. Table 2 reports the Spearman rank correlation analysis of the professors' performance and the different characteristics of the online modality, as assessed in the participants' answers to the question: "Taking into consideration your experience in the online modality, how do you evaluate the following aspects?" It can be noted that undergraduates' punctuality and attendance is the only variable that did not correlate with the professors' assessment of their own performance. On the contrary, professors' performance in the online

	Definitely face-to-face modality	A little better in face-to-face modality	Equivalent in both	A little better in the online modality	Definitely online modality
Your own performance	22	33	36	10	4
Undergraduates' participation	38	40	18	7	2
Undergraduates' fulfillment in assignments	14	19	58	11	3
Integrity during evaluation	35	31	38	1	0
Undergraduates' learning	13	44	41	6	1
Quality in undergraduates' contribution	18	32	43	10	2
Undergraduates' punctuality and attendance	17	15	46	15	12
Fluidity in sessions	19	25	45	11	5
Professor-undergraduate interaction	35	32	25	8	5
Interaction between undergraduates	46	31	22	6	0
Achievement of learning content	15	29	55	5	1
Undergraduates' attitudes towards learning	17	38	43	7	0
Assessment effectivity	22	42	34	5	2
Innovation in lectures	11	12	31	33	18

**FIGURE 2** Frequency in professors' response to the question: "Considering your previous answers, in which of the two modalities do you perceive the following characteristics are better?" after mandatory closure of face-to-face instruction during COVID-19 quarantine. Higher intensity corresponds to higher frequency.

**TABLE 2** Spearman's rank correlation (Significance level: 0.05) coefficient between professors' perception of their own performance (Question 2A) and the rest of perceptions about the online modality, according to Question 2: "Taking into consideration your experience in the online modality, how do you evaluate the following aspects?"

Professors' performance versus:	Correlation	p value	Conclusion
Undergraduates' participation	0.432	0.000	Correlated
Undergraduates' fulfillment in assignments	0.364	0.000	Correlated
Integrity during evaluation	0.376	0.000	Correlated
Undergraduates' learning	0.422	0.000	Correlated
Quality in undergraduates' contribution	0.424	0.000	Correlated
Undergraduates' punctuality and attendance	0.029	0.728	---
Fluidity in sessions	0.418	0.000	Correlated
Personal interaction with undergraduates	0.289	0.003	Correlated
Interaction between undergraduates	0.265	0.007	Correlated
Achievement of learning content	0.379	0.000	Correlated
Undergraduates' attitudes toward learning	0.276	0.005	Correlated
Assessment effectivity	0.380	0.000	Correlated
Innovation in lectures	0.401	0.000	Correlated

modality showed the highest correlation with undergraduates' participation, quality in undergraduates' contribution during lectures and undergraduates' learning. The positive correlation with these variables reflects how the professors' attention was student-centered, and therefore it becomes clear that personal interaction between professors and undergraduates is fundamental for the teaching-learning process.

According to the perspective of the professors who participated in this study, there was a correlation between their teaching performance and the characteristics of the workspace at home and the harmony with their families. Table 3 reports the Spearman correlation analysis

between professors' perception of their own performance (Question 2) and answers given to Questions 1, 15, and 17. It is valuable to note that characteristics of the space at home dedicated to online teaching as well as family harmony with work correlate positively with instructor's perception of their performance and are relevant when considering future education scenarios during emergencies.

Professors' satisfaction with their online teaching correlated with the harmony they perceived between their families, their job, and with having an appropriate workspace at home. Table 4 shows the clustering K-means results performed without dimensionality reduction on 11 features, where three of them accounted for 58% of

**TABLE 3 Spearman's rank correlation coefficients between professors' perception of their own performance (Question 2A) and characteristics of the workspace at home, personal satisfaction about teaching, and work-family harmony.**

Professors' performance (Question 2) versus:	Correlation	<i>p</i> value	Conclusion
1. At home, how is your workspace to deliver online lessons? Is it isolated, illuminated and free from distractions and noise?	0.254	0.009	Correlated
15. When your online lessons end, you say goodbye to your alumni and close your Zoom, how satisfied do you feel with your teaching?	0.530	0.000	Correlated
17. How much harmony is there between your family issues and your job responsibilities working from home?	0.208	0.034	Correlated

Significance level: 0.05.

**TABLE 4 Clustering K-means results (11 features, without dimensionality reduction, and Silhouette coefficient of 0.1929).**

	Professors in cluster	Family-job harmony means		Working space quality means		Online-performance satisfaction means	
		Cluster	Population	Cluster	Population	Cluster	Population
Cluster 1 Low online teaching performance	21 (20%)	2.1	3.23	1.76	3.1	2.57	3.26
Cluster 2 High online teaching performance	84 (80%)	3.51		3.42		3.46	

Participants in Cluster 1 perceived their online-teaching performance on average 21% lower than the population mean; while participants in Cluster 2 perceived their online-teaching performance on average 5% higher than the population mean.

the variance: harmony between job and family issues (23%), quality of the working space at home (20%), and satisfaction with their own online teaching performance (15%). Classification resulted in two clusters with a silhouette coefficient of 0.1929. Cluster 1 included 20% of the participants showing a lower quality workspace at home and scarce harmony between family issues and their job, which resulted in a lower perception of their online teaching performance. Cluster 2 included 80% of the participants showing a higher quality workspace and more harmony between family and work, which concurs with a higher perception of their online teaching performance. These results point out professors' necessity for a space and time especially dedicated to their academic activities, far from distractions, and family concerns. This might provide evidence for decision-makers to return every academic activity inside institutional facilities, whenever possible.

While none of the participants reported not having adapted to the online modality, professors' time to adjust correlated positively with their perception of their teaching performance and achievement of the learning content. Table 5 reports the Spearman correlation analysis of the professors' perception of the time needed to adapt to the online modality (Question 7) and their perception of the different aspects evaluated in Question 2 about this modality. 61.9% of the participants considered that they quickly adapted to the online modality; 33.3% of them adapted moderately fast and only 4.76% of them adapted slowly to this modality. Among the highest positive correlations with the time needed to become accustomed to the online modality, two are related with the professor: the achievement of learning content and their own performance. The other three characteristics are related with the undergraduates: their participation, their fulfillment in assignments, and the quality of their contribution during lectures.

In agreement with Hayes et al. (2020), professors who participated in this research perceived that the workload related to preparing lessons and evaluating increased when changing from face-to-face to

online instruction due to the COVID-19 lockdown. Their answers to Question 12 (Table 1) reflected that for 7.6% of the participants the workload decreased in comparison to face-to-face lectures, for 7.6% of the participants the workload remained the same, but for 84.8% of the participants the workload increased. These results can be understood considering that participants' expertise focused on face-to-face modality, and they identified the online modality as highly innovative. Besides, the survey time span was too close to the beginning of the COVID-19 lockdown to allow professors to go through a natural learning curve and adapt to the new requirements of online/digital teaching, as has been reported in the literature.

Participants perceived interaction as the main difference between face-to-face and online modalities. Figure 3 shows the word cloud of the top 20 words in the answers to Question 9. The term "interaction" was the most significant term in this word cloud. Table 6 reports some relevant terms and their highest correlations to other terms present in the open-ended questions. Results suggest that participants identified the interaction between lecturer-students and student-student as being relevant and must be incorporated in lectures regardless of the modality. In agreement with previous results, the participants identified the workload as a difference between modalities and there was a correlation with the online modality.

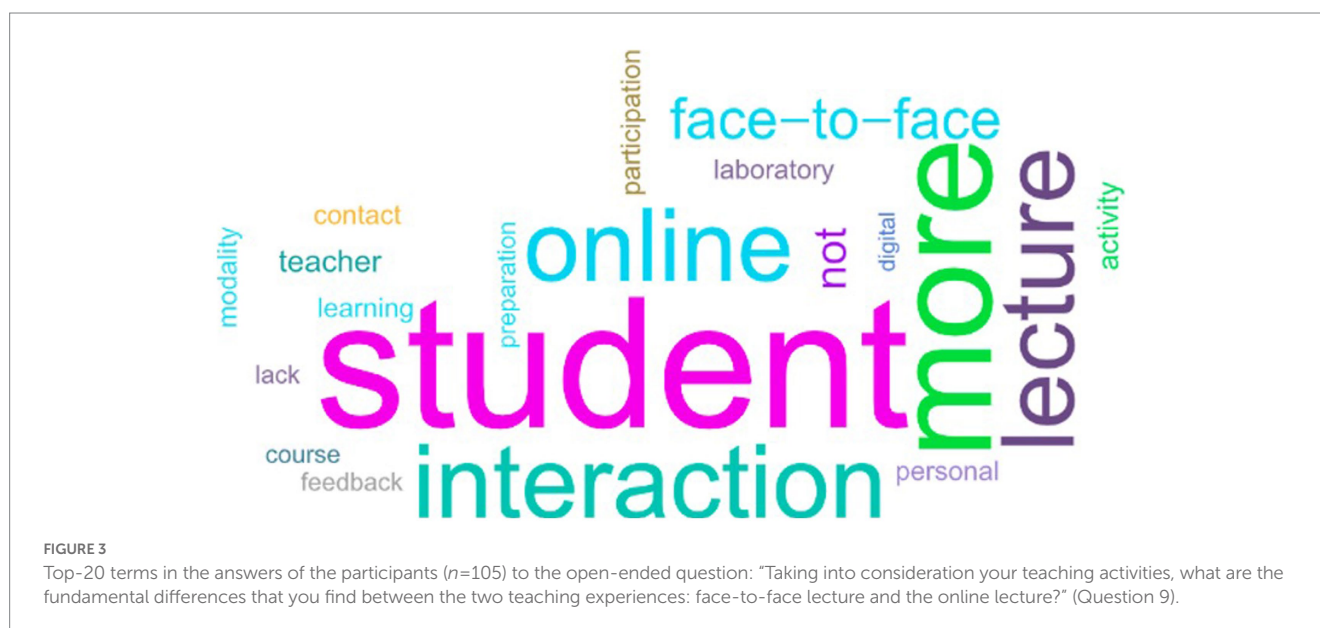
Participants identified "attention" as a difference in undergraduates' performance in the face-to-face and online modalities. Figure 4 shows the word cloud of the top 20 words in the answers to Question 10 with the most significant term being "attention," which is strongly correlated with "environment"; this might be linked to the difficulty students had to focus their attention during the online lessons due to the multiple sources of distractions in their homes and in the WWW.

Professors who participated in this research mentioned less transportation as the main advantage of the online modality. Figure 5 shows the word cloud of the top 20 terms present in the

**TABLE 5** Spearman's rank correlation coefficient between professors' perception of the time to adapt to the shift from face-to-face modality to online modality (Question 7) and their perception of the online modality (Question 2).

Time to adapt (Question 7) versus:	Correlation	p value	Conclusion
Professors' performance	0.360	0.000	Correlated
Undergraduates' participation	0.307	0.002	Correlated
Undergraduates' fulfillment in assignments	0.303	0.002	Correlated
Integrity during evaluation	0.150	0.129	---
Undergraduates' learning	0.280	0.004	Correlated
Quality in undergraduates' contribution	0.287	0.003	Correlated
Undergraduates' punctuality and attendance	0.146	0.140	---
Fluidity in sessions	0.260	0.008	Correlated
Personal interaction with undergraduates	0.126	0.203	---
Interaction between undergraduates	0.073	0.464	---
Achievement of learning content	0.287	0.003	Correlated
Undergraduates' attitudes toward learning	0.265	0.007	Correlated
Assessment effectivity	0.151	0.126	---
Innovation in lectures	0.279	0.004	Correlated

Significance level: 0.05.



answers to Question 9, concerning the main advantage of the online modality. The results identified that the most significant terms were "home," "transportation," "family," and "recorded." The correlations shown in Table 5 suggest that less transportation during the online modality led to more interaction with their families and that the possibility to record the lessons facilitated comprehension in the undergraduate students.

According to the perceptions of the participants, the lack of interaction with the undergraduates and the absence of laboratories constituted the disadvantages of the online modality. Figure 6 shows the word cloud of the top 20 terms in the professors' answers to Question 14. Table 6 shows that "interaction" is clearly related to "lack" and "student." It can be concluded that the online modality strongly limited the instructor-student and student-student

interactions, which agrees with the previously discussed answers to Question 2 and 9. The other significant term that appeared in this word cloud is "laboratory." In higher education programs, laboratories play an important role in the development of specific competencies, with several of them requiring experimentation and use of materials and equipment that are not always available in the virtual environment.

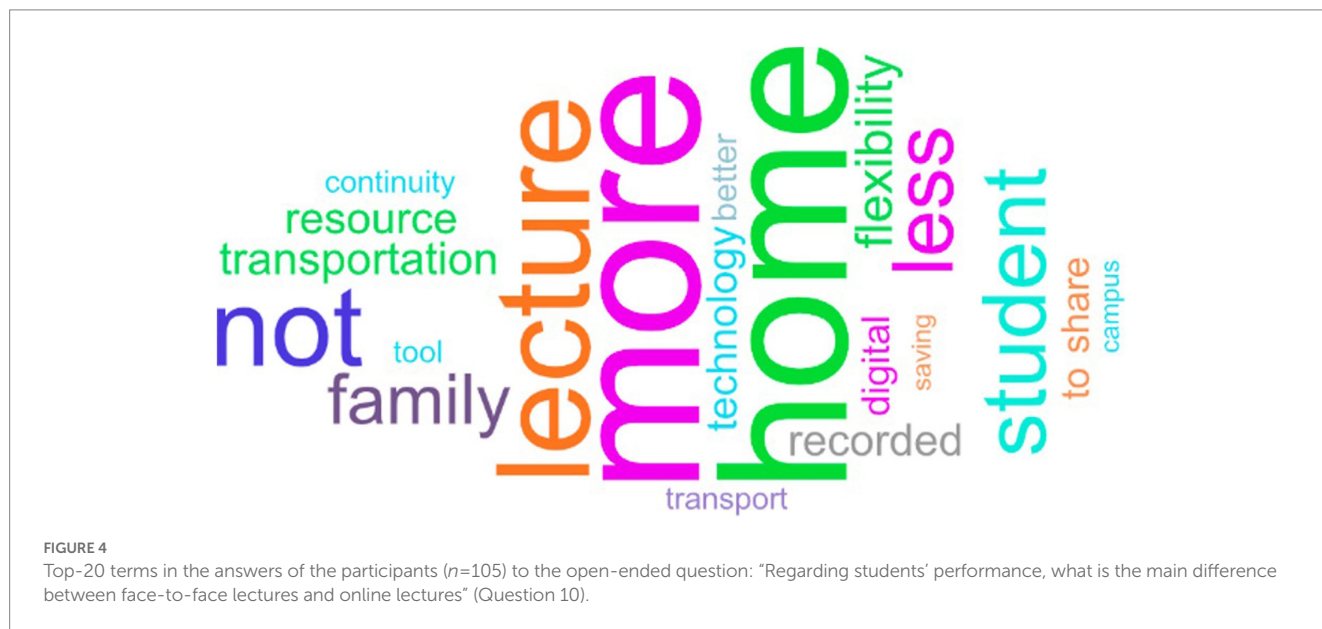
## 5. Discussion

Worldwide, the lockdown to diminish the spread of COVID-19 strongly affected the way professors delivered their teaching (Allen et al., 2020). In March 2020, Mexican higher education institutions promoted lockdown as a measure to diminish the spread of



**TABLE 6** Pairs of terms with highest correlation in the professors’ open-ended answers to the fundamental differences between face-to-face and online modalities (Question 9), the main differences between the undergraduates’ performance (Question 10), as well as the advantages (Question 13) and disadvantages of the online modality (Question 14).

Question	Term 1	Term 2	Correlation
Question 9	Important/importancia	Interaction/interacción	0.7170
	Incorporation/incorporación	Interaction/interacción	0.7170
	Student/estudiante	Interaction/interacción	0.6949
	Advance/avance	Interaction/interacción	0.6411
	Workload/carga	Online/en línea	0.6201
	Contents/contenido	Online/en línea	0.6201
	Communication/comunicación	Face-to-face/presencial	0.6343
	Camera/cámara	Evaluation/evaluación	0.6124
	Complicated/complicado	Evaluation/evaluación	0.6124
	Contents/contenidos	Evaluation/evaluación	0.6124
	Coexistence/cohabitar	Evaluation/evaluación	0.6124
Question 10	Trust/confianza	Performance/desempeño	0.7638
	Environment/ambiente	Attention/atencion	0.7071
Question 13	None/ningun	Transportation/traslado	0.8023
	Less/menos	Transportation/traslado	0.7981
	Learning/aprendizaje	Transportation/traslado	0.7158
	To eat/comer	Transportation/traslado	0.7158
	Knowledge/conocimiento	Transportation/traslado	0.7158
	Understanding/entendimiento	Recorded/grabada	0.6784
Question 14	Lack/falta	Interaction/interacción	0.7673
	Student/estudiante	Interaction/interacción	0.6710



COVID-19. Mandatory closure of all educational facilities and schools forced every teaching activity from face-to-face modality into an online modality. Despite their previous expertise, professors were forced to adapt their face-to-face teaching methods to the technological tools and requirements of the online modality in a

two-week timespan. Besides that, professors had to deal with the use of digital tools and platforms as well as having to teach from home (Trust and Whalen, 2020).

From an overall perspective, after a month of mandatory closure of face-to-face instruction, faculty from this private Mexican



FIGURE 5

Top-20 terms in the answers of the participants ( $n=105$ ) to the open-ended question: "What is the main advantage in online lectures?" (Question 13).



FIGURE 6

Top-20 terms in the answers of the participants ( $n=105$ ) to the open-ended question: "What is the main disadvantage in online lectures?" (Question 14).

university evaluated the online modality positively. This might have reflected the previous experience of the institution with online learning, distance programs, and in emergencies such as the damage caused to the facilities after an earthquake in 2017. However, during the global COVID-19 emergency, the university trained its professors in the use of technologies and strategies for the online modality and launched it within 1 week. This result also reflected on the micro-environment inside of each class, as a continuously adapting organism where the professor designed the best suitable track under his/her academic freedom.

From the perspective of professors used to a face-to-face modality, some of the challenges involved in the online modality were the interaction with the undergraduate students (Ferri et al., 2020), the laboratory instruction, the attention of undergraduates, and the efficiency of evaluation (UNESCO Office Santiago and Regional Bureau for Education in Latin America and the Caribbean, Economic Commission for Latin America and the Caribbean, 2020). The lack of

social interaction and communication was also recognized by students and reported in literature (Instituto Internacional de la UNESCO para la Educación Superior en América Latina y el Caribe, 2020). Student-student interaction promotes significant learning; while instructor-student interaction is relevant to tracking the learning process, and even facilitates that the undergraduates focus their attention. Therefore, personal interaction must be favored during lessons through any tool, e.g., synchronic sessions, collaborative activities, and breakout rooms. Regarding the evaluation efficiency, professors must be aware of the multiple sources of information available for the students not only during professional life, but also while taking exams. Instead of mimicking traditional evaluation into a digital environment, a new and improved assessment framework needs to be developed. Evaluation in online courses is a relevant topic that requires further research.

Participants positively evaluated coverage of the syllabus and fluidity during lessons in the online modality; in addition to

recognizing that recordings of synchronic lessons were helpful to promote students' understanding. This might reflect the multiple digital tools at hand in online learning, e.g., videos, digital libraries, presentations, simulators, and graphing calculators; unfortunately, it might also be related to the decreased or null interaction with students, which led to high fluidity in professors' lecturing.

Over 95% of the faculty that used to be in a face-to-face or in-person modality adapted fast or moderately fast to the requirements of this new modality; however, after 2 months of online instructions, more than 83.7% reported that their workload increased. Even though this might be caused by the learning curve related to the abrupt change in activities, the private Mexican university established different strategies to support its faculty in this and other wellbeing issues, and the analysis of their impact is the topic of another publication from this research group.

From the perspective of professors used to face-to-face modality, among the advantages involved in the online modality were saving time in transportation which also gave them opportunities to invest in their wellbeing like spending time with their families or having enough time to eat.

A relevant finding related to teaching from home was the direct correlation of the professors' performance with the appropriateness of a workspace and the consensus between family and work, in agreement with other authors (Ferri et al., 2020; Instituto Internacional de la UNESCO para la Educación Superior en América Latina y el Caribe, 2020). Higher education institutions must consider this condition in case of future scenarios, which require similar shifts from a face-to-face modality to an online modality. Despite the increasing trends toward working from home, in this case, teaching from home did impede optimal performance of faculty.

Approximately 60% of the faculty participants preferred face-to-face over online instruction. Nevertheless, about 50% of them also recognized that digital environments involve multiple innovations. This abrupt change also represented a great opportunity for educational institutions and for all teachers, instructors, and professors to learn and use the best of both the face-to-face and online modalities in favor of a better education in emergencies.

## 6. Conclusion

Beyond the relevance of our findings, it is noteworthy to mention that for teachers and professors from other educational institutions conditions were different. In Mexico and Latin America, in general, a vast majority of them lacked digital competences. They also lacked competences for designing, implementing, and assessing online courses, with synchronous and asynchronous interactions (Area and Adell, 2021). Even more, the digital divide that is the differences in the access to electronic devices and a good internet connectivity, among learners and teachers worsened the situation and increased inequalities among the population (See et al., 2020; Area and Adell, 2021).

The evidence gives raise to the following highlights for higher education institutions and policy makers when considering education in emergency scenarios:

1. Most of the participants positively evaluated their performance in the online modality, which might be a consequence of the previous experience of the institution in innovation and in distance modality. Besides, it might be a consequence of the freedom provided to the professors to decide on the optimal path for their courses.
2. Most participants preferred face-to-face over online modality. They recognized that the later diminished personal interactions and multiple distractors from learning. Since social relevance is an intrinsic motivation for learning, more strategies need to be explored to fully overcome this challenge.
3. With training in technological tools provided by the Institution, most of the participants promptly adapted their instruction to the online modality. Even though they also reported an increment in their workload, literature has reported a natural learning curve that might restore the equilibrium. The well-being of faculty must be the topic of further analysis.
4. Evidence demonstrated, through correlational statistics and classification techniques, that professors' performance depends on the conditions of their teaching space at home and the balance and harmony between their family issues and their job responsibilities. This provides valid arguments to promote the return of faculty to higher education facilities.
5. Evaluation and assessment methods in online modality require further research to ensure their effectiveness. Instead of adapting traditional evaluation methods into the digital environment, a new and improved assessment framework needs to be developed.
6. Evidence shows that the online modality represented a great opportunity to innovate. In order to enhance educational quality, institutions and educators should strive to integrate the most effective online and face-to-face teaching strategies, not solely in response to crises, but also in everyday academic contexts.

Our research on assessing professors' perceptions from a Mexican Higher education institution during the transitional phase to an Emergency Remote Teaching (ERT) amid COVID-19 pandemic holds relevance for other emergency situations that may arise in the future. As emergency situations are predicted to become more frequent in the coming years, our findings are of particular significance to higher education institutions and policymakers, who may draw upon the insights gained from our study to better prepare for and respond to such crises. Therefore, our research has broader implications for emergency planning and management to ensure education of future generations under any challenging situation.

## Data availability statement

The datasets presented in this article are not readily available because the consent of the participants was obtained under the statement that the information collected during the study would be anonymized and kept confidential. Requests to access the datasets should be directed to CC-Z, [claudia.camacho@tec.mx](mailto:claudia.camacho@tec.mx).

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

MP-B, MC-C, and CC-Z contributed to conception and design of the study. CC-Z organized the database, performed the data mining, including text mining, and wrote the final draft of the manuscript. EA-R performed the statistical analysis. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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