Full research paper

EVALUATION OF THE EFFICIENCY OF THE SUDDEN IMPLEMENTATION OF THE SYNCHRONOUS ONLINE COURSE: FINDINGS OF A MIXED METHOD STUDY

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ABSTRACT

Tragedies are neither sought nor requested. Unfortunately, they happen and affect all areas of life, especially education. However, they leave lessons that work to face new challenges. This study aims to analyze the transition from classroom classes to distance classes due to an earthquake that hit Mexico City in 2017, damaging its buildings and infrastructure, to find the necessary aspects for an efficient transition in these cases, using different Tecnologico de Monterrey's institutional data. Faculty members were interviewed about their views during the transition. The student's grades were also compared. Student responses were analyzed in the teacher satisfaction surveys. Challenges encountered by faculty during the sudden implementation of online courses were difficulties in the use of digital technologies, the amount of time spent preparing the class, the new ways of communication, the lack of use and knowledge of the online model, and the student's evaluation in online settings. The advantages mentioned by the faculty were flexibility, recorded classes, and the new tools that can be used for teaching. It was also observed that the student averages were higher in the semester after the earthquake. However, although young faculty with excellent technology management or experienced faculty with good use of technology and who are very well trained were the profiles that students better evaluated, no correlation was found between their teacher-associated variables and teacher performance indicators with the student averages. This experience served as a basis for meeting the contingency of 2020 with COVID-19. It represented itself as one antecedent in evaluating online education, allowing the establishment of a more expeditious and efficient online educational system.

KEYWORDS

Distance learning, educational innovation, higher education, online synchronous models, STEM

HOW TO CITE

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Highlights

- *Teacher survey answers and recommendation levels in sudden online courses were evaluated.*
- *Good technology management and teaching experience are positive factors to success in online courses.*
- *Faculty training in digital technology is needed to transform from classroom to distance education efficiently.*
- *Given the uncertainty of these times, higher education institutions' investment in teacher education is a responsibility.*

INTRODUCTION

Catastrophes are unplanned; they may suddenly arise and completely transform the everyday life of society. In 2020, the World experienced a health emergency that forced the population to take shelter at home. The consequences of these actions are evident in the economy and society in general. Universities had to implement strategies to continue their courses. In general, many classes had to migrate to the digital mode; however, this required many parameters to comply with so that the course quality, frequency, and length were unaffected. Studies of similar implementations help us understand, design, and efficiently face contingencies of different magnitudes, affecting the course of university education as little as possible. A similar case happened in September 2017. A 7.1 magnitude earthquake in Mexico City damaged the infrastructure of the Mexico City campus of Tecnologico de Monterrey. At that time, the science department offered 118 courses in 21 different subjects (Physics (6), Mathematics (11), and Statistics and Probability (4)) for 3,068 students. The department had 45 faculty members, both full-time and part-time. At the time of the earthquake, the students were in the fifth week of the fall semester and faced the campus's inability. The science department faced the challenge of ending the semester (9 remaining weeks) without physical facilities. After considering different possibilities, it was decided to use an online synchronous model for the courses. However, is distance learning as efficient as classroom learning? (Bernard et al., 2004). If so, what are the elements that made it efficient? We intend to answer those questions using available institutional data in this work.

Literature Review

Access to information and distribution of educational content facilitated by the World Wide Web and the advancement of technology in the digital age helped the emergence and establishment of distance education (Fidalgo et al., 2020). Whether synchronous, asynchronous, blended, massive online open courses (MOOC), or open scheduled online classes, there has always been a need to compare their efficiency with formal face-to-face education.

Al Lily et al. (2020) developed a conceptual framework for distance education in times of catastrophe composed of procedural, logistical, social, cultural, pedagogical, and psychological ramifications. These authors identified that distance education forced by the pandemic dissipated from traditional distance education in many aspects: abruptness, international interest, popularization, expansion, and imposition. In their research, they concluded that in times of crisis, there is a political dynamic between technology and society that depends on cultural perspectives.

Similar studies of distance education with face-to-face education have concluded that the relationship between student and instructor is the central differential (Bernard et al., 2004). However, this can also be achieved through synchronous courses. On the other hand, distance education can be more constructive and effective through students' and teachers' correct use of technology (Bernard et al., 2004). These elements are included in Moore's (1993) traditional theory of distance education: interaction, structure, and autonomy. These comparative studies have increased emphasis on institution preparation, skills development, instructor training, and the offering of blended learning courses to familiarize students with distance education in disasters (Fidalgo, 2020).

A literature review conducted by Bernard et al. (2004) examined students' achievements, attitudes, and retention rates in distance education compared to traditional classroom instruction. The authors found that the two modes of instruction were comparable in terms of study features and outcomes. However, there were differences in achievement and attitudes between synchronous and asynchronous distance education. Synchronous outcomes were better for classroom instruction, while asynchronous outcomes were better for distance education. Attitudes towards both modes of instruction were negative, but the difference was more significant for synchronous distance education, where classroom instruction was preferred. Retention rates showed the opposite outcome, with asynchronous distance education having a higher dropout rate than synchronous distance education.

Lynch and Dembo's (2004) research on distance courses used students' final grades to measure their online academic performance. The study found a positive correlation between self-efficacy, verbal ability, and course grades. This work suggested that these variables may impact performance in online, blended learning contexts. However, the authors suggested additional research to validate this relationship.

In another study, the question of distance education effectiveness was answered through interviews with students and teachers. Koçoglu & Tekdal (2020) proposed that it could be improved by various means, for example, parent participation through teacher-parent communications, internet, and technological material support, monitoring student participation, conducting online exams in different intervals, informative instruction on distance education, rich content support to motivate students, temporal freedom in participation, development of face-to-face education platforms, learning interaction, and development of advanced software.

With this in mind, the speed of transition in times of crisis depends on the efficiency of the university's information system, which differs whether it is a public or private school (Bojovic et al., 2020; Korkman & Toraman, 2020). In fact, before the pandemic, much of the research on efficiency in distance education was related to it (Vadnere, 2018; Cacheiro-Gonzalez et al., 2019; Samoylov & Budnik, 2019). Now, efficiency is also measured in the pedagogical field, such as using technology to achieve efficient curriculum delivery. In this regard, Cacheiro-Gonzalez et al. (2019) have mentioned that an educational model that effectively utilizes transdisciplinary knowledge is necessary; to achieve this, the basic tools of the learning platform, such as forums, chat, and web conferences, must be creatively and rationally utilized. Creating future universities is not solely a technological challenge but also an epistemological, discursive, and ideological one, for which it is vital to develop strategies for educators' initial and continuing training.

In the case of the COVID-19 transition from face-to-face to hybrid classes or totally online, there are different opinions regarding students' satisfaction with teaching. There were critiques about the lecturers´ computer use, implying that some lecturers graded the students' works without reading them, or others considered that even with high grades, it did not mean that students fully understood the subjects (Uluöz, 2020). In other work, it was suggested that instructors should use peer group grading since no difference was seen between peer group and instructor grades for hybrid and online courses pre- and post-COVID-19. Students found peer group grading fair in both course formats, considering it a confident, fair, and time-saving assessment tool (Vander Schee & Birrittella, 2021).

Themes emerged, including changes to human interaction, modifications to assessments to prevent cheating, challenges with technology and institutional policies, and advantages such as inclusivity, flexibility, and faculty skill enhancement

(Khan et al., 2022). Recommendations included grading class participation, providing clear assessment guidelines, and utilizing communication methods and recorded sessions. In some cases, it was found that web-based distance education can be less effective than face-to-face courses, especially for applied subjects; also, technical issues can disrupt learning (Ozer & Unstun, 2020).

During COVID-19, grades were the biggest concern among students (Meccawy, 2021). Udeogalanya (2022) argues that during the COVID-19 pandemic, the transition from classroom to online education proved challenging for students, especially those whose future success depended on their academic performance. When students were asked to identify the main drivers of academic success, they cited hands-on instruction (83%), faculty quality (81%), and technology availability (87%). Thus, the author recommends that educators increase their understanding of student performance by regularly checking student grades before and during pandemics to ensure that fears and concerns about grades are justified. She argued that to teach and learn online effectively, there is a need to develop a reliable educational system.

On the other hand, most faculty prefer online assessments for convenience and auto-correction but not for practical or skill-based subjects (Meccawy, 2021). However, cheating was the biggest challenge from the faculty members' point of view due to a lack of proper invigilation as the main cause. This led to grade inflation and did not reflect the actual student performance. It positively influenced interaction but negatively affected attendance (Meccawy, 2021). In the same way, not all faculty members were found competent in online teaching for student engagement, instructional strategy, technical communication, and time management skills (Sarfaraz et al., 2020). Due to the sudden pandemic, teachers were not provided with professional training in ICT, which put many students at risk. This led to excessive pressure on teachers to achieve educational attainment. In some cases, despite their efforts, challenges such as insufficient coordination and little investment in technology hindered the adoption of digital platforms for teaching (Akram et al., 2021). Research has demonstrated that using information and communication technology (ICT) tools, specifically improving digital teacher competence and providing opportunities for teachers to learn digital skills, is key to successfully transitioning to online teaching during unexpected events such as COVID-19 school closures (König et al., 2020). This has significant implications for teacher education and the integration of ICT into teaching practices.

Nonetheless, there are a few studies on using distance education after an earthquake. One study of this kind suggested using social networks to support collaboration in higher education contexts (Dablner, 2012). In another case study, in which the framework of readiness, response, and recovery matrix for disaster management is used, it was found that despite different crises, such as seismic events or tsunamis, the transition from the classroom to distance education has not been an immediate event, but has taken some time (Ayebi-Arthur, 2017). The analysis of case studies allows for generating recommendations about the best practices, in this case, to make an efficient change from the classroom to distance education and find the appropriate conditions that allow efficient use of technology in the completion of this task (Sun & Chen, 2016; Fadde, 2014).

Study Objective

None of the works in the literature review employed institutional data to prove their asseverations. This work aims to evaluate the efficiency of the sudden implementation of synchronous online courses after an unexpected catastrophe (an earthquake), comparing institutional data from courses previously taught in the classroom model with their hybrid counterpart. As the class contents and professors were the same, our null hypothesis is that the analyzed institutional data (students' grades and teaching satisfaction survey results) are equal. However, faculty training data may reveal hidden differences.

METHOD

A comparative statistical study of partial and final grades was carried out on the two models. The faculty profiles and their relation to their evaluation by the student and the student's final grades were also examined. This document describes the general methodology used for these online courses and presents the advantages and disadvantages of the synchronous online model, expressed by the teachers and students involved.

The research had a mixed design (qualitative and quantitative). For the qualitative analysis, an anonymous survey was sent to all 45 faculty members involved in the study. Some questions were on a Likert scale of 1 to 10, where 1 means strongly disagrees and 10 means strongly agrees, and others were open-ended questions. The questions of the survey are shown in Table 1.

Question	Scale
I can adequately teach the contents of the course in this model	1 to 10
The model allows the students to develop the competencies established for the course	1 to 10
The model encouraged discussion, learning, evaluation	1 to 10
I find the model very interesting; I would like to use it in the future	1 to 10
Compared to other semesters, I believe that the learning of the students in my course was	Well below average, below average, average, above average, well above average
What are the main challenges of the implementation of the new model	Open-ended
What are the main advantages of the model	Open-ended

Table 1: Questions of the survey applied to faculty after a hybrid semester.

Another instrument was the Student Opinion Survey (SOS or ECOA in Spanish), an institutional tool consisting of 9 questions regarding the student's perception of the course teaching. Table 2 shows the texts of three questions of the ECOA survey applied to students. After evaluations, students are asked to leave comments about the course.

Number	Text Question	Scale
5	Regarding the level of intellectual challenge (it motivated me and required me to give my best effort and comply with quality for the benefit of my learning and my personal growth), the course was:	From 0 (bad) to 10 (exceptional). "I do not have elements to evaluate" is also possible.
6	Regarding its role as a guide to learning (it inspired me and showed commitment to my learning, development, and integral growth), the teacher was:	From 0 (bad) to 10 (exceptional). "I do not have elements to evaluate" is also possible.
7	Would you recommend a friend take this subject with this teacher?	From 0 (bad) to 10 (exceptional). "I do not have elements to evaluate" is also possible.

Table 2: Questions from the student opinion survey (ECOA).

This investigation only analyses the results of question 7, which concerns the recommendation to take courses with the same teacher in the future (REC). The weighted average of questions 5, 6, and 7, together grouped into the concept "inspiring teacher" (INSP) that has to do with the challenge of being in the specific class and how much the teacher is a guide, an inspiring mentor to follow their studies with passion. Both sets of teacher performance indicators questions were analyzed in the fall courses of 2016 (face-to-face classes) and the fall courses of 2017 (courses that started in person and, due to the contingency, became hybrid).

The quantitative analysis was carried out by comparing the institutional records of two partial grades and the final grades of the students of 21 subjects of the Science Department for the Fall Terms of 20015, 2016, and 2017. The fall term of 2017 was when the earthquake happened, and the fall term of 2016 was the semester of the previous year that the catastrophe occurred. The comparison was made with the same subjects and the same teachers. This was considered a quasi-experimental design because the students who enter these courses have the same requirements but may differ in number. We must stress that we are comparing the results of regular face-to-face courses with a group of "forced hybrid" courses that experienced five weeks of regular teaching and nine sudden synchronous online sessions.

This work mainly presents descriptive statistics. Moreover, the student marks of the second semester (P2) for the years 2016 and 2017 at the Basic Sciences department (Math and Physics) were used to analyze the effect of the seismological event on student performance through a t-student test with a significance level of 5%.

A first test was done using the whole department's marks. After that, individual nonparametric Mann-Whitney tests were performed for each one of the sixteen subjects (Mathematics Introduction, Mathematics I, Mathematics II, Mathematics III, Differential Equations, Applied Mathematics, Advanced Mathematics, Mathematics for design, Probability and Statistics, Statistics for Research in Social Sciences, Statistics II, Physics I, Physics II, Physics introduction, Electricity and Magnetism, Physics for design). The null hypothesis established that the average mark for the second partial mark was similar for both years (2016 and 2017), while the alternative hypothesis established the difference between the two partials of both years. All the analyses were performed in Minitab® Statistical software 21.4, 2023. A multi-vary chart for the second partial period marks was generated for all the subjects. Once the differences between the marks of the compared two years were verified, a correlogram was created using distinct variables (year (2016 or 2017), professor age, experience (EXP - semesters of teaching experience in the institution), training of teacher (TRA - the percentage of courses approved in didactic techniques and educational model), teacher use of technology) to verify possible correlations. In the same way, the influence of the second partial mark on the satisfaction survey of students about teachers was investigated through the teacher recommendation data in both years, building the corresponding multi-vary chart. All this information was obtained anonymously from the Science Department of Campus Mexico City at Tecnologico de Monterrey, so no ethical approval was required for this analysis.

FINDINGS

The faculty survey was applied to teachers after the Fall term of 2017 to respond anonymously, and 35 of the 45 teachers involved in the study answered it. Figure 1 shows that 91% of faculty considered that the synchronous online model allowed the topic's content to be adequately transmitted (rating equal to or greater than 8). In contrast, none considered it inappropriate to transmit the knowledge (Panel 1A).

As observed, 74% of the teachers stated that the rapidly adopted model allowed students to adequately develop the competencies established from the beginning of the course, and none considered it inappropriate for developing competencies (score equal or greater than 8; Panel 1B). About 91% considered that the model promoted reflection on learning assessment (score equal or greater than t 8; Panel 1C), and 77% of teachers considered the model exciting and wanted to continue using it (score equal or greater than 8; Panel 1D). Interestingly, 89% thought that students learning under this new model was equal to or greater than average (Figure 2).

When teachers were asked what the main challenges of implementing the new model, the answers can be summarized in five topics:

- Teachers are digital migrants. Teaching digital natives is a tough challenge for digital migrants; it requires preparation, knowledge of technologies, and access to good enough connection conditions.

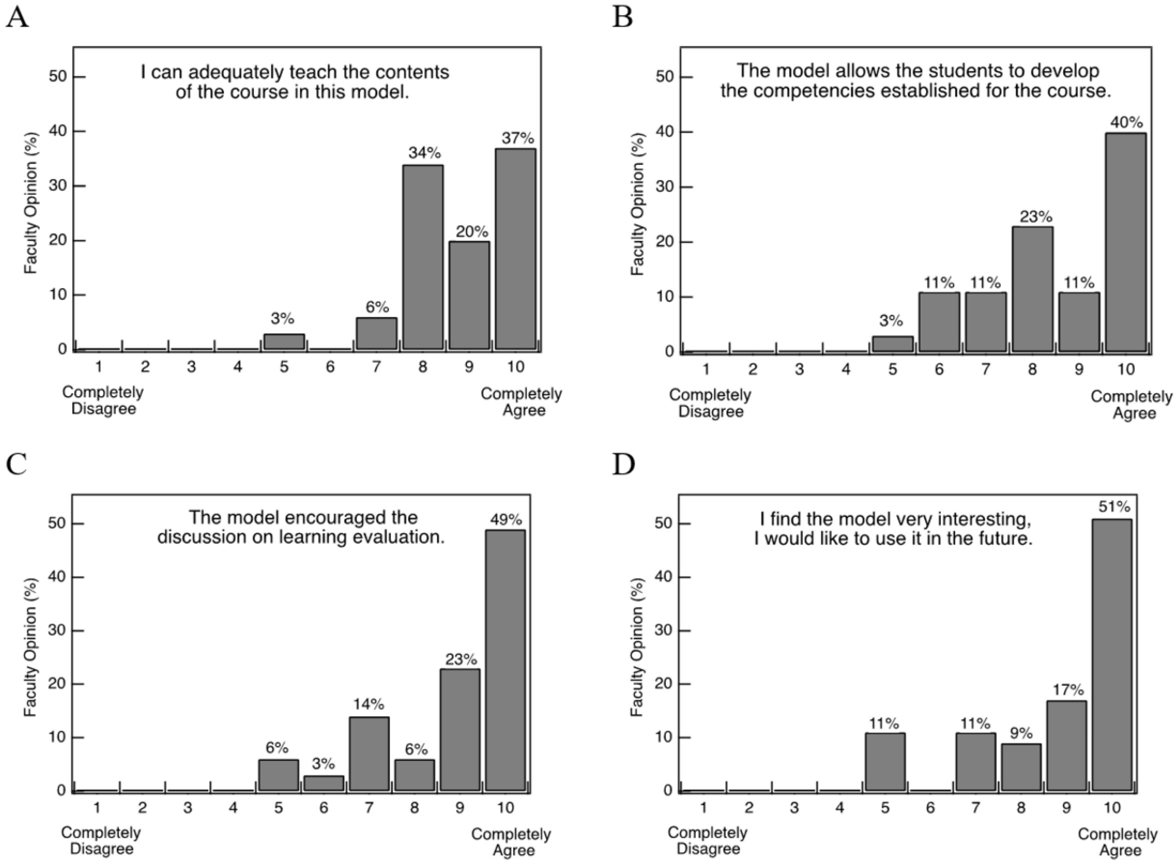

Figure 1: Results of the qualitative survey applied to the faculty on implementing the distance model during the Earthquake at Tecnologico de Monterrey, Mexico City campus in 2017.

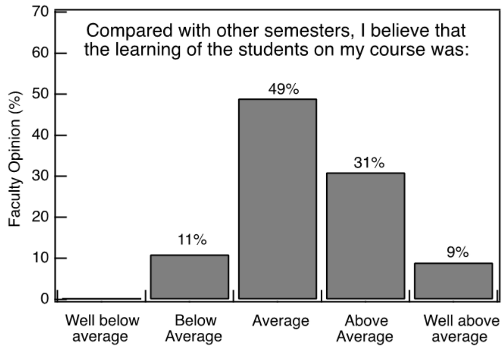

Figure 2: Faculty perception about learning of the students on the distance model.

- The time spent preparing the class. The teachers felt that the planning was different, and the magnitude of the time and effort involved much more time than the one already designated for the classroom.
- The new ways of communication. The interaction between teacher and student and between students was a challenge. Keeping attention, observing gestures, giving so much information to the teacher about the student's understanding, and keeping the students' attention is a more complicated task. In their judgment, the students showed little interaction with each other.
- There was a lack of use and knowledge of the online model. Teachers and students were suddenly confronted by a model that was not their choice or prepared for. They were learning on the go.
- The evaluation. Teachers had to find suitable assessment methods because individual classroom tests were no longer an option. A frequent concern was how to evaluate them so that academic integrity was not a concern. Online assessment tools in science are not well developed, particularly when cognitive analysis is required, so mathematical symbology makes the evaluation more complex.

Teachers were also asked what the main advantages of the model were. The answers can be summarized in three categories:

- Flexibility. Teachers and students can connect from anywhere with a good internet signal.
- Recorded classes. Since all the classes were recorded, students could review them when necessary. If the students did not understand something, they could see the explanation again and understand it or find what they did not understand.

- Several tools can be used. To improve the teaching-learning process, there are tools that they would not have known without this experience. These include tools to display content and perform evaluations that can be used synchronously and asynchronously.

Figure 3 shows the results of the means of the REC and INSP. The students of face-to-face courses of the Fall 2016 Semester rated their teachers with 8.07 (REC) and 8.48 (INSP). In contrast, students in the course who underwent a sudden change in a contingency in the Fall of 2017 scored 8.19 (REC) and 8.63 (INSP). Teachers, in general, consistently obtained the same or better evaluation with the online model (Figure 3).

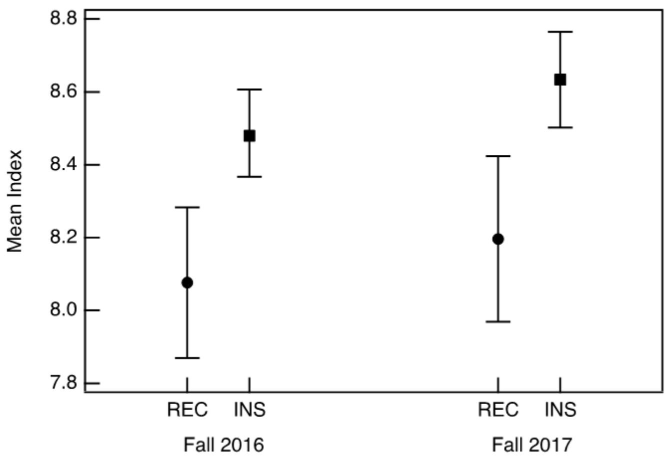

Figure 3: Comparison of the REC and INS indexes of ECOA.

Regarding the students' comments in the ECOA, it was noticed that most comments were about the teacher's performance but not the implementation of the online model. Comments where the online model was mentioned can be grouped into the following answers:

- The teacher is good in class but not online. He does not know how to use technological tools properly.
- The teacher adapted well to the online model. The model favored the class.
- The best thing about the online model is that it allows you to record videos of the classes and review them.
- Editorial platforms for online assessment aided in learning the topics.
- The online model is good, but not for all teachers or all the time. In-person teacher-student and student-student interactions are required.

The students´ grades from the fall semesters of 2015, 2016, and 2017 were compared. The evaluation percentages in the different activities, such as exams, assignments, and research projects, are similar for the 2015 term but the same for the 2016 and 2017 terms studied. Therefore, this analysis allows the grades comparison of three models: a traditional one (2015), one where active learning is emphasized (2016), and the last one, a hybrid model with an initial face-to-face period and a final online segment (2017). The average final scores were 77.19 in 2015, 78.7 in 2016, and 80.7 in 2017.

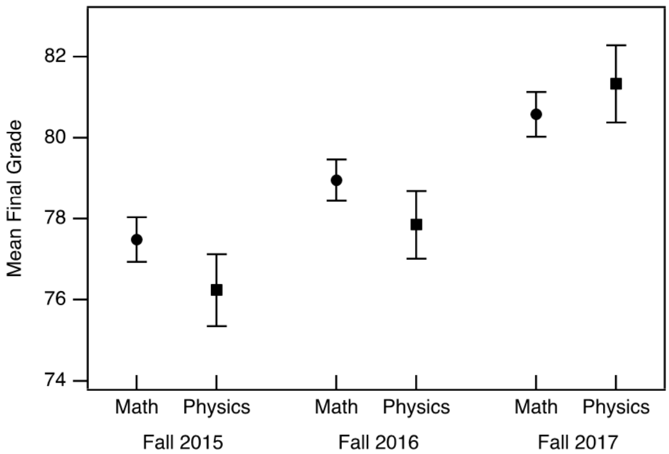

Figure 4: Comparison of mean final grades for the Mathematics and Physics courses.

Concerning the first and second partial grades reports, the average in 2016 was significantly higher than the other two, which do not present significant differences. For the 2017 case in partial 1, the implementation of the online model had not yet started. However, in partial 2, it had already been implemented. Surprisingly, the second partial grade average in 2017 was higher than the previous two years (Figure 5).

From here, we decided only to compare the grades from the second partial of the 2016 and 2017 terms. To this end, we consider that both groups of students (2016 vs. 2017) are

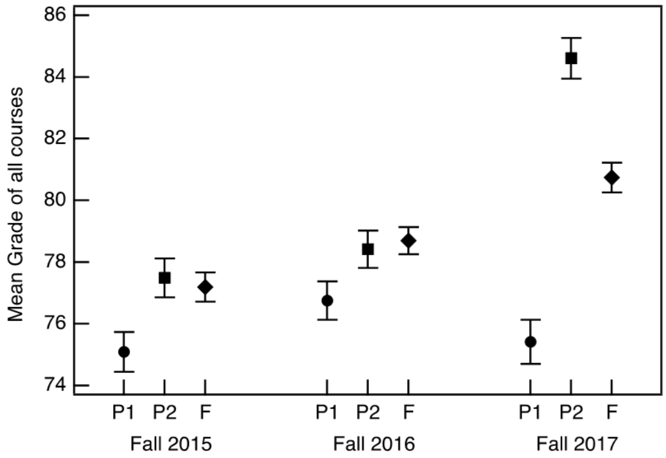

Figure 5: Comparison of mean grades for all the Science Department courses considering the first partial (P1), second partial (P2), and final (F) evaluations.

independent since students with similar characteristics (full academic load, meet the requirements of the subject considering previous years) are randomly assigned to each group, while the instructors are the same, the subjects and their contents are the same, the only thing that changes is the educational model. In 2016, they were taught in a traditional face-to-face classroom setting. In 2017, the subjects were taught in hybrid mode (the first part was face-to-face, and the second part was online in distance mode).

To compare two independent samples, the groups of the subjects analyzed alone did not have a normal distribution (either Anderson-Darling, Ryan-Joiner, Kolmogorov-Smirnov). Therefore, the results were analyzed using a nonparametric Mann-Whitney test since they did not pass the normality test. Table 3 indicates the results for evaluating whether there was a change in the marks/performance of the students after the September 2017 earthquake compared to the 2016 term at campus Ciudad de México for 16 courses.

Knowledge area	Set of subjects or subjects	*p*-value*
Physics	Physics II	0.000
	Elementary Physics	0.000
	Physics for design	0.000
	Electricity and Magnetism	0.023
	Physics I	0.000
Mathematics	Differential equations	0.000
	Applied Mathematics	0.860*
	Advanced Mathematics	0.709*
	Mathematics III	0.000
	Mathematics for design	0.001
	Introduction to Mathematics	0.250*
	Mathematics I	0.000
	Mathematics II	0.105*
Statistics	Statistics II	0.000
	Statistics for research in social sciences	0.000
	Probability and Statistics	0.004

**Significant difference at p ≤ 0.05*

Table 3: Performed Mann-Whitney test to compare P2 marks in 2016 and 2017 by subject.

As observed, most of the analyses were significant, showing a difference in students' marks in the second partial of 2016 and 2017, indicating an earthquake effect by subject, except for some math subjects (Applied Mathematics, Advanced Mathematics, Introduction to Mathematics, and Mathematics II). This result in mathematics subjects has been observed in other works (Abd Rahman et al., 2022), where no significant difference has been observed when comparing teaching in face-to-face modalities vs teaching in distance modalities. The reason that there was no difference has been attributed to the fact that these mathematics subjects may require more time for preparation and learning than other areas of study (Banjević et al., 2021).

The average marks of the second partial of 16 courses in 2017 were greater than in 2016 (Figure 6).

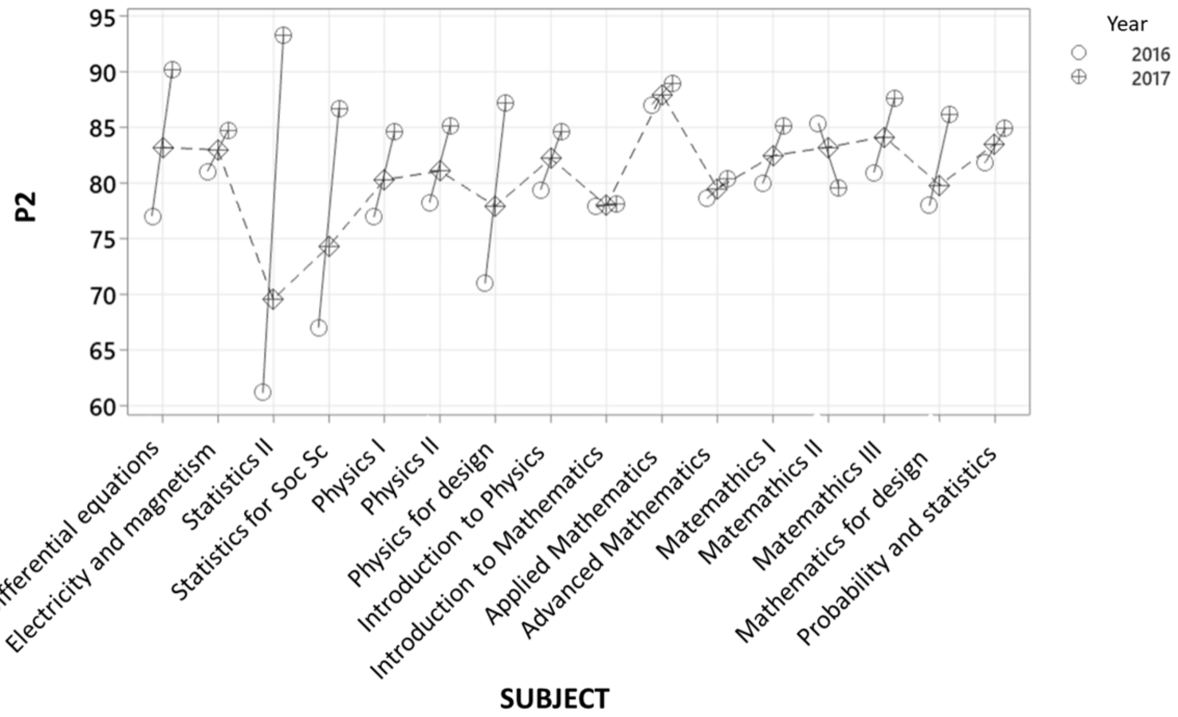

Figure 6: Multi-chart for student marks of P2 by year-subject.

Figure 7 indicates the degree of correlation between some variables measured in both studied periods, some of which are associated with the teacher profile, such as age, experience, use of technology (TECH), and training (TRA).

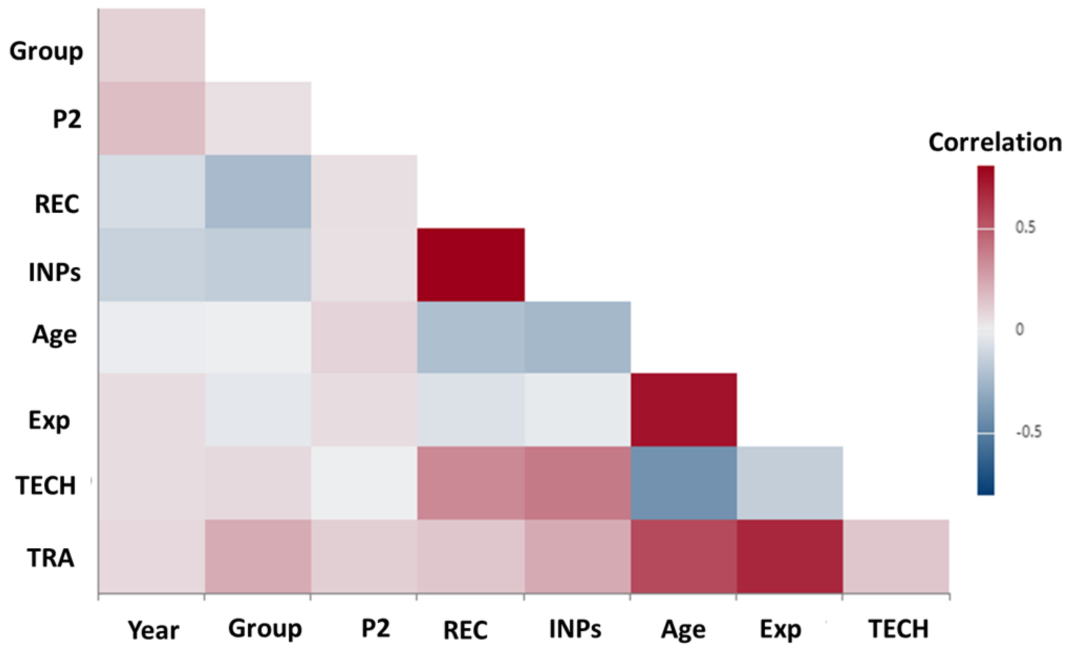

Figure 7: Correlogram showing the relationship between each considered variable: P2 mark, teacher performance indicators, and teacher-associated variables.

The correlogram reinforces the effect of the year on the P2 marks as a direct correlation. At the same time, it is observed that REC and INPs are weakly correlated (values less than 0.5) with other variables, for example, age, technology use, and training, without having a strong or significant impact, which it seems to indicate that these do not influence completely at all in the high marks gotten for P2 in the year 2017. In the same way, intense correlation is denoted among the subgroups of variables but not with P2 or teacher performance indicators (REC or INPs). To check for some trends by year in teacher evaluations by students, a multi-chart for REC by year-subject was generated (Figure 8). No relationship was found since some teachers were evaluated differently in both years. In about four subjects, REC was more favorable in 2017 than in 2016, but in about four subjects, REC was more favorable in 2016. In the rest of the subjects, REC stayed equal.

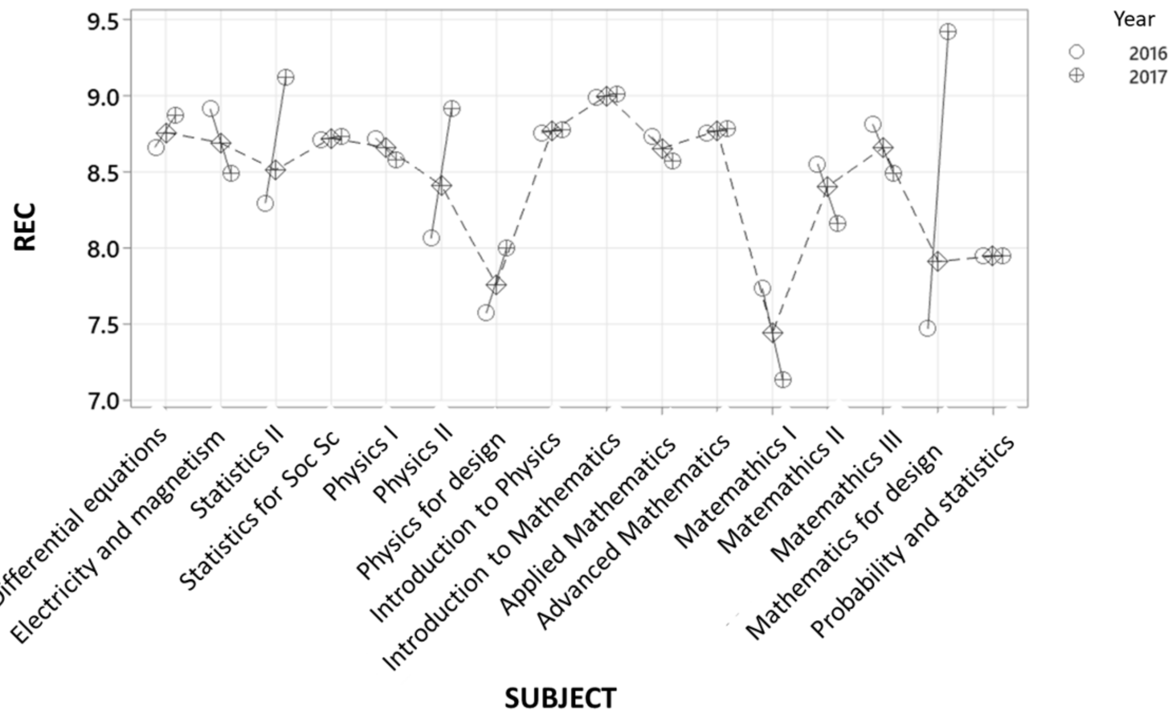

Figure 8: Multi-chart for REC by year-subject.

DISCUSSIONS AND CONCLUSION

In 2020, we experienced a health emergency that forced education to change its teaching models radically. The sudden change from one educational system to another implied a sudden and forced adaptation for teachers, as they did not have physical classroom spaces. Many universities suspended their courses, and others had to assume a new teaching system: distance classes with students at home. Only those institutions that have been training their teaching staff on using new technological tools have chosen to follow their courses online. For this reason, analyzing previous experiences helps establish application parameters of emergent situations in education.

As presented, in this case, in the study of the implementation of an online model in 2017 for the basic sciences department of Tecnologico de Monterrey, Mexico City Campus, during an earthquake catastrophe, Faculty indicated that the contents and competencies could be reached for the students in this online mode and that the student performance was better in it respect to the traditional model. This last declaration agrees with the subsequent comparison of average marks of the obtained partial marks (P2) for the students during the catastrophe, compared to the corresponding partial in 2016. Even teachers were inclined to use the model in the future. Although, in other Universities hit by earthquakes, such as the University of Canterbury, New Zealand (2011) and the Kathmandu University in Nepal (2015), the satisfaction degree of the students concerning online learning courses has been measured (Wright & Wordsworth, 2013; Joshi et al., 2018), not quantitative evidence is given about their learning achieved as provided in this work.

The advantages for teachers in their comments (flexibility, recorded classes, and online tools) have already been mentioned in other works (Arkorful & Abaidoo, 2015; Kahigi, 2022), particularly recently during the pandemic. However, these teachers also manifested some challenges of online education, such as digital migration, a major demand for time for class preparation, the use of new communication alternatives, and insufficient knowledge and use of online education on their part before the implementation. These comments were presented in similar studies even during the COVID-19 emergence (Visser, 2000; Adedoyin & Soykan, 2020). As said in the literature, for the online model to be efficient, teachers need to be adequately trained and comfortable with technology (Rehn et al., 2016). It is evident that teachers take much longer to prepare their classes in this format at the beginning because they had to rethink the way of evaluating the student and change some methodologies and didactic techniques (Visser, 2000) to allow different interactions between them: teacher-student and student-student, the situation also observed when other learning formats are used such as inverted classroom and active learning.

Concerning the challenge of the little knowledge of educational models and use, it allowed us to distinguish that there was an important population of teachers not linked to online learning, around 50% of the Basic Science Department. However, the other 50% have been involved in educational technology and innovation projects, designing simulators, games, augmented reality applications, virtual environments, e-books, educational videos, and online assessment systems (Medina et al., 2018). Fortunately, Tecnologico de Monterrey has promoted this technology immersion with the TEC-21 educational model since 2012, which highly demands educational technology, continuous assessment, active learning, and novel didactic techniques (Membrillo-Hernández et al., 2018; 2019). Online courses require the teacher to know and manage the tools for a virtual classroom (Wallace, 2003; Martin & Parker, 2014).

The approach of these online system tools enables the teacher to speak, show, demonstrate, explore, and even be attentive to a particular student during the class (Wallace, 2003; Wandler & Imbriale, 2017; Yu & Kuang-Chao, 2015). Here, it is important to consider a change in the educational systems to cope with the technological advances of the digital world.

When the marks of Basic Sciences Department students were analyzed, our data concludingly indicated that the marks of the P2 2017 students were higher than those of the students in the P2 2016, the difference evident even for each subject of the department, supporting that much difference in the average marks is not only for a certain area (mathematics or physics) or topics. Again, this observation about 2017 marks reinforces teachers' comments about these students' performance. The analysis to review a possible relationship between teacher performance indicators and teacher-associated variables on student marks (P2) or teacher-associated variables with performance indicators does not identify significant correlations; only age, use of technology, and training are weakly related to REC or INPs (less than 0.5). Deeper research will be required to test these relationships. We suggest researching other factors affecting the basic sciences student performance at Tecnologico de Monterrey in this online model learning after the 2017 earthquake in Mexico City. Examples of these factors may be the emotional state of the students, the different pedagogical strategies adopted by the faculty during the online education system, and the ethical implications, such as the cheating issues suggested by Meccawy (2021).

The García-Castelán et al. (2021) study explored the advantages and disadvantages of in-person classes versus online training sessions for engineering courses during the same earthquake but using different instruments. The study surveyed 396 engineering students from the Campus of Mexico City using a 25-item survey focused on human interaction, self-discipline, and academic performance. The results showed that most students felt that face-to-face classes were more conducive to their learning process and facilitated better communication with teachers and peers. Lack of human contact, outdoor activities, and difficulty forming new friendships were cited as factors against distance learning. The study also found that online learning increased distractions, depression, and stress. However, from an academic standpoint, student performance remained consistent between face-to-face and online learning, as observed in our work (García-Castelán, 2021).

This experience was a precursor for online education during the Covid-19 at Tecnologico de Monterrey. Sayeg-Sánchez et al. (2021) found empirical evidence during the COVID-19 pandemic from 108 students in a Business Mathematics course from Tecnologico de Monterrey showing a statistically significant decrease in students' stress levels when using Guided Learning Sequences as a content delivery strategy which allows the student to receive information, think about its meaning, put it into practice, and receive instantaneous feedback to reinforce their learning process. Also, a pre-test and post-test analysis of 45 students showed evidence of a positive impact on students' performance.

This implies that only accounting with well-prepared teachers is insufficient to obtain good student performance when changing from a face-to-face to an online environment due to a sudden event. Amidst the COVID-19 pandemic, Gao et al. (2020) discovered that students enrolled in chemistry laboratory courses favored in-person instruction over virtual laboratory exercises despite achieving lower performance scores in face-to-face labs than in online classes. The study suggests that combining in-person teaching with computer-assisted grading and assessments could hold potential for the future (Gao et al., 2020). Delgado et. al. (2021) suggests that to relate the course design and teacher support with the student performances, actions are necessary, such as preparing several channels for the delivering, keeping in touch, considering the learning styles, supporting the challenge resolution creatively and to keep coordinated with teacher partners for success in the delivery in the same (COVID-19) contexts.

The results of this experience suggest that the sudden transformation from one model to another implies more outstanding preparation and updating of teachers, a willingness of students to use technological tools, and a global commitment to 100% digital communication. The studies of the educational transformation in 2017 generated a solid basis for having a group of expert teachers transform face-to-face courses into online ones in the Mexico City Campus of Tecnologico de Monterrey. In this Campus, the digital transformation in 2020 was much smoother than the one described in this study. In this regard, it is important to note that a limitation of this work was that a student satisfaction survey could not be obtained because the implementation of the model was unexpected or abrupt. On the other hand, from the teacher´s perspective, the model allowed the course content to be transmitted appropriately and allowed students to learn and develop competencies.

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