Academic performance, teacher assessment, and student-faculty interaction in online versus face-to-face teaching

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Abstract

Introduction: The change in the learning environment, from face-to-face to online, caused by the SARS-COV2 coronavirus pandemic in the Singapore university environment had an impact on academic performance, teacher assessment and student-teacher interaction. **Objective:** To evaluate the impact of the change in the learning environment on academic performance, teacher assessment and student-teacher interaction. **Method:** The grades and evaluation surveys of 282 students from two cohorts who studied in 2020 were compared consecutively face-to-face and online university training. **Results:** The results show differences in academic performance, but not the teacher's assessment and student-teacher interaction. **Discussion:** It is possible to maintain an optimal educational quality without altering the teacher's assessment and the student-teacher interaction, both in the online and face-to-face modes, but it is necessary to present an evaluation method consistent with the modality used.

Keywords: long distance education; online evaluation; COVID-19; teacher assessment; student-teacher interaction; academic performance.

Rendimiento académico, valoración del docente e interacción alumno-profesor en la docencia online frente a presencial

Resumen

Introducción: el cambio de entorno de aprendizaje, de presencial a online, provocado por la pandemia del coronavirus SARS-COV2 en el ámbito universitario de Singapur tuvo impacto en el rendimiento académico, la valoración del docente y la interacción alumno-profesor. **Objetivo:** evaluar el impacto del cambio de entorno de aprendizaje en el rendimiento académico, la valoración del docente y la interacción alumno-profesor, **Método:** se compararon las calificaciones y las encuestas de evaluación de 282 estudiantes de dos cohortes que en el año 2020 cursaron de forma consecutiva formación universitaria presencial y online. **Resultados:** los resultados muestran diferencias en el rendimiento académico, pero no así la valoración del docente y la interacción alumno-profesor. **Discusión:** es posible mantener una calidad educativa óptima sin alterar la

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valoración del docente y la interacción alumno-profesor, tanto en la modalidad online como presencial, pero es necesario presentar un método de evaluación coherente con la modalidad utilizada.

Palabras clave: educación a distancia; evaluación online; COVID-19; valoración del docente; interacción alumno-profesor; rendimiento académico.

Introducción

In Wuhan (China), at the end of 2019, the SARS-COV2 coronavirus appeared and spread globally, causing the pathological symptomatology categorized as COVID-19, highly contagious and for which the human immune system was not adequately prepared. The rapid spread of the SARS-COV2 coronavirus throughout the world led to the outbreak of the global pandemic that has profoundly affected all countries over the next two years. This pandemic, generated by the SARS-COV2 coronavirus, has had enormous social consequences in all areas and at all levels (Hosseinzadeh et al., 2022; Szcześniak et al., 2021). One of the most affected areas has been the educational sphere, as the pandemic outbreak caused all educational institutions at all school levels to close for a prolonged period and prevented schools to conduct face-to-face classes for two school years in most countries. In addition, the consequences of the pandemic caused innumerable and varied measures that profoundly affected the normal development of the educational process, especially among the most vulnerable (Araújo et al., 2020; Vlachos et al., 2021).

Pérez and Hernández (2020) point out that, in the case of Spain, once the educational centers migrated their activities to the new online environment during the confinement, the main problem was not the lack of equipment, but the lack of training in the use of technological tools, both for students and teachers. Although the possible equipment deficiencies were duly resolved by the centers and the administrations, the problems regarding training and digital competence were not, which contributed to increasing inequality.

Likewise, Alharthi (2020) noted that most of the people who have received training in a virtual environment, even at higher educational levels, consider it essential to receive specific training beforehand on the technology to be used in this environment, which was not possible during confinement (García-Martín & García-Martín, 2021; Sánchez-Cabrero et al., 2021b). Some even mention a paradigm shift in education in the aftermath of the pandemic, beyond the changes experienced at the time, based on the combination of Information and Communication Technologies (ICT) and neuroeducation (Espino-Díaz et al., 2021).

Among other studies, Bączek et al. (2021) studied the effects of the sudden change of the learning environment (from face-to-face to online) promoted by confinements. From the responses of 804 students to their questionnaire, they concluded that students perceive both environments as equally valid in facilitating their learning, and that 73% believe the virtual environment is as enjoyable as the face-to-face one. Regarding this comparison, focused on the link between the sudden change in the learning environment and the emotional impact on students, the recent study by Sánchez-Cabrero et al. (2022) analyzed how, despite the drastic change and the multiple psychological and social consequences on the population, the students' emotional intelligence was not affected, allowing them to maintain an adequate educational functioning level during the pandemic without visibly altering academic performance or test anxiety. However, the comparative analysis of face-to-face and virtual learning environments had already been extensively discussed prior to the pandemic. Paechter and Maier (2010), after analyzing information from 2196 students about their experience and preferences for face-to-face or virtual (online) learning, highlighted clarity and coherence of teaching materials, self-regulated learning, and the distribution of information as the advantages of virtual learning. On the other hand, communication and interpersonal relations were highlighted as positive aspects of face-to-face learning.

Alonso and Blázquez (2009) analyze the functions of teachers in face-to-face and virtual

(online) environments based on the study of four aspects (theoretical content, practical content, student-faculty interaction, and design of activities), concluding that no statistically significant differences are found that can be explained by the learning environment. Johnson et al. (2000) carried out a comparative study of the same course taught in a face-to-face and an online environment. For this purpose, they analyzed, among others, three aspects of the teaching-learning process—the learning results, the students' evaluation of the teacher, and the student-faculty interaction. This study shows a slightly more favorable perception of the teacher in the face-to-face environment, which could be explained by greater emotional proximity. Learning outcomes were very similar in both environments.

Regarding student-faculty interaction, the results indicate a more favorable perception in the face-to-face environment. Likewise, Paul and Jefferson (2019), after analyzing the grades of 548 students of a subject over 8 consecutive years, conducted in face-to-face (401) and online (147) formats, conclude that there were no statistically significant differences in the students' learning outcomes, a conclusion that is similar to that presented by Toyne et al. (2019).

Shortly before the onset of the pandemic caused by the SARS-COV2 coronavirus, Bengtsson (2019) concluded in his study that non-face-to-face examinations were the best form of assessment for higher educational levels because they facilitate constructive learning, allow reflection and the development of higher cognitive abilities, and at the same time turn assessment into a learning process. The author warns that these exams are not recommended at lower levels because of the obvious risk of unethical student behavior.

Myyry and Joutsenvirta (2015) studied open book testing as a suitable alternative for summative and formative assessment, which avoids the negative influence of plagiarism.

They conclude that the time spent in preparation is similar in both types of exams, but that for half of the students responding and learning in the open exams involved a much greater investment of time.

In another study prior to the pandemic, Gaytan (2005) studied the elements necessary for assessment techniques to be effective in an online environment and pointed out the need for them to take into account aspects as diverse as technological requirements, teaching style, pedagogical approach, and learning outcomes. In the following years, Gaytan and McEwen (2007) studied online assessment strategies and effective techniques. Their work is based on two questionnaires sent to 85 teachers and 1963 students in the US participating in online environments, from which they obtained 361 responses (29 teachers and 332 students). The questionnaire sent to the teachers was focused on their perception of whether the quality of teaching was affected by working in an online environment, as well as the effectiveness of assessment strategies in such an environment. The one sent to students sought to measure their perception of the effectiveness of the Internet as a learning environment and the most effective assessment strategies. After analyzing the results, the authors conclude that the strategies should be based on a wide variety of tasks to be performed regularly, from which the teacher can provide meaningful feedback for students' learning in a timely manner. They state that effective techniques are projects, portfolios, co-assessment, self-assessment, and weekly assignments with immediate feedback. For Deeley (2018), summative assessment can be used for learning, hand in hand with appropriate technology. This switch from assessment of learning to assessment for learning must occur in an environment where teachers and students trust each other and feel comfortable and close and requires its implementation to be flexible and progressive.

Whenever the context allows, student preference for online and face-to-face assessment should be considered (Hewson, 2012).

Likewise, Hewson (2012) studies whether this preference determines the results obtained. To do so, she analyzes two consecutive cohorts of 33 and 41 students, respectively, who took the same subject with the same teachers. All students took the same exam, but those in the first cohort took

the exam face-to-face and those in the second cohort took it online. In her paper, she concludes that preference does not influence the results, but that this does not mean that the reluctance towards online testing, especially important in social sciences and humanities students, can be ignored. In times of the SARS-COV2 coronavirus pandemic, a change in these preferences could be expected, with a better predisposition towards online assessment, given that the priorities and concerns of students are focused on dimensions not considered in the aforementioned work, such as personal safety.

Authors such as Fuller et al. (2020) and Sánchez-Cabrero et al. (2021a) present the current context as the definitive opportunity to expand and improve the way assessment has traditionally been conducted. The recent study by Sánchez-Cabrero et al. (2021a) showed how "proctored online evaluation provides the same guarantees of fairness and equality as desktop exams, with the added bonus of certain advantages, which strongly support their continued use, especially in degrees with many students who may come from many different locations" (p. 1). However, the authors also noted how the assessment environment (online/face-to-face) led to differences in the examination design by lecturers, which impacted on the difficulty of the test. In their study, they observed that the inexperience of teachers in designing online exams caused them to design easier exams, which improved the scores, although the distribution of scores by level remained unchanged, leading to the conclusion that there are no real differences in the type of assessment, but that teachers' fears or expectations can affect the results, since they can include compensatory measures that can alter them (Sánchez-Cabrero et al., 2021a).

Given the information above, and due to the unique opportunity presented by the unfortunate global pandemic situation, this study aims to assess the impact of the change in the learning environment implemented in an undergraduate course at a university level in Singapore in 2020, as a consequence of the restrictions on mobility and social contact imposed during the SARS-COV2 coronavirus pandemic. The research study is designed with two research objectives. First, (1) it is intended to compare the academic performance of the last cohort with a fully face-to-face learning environment and the first cohort with a fully online learning environment, considering not only the overall final examination, but also its different assessment components. Secondly, (2) the aim is to evaluate whether the change in the learning environment has affected the teacher assessment and the student-faculty interaction, and whether these factors have influenced academic performance.

Based on the previous literature on this field of study, previously described, we can state that the sudden change and teachers' lack of training could negatively affect both academic performance and the student-faculty relationship (Alharti, 2020; Araújo et al., 2020; Pérez & Hernández, 2020). However, other studies highlight the adaptability and resilience of students to educational changes, so we can hypothesize that these students' characteristics will modulate and reduce the adverse effects and the impact of the change in the educational environment, so that the impact will be low or even imperceptible in those studies (Bączek et al., 2021; Sánchez-Cabrero et al., 2021a; Sánchez-Cabrero et al., 2022).

Method

Design

The study employed an ex post facto design with a descriptive nature, since it is based on data related to the students' grades and their teaching assessment surveys. It is correlational, since it analyzes the correlation between variables—such as grades,—as well as cross-sectional and sequential since it studies two consecutive cohorts of the same course.

Participants

The aim of this study was to use a representative sample of the university population in Singapore while conducting the study through the prism of

the Western educational structure, so, by means of cluster sampling, students who studied the official Bachelor of Business Studies program of the prestigious University College Dublin in its international edition were selected, by choosing the two cohorts closest to the outbreak of the SARS-COV2 coronavirus pandemic. University College Dublin is one of the few universities in the world to hold the Triple Crown accreditation from EQUIS (Europe), AACSB (United States), and AMBA (United Kingdom), which guarantees its international profile, great educational excellence, transparency and quality in its educational processes, and the reliability and validity of its assessment processes. The sample consisted of 282 undergraduate university students, distributed in two cohorts of 125 and 157 students, with an age range between 18 to 21 years. All participants were enrolled in the same module in both cohorts and completed the university's standard grade and evaluation form, which guaranteed the anonymity of their data, the protection of their rights and the informed consent to the anonymous use of their academic results and educational evaluations for exclusively scientific purposes. Both cohorts were culturally diverse, and no statistically significant gender differences were found. The specific distribution of participants according to gender and age is unknown due to privacy restrictions imposed by the university to guarantee the anonymity of the students. However, the equal and random distribution according to gender and the limited age range evaluated (18-21 years) ensured that both variables were controlled and did not interfere with the results.

The educational system in which the courses under analysis are framed is that of Singapore, although the degree also complies with the European Higher Education Area (EHEA) standards, which imposes high-level requirements of reliability and validity in all its processes for its validation, including an exquisite and scrupulous use of student satisfaction surveys with their teachers and study programs (EURYDICE, 2020). The degree (180 ECTS) belongs to the social sciences field and is structured by semesters. Therefore, it is possible to begin the program at two different times of the year, which translates into the existence of two cohorts in each calendar year.

For the first cohort (125 students), the learning environment was face-to-face, while for the second cohort (157 students), it was virtual, replacing the face-to-face classes with synchronous online classes. As shown in Figure 1, the final grades and their continuous assessment components of the 282 students are available. On the other hand, for the evaluative analysis of the teacher and student-faculty interaction, the results of 114 questionnaires are available, since these assessment questionnaires were strictly anonymous and voluntary, as part of the students' agreement with the university in the informed consent of the scientific use of their evaluations. The research was conducted at the beginning of the school closure period in Singapore, and the students were quite enthusiastic and supportive of the new learning environment. It is possible that, if the study had been conducted later, after a longer period of confinement, the students' mood towards the new methodology might have changed, which could have altered the results obtained.

Instruments for Data Collection and Variables Evaluated

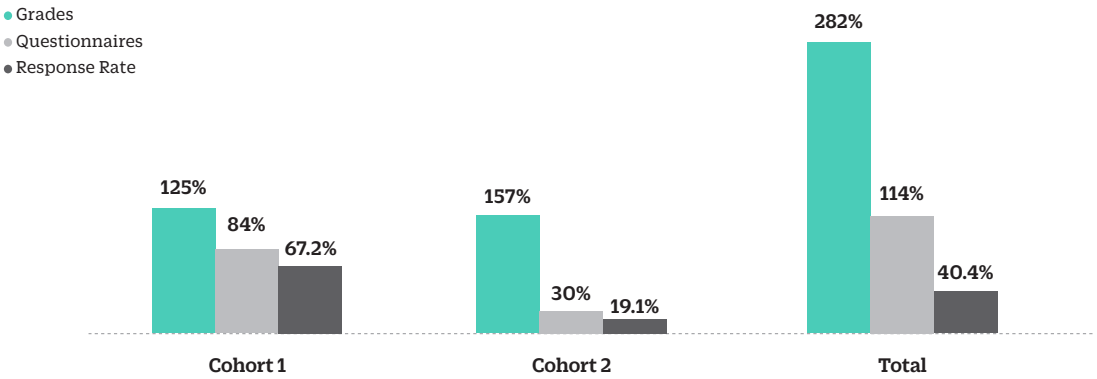
The main variables evaluated in this study are described below:

a) Learning environment. This is the main variable of the study. Nominal variable with two levels, face-to-face learning environment and online learning environment. It consists of two cohorts of the same course, taken in the same academic year.
b) Academic performance. Continuous quantitative variable made up of the students'grades in each of the evaluation components: course project, final exam, and overall grade.
c) Teacher assessment. Analyzed from official surveys answered by students through nine items on a five-point Likert scale.
d) Student-faculty interaction. Analyzed from official surveys answered by students through three items on a five-point Likert scale.

There are two evaluation instruments. On the one hand, for the analysis of academic

Figure 1

Sample Distribution based on Participation in the Different Evaluative Components



performance, the students' final grades were available, as well as the grades of the components of said final grade (a project and an online written final exam). The reliability of the evaluation of the students' academic performance has been measured through Cronbach's Alpha coefficient, resulting in an adequate level of reliability (α=0.786). On the other hand, the teacher assessment and the student-faculty interaction were analyzed based on the results obtained in the official surveys completed by the students using a five-point Likert scale. These ratings were managed by an external company, Kaplan Higher Education (Kaplan Higher Education, 2022), in accordance with the requirements established by the EHEA (EURYDICE, 2020), guaranteeing their anonymity and data protection using a strictly neutral process, previously validated and managed externally, guaranteeing the compliance with all ethical requirements relating to data processing. Unfortunately, this external evaluation reports only the final result, so it does not allow any external calculation of its reliability, although it complies with all the standards of validity and reliability established by the EHEA (EURYDICE, 2020).

Procedures

The data were collected from the standard evaluation form previously designed by the university, so the students did not know they were part of any specific research, so no Hawthorne effects were expected, nor social desirability relative to specific responses. The university's standardized protocol was followed throughout, both for the assessment by means of an examination and in the student satisfaction surveys. Such a process requires an evaluation of student-faculty interaction by students prior to their learning assessment, so that it did not affect the evaluation results (EURYDICE, 2020). This standardized system complies with all the standards established by the EHEA and by the competent authority of Singapore in university education to guarantee objectivity and respect the students' rights and anonymity.

Table 1

Results of the Kolmogorov-Smirnov Test

Variable	K-S	Significance
Project grade	0.159	0.000**
Exam grade	0.159	0.000**
Final average grade	0.143	0.000**

***Significant correlation above the 99% confidence level*

Data Analysis

To assess the use of the appropriate inferential statistical tests, the Kolmogorov-Smirnov (K-S) test was performed first to verify whether the analysis data followed a normal distribution. The results of the K-S test are shown in Table 1 above.

Table 1 shows that none of the data distributions corresponds to a normal distribution, so the use of non-parametric tests is recommended. Therefore, for the study of the grades obtained by the students, a correlational analysis of their distribution in both cohorts will be carried out using Spearman's Rho as the contrast statistic test, since it is a non-parametric statistic test that allows the combination of ordinal variables. Furthermore, an inferential statistical treatment will be carried out using the t-test for independent samples and the Mann-Whitney U-test for independent samples as a non-parametric test.

A confidence level higher than 95% (α=0.05) or 99% (α=0.01) is established to accept the statistical significance of the results of the inferential or correlational contrasts performed, and the effect size of the inferential results is calculated using eta squared.

The data relating to both cohorts and to all students' grades were statistically analyzed using the IBM SPSS statistical software, version 24. In addition, the results obtained in the teacher assessment surveys completed by the students of the two cohorts will be analyzed. To analyze the student-faculty interaction, the teacher assessment results of three aspects of the new online environment, collected in the questionnaire answered by the students of the second cohort, will be reviewed.

Results

Regarding the comparative evaluation of academic performance, Table 2 shows the resulting descriptive analysis in both cohorts according to the arithmetic mean and standard deviation (descriptive statistics), and by means of the asymmetry and kurtosis (sampling distribution parameters). Students in the face-to-face cohort (N=125) took the course in a face-to-face environment during the first semester, and those in the online cohort (N=157) took the course in an online environment during the second semester of the year. The grading system is alphabetical, where D is the minimum passing grade and A+ is the highest grade. For its numerical definition, the scores are converted into a 0-12 scale (from 0= fail to 12= A+). The final grade is obtained from the grades of a project (weight = 40%) and a final written exam (weight = 60%). In Table 2, it can be clearly seen how there are notable differences between the two groups in the Exam and Final Average grades, while the differences in the Project grade are much smaller. The visual analysis of the results, shown in Figure 2 below, may help to clarify these differences.

Table 2
Descriptive Statistics

	Cohort	n	*M*	*DE*	*g1*	*g2*
Project Grade	Face-to-face	125	8,50	2,395	-0.951	0.841
	Online	157	8,53	2,171	-0.923	0.834
Final Exam Grade	Face-to-face	125	6,82	2,821	-0.841	-0.024
	Online	157	4,13	3,061	0.181	-1.017
Final Average	Face-to-face	125	7,47	2,131	-0.926	1.038
	Online	157	5,82	2,492	-0.151	-0.580

In Figure 2, the percentage of students who failed in both cases is similar (less than 2%), yet the distribution of the grades of the students who passed the course shows a higher concentration of low grades (between D- and C+) in the online Cohort 2 (57%) and of high grades (between B- and A-) in the face-to-face Cohort 1 (77%). The distribution of grades for Cohort 2 is very similar to the distribution of grades for all courses in the department, which shows a more standardized distribution than the face-to-face Cohort 1.

Figures 3 and 4 show the distribution of grades for the two components that make up the final average grade.

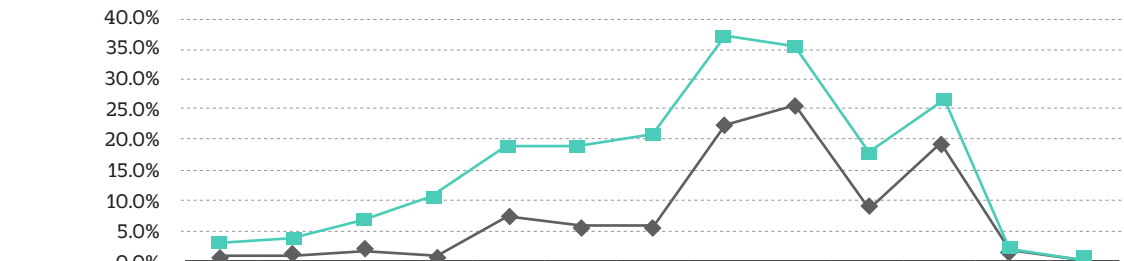
As can be seen in Figure 3, the distribution of project grades is remarkably similar for both cohorts.

In the case of the distribution of the final exam grades, the differences between the two cohorts are relevant. In the online Cohort 2, the percentage of students who failed is much higher, while in the face-to-face Cohort 1 there is a greater number of high grades (between B- and A-). The results seem to indicate that the difference between the two cohorts could be due to the differences in the distribution of the Final Exam grades, as can be seen in Figure 4. Therefore, it is important to perform an inferential statistical analysis of the data to determine the significance of the differences between the two groups.

First, to assess the significance of the differences between the two cohorts, the t-test for independent samples was used, using Student's t-test as the contrast statistic and the Mann-Whitney U-test as

Figure 2

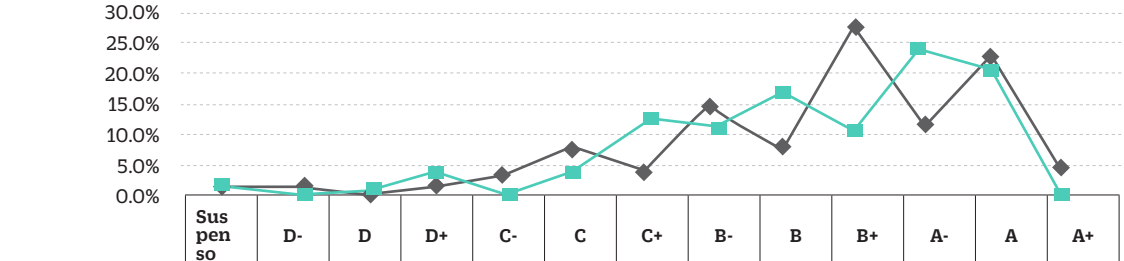
Distribution of Final Average Grades



	Suspenso	D-	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Cohort 1	1.9%	2.5%	5.1%	9.6%	11.5%	13.4%	15.3%	14.6%	9.6%	8.9%	7.0%	0.6%	0.0%
Cohort 2	0.8%	0.8%	1.6%	0.8%	7.2%	5.6%	5.6%	22.4%	25.6%	8.8%	19.2%	1.6%	0.0%

Figure 3

Distribution of Project Grades



	Suspenso	D-	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Cohort 1	0.8%	0.8%	0.0%	1.6%	3.2%	7.2%	4.0%	13.6%	7.2%	26.4%	9.6%	22.4%	3.2%
Cohort 2	0.6%	0.0%	0.0%	3.2%	0.0%	3.2%	12.1%	10.8%	15.9%	10.2%	23.6%	20.4%	0.0%

the nonparametric test; the ETA squared was also calculated to show the effect size of each contrast. The results obtained can be seen in Table 3.

Table 3 shows that both the Final Exam and Final Average grades show statistically significant differences among the cohorts in the results, while the Project grade does not show statistically significant differences. Considering that the Average Grade depends on both grades, it is possible to affirm that it is the Final Exam grade that generates the differences between both groups. Regarding the effect size, the effect size of the Final Exam grade, although low, is considerably higher than in the other two measurements, which supports the explanation that it is in the exam where the statistically significant differences between the two cohorts are observed.

Finally, the correlations between the different grades are analyzed to observe the degree of covariation between grades, using Spearman's Rho as the contrast statistic, since it allows the inclusion of ordinal variables and is a non-parametric statistic; thus, the cohort variable converted to an ordinal scale can also be included in the comparison, as can be seen in Table 4.

The analysis of the correlations in Table 4 shows that all are statistically significant, which reflects a high intrasubject coherence (i.e., the grades are highly dependent on the student's effort and talent, which is desirable). However, it is possible to observe, as in the mean comparisons, how the strongest association is found between the Final Average and the Final Exam grades, and how the only non-significant correlation is found between the Cohort and the Project Grade.

Regarding the teacher assessment survey, it was submitted by 84 of the 125 students in the face-to-face Cohort 1 and by 30 of the 157 students in the online Cohort 2. Table 5 shows the average results of the assessment survey on a five-point Likert scale for each cohort according to nine items.

Table 5 shows how there are very few differences between cohorts in the assessment of professors, so it can be affirmed that the change of learning environment was not a factor that altered this variable and the differences in academic performance between cohorts are probably not due to a different role of professors. Figure 5 below shows these results to provide further information on which to draw various conclusions.

As with Table 5, Figure 5 shows a high consistency in student ratings of the professor,

Table 3

Results of Student's t-test and Mann-Whitney U-test for Independent Samples

Variable	*t*	p^a	p^b	η^2
Project Grade	-,120	0,905	0,902	0.000
Final Exam Grade	7,656	0,000**	0,000**	0.170
Final Average	5,991	0,000**	0,000**	0.110

Note. pa = Student's t-test statistical significance; pb = Mann Whitney U statistical significance; η^2 *= Eta squared.*

Table 4

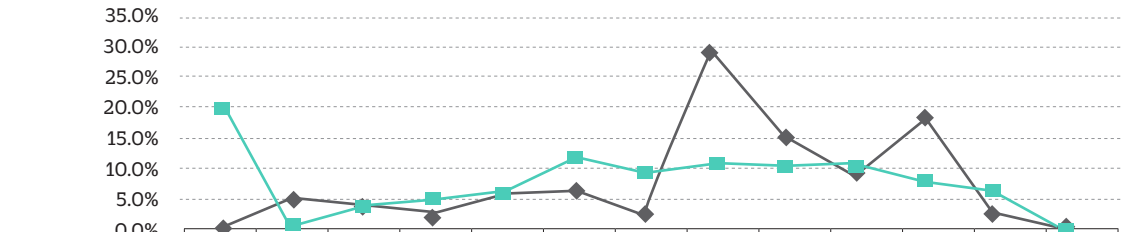
Correlations Between Variables

	1	2	3	4
C. Project	-			
C. Final Exam	.209**	-		
C. Final Average	.504**	.930**	-	
Cohort	-.009	-.424**	-.344**	-

*Note. ** rs Significant correlation above the 99% confidence level (bilateral).*

Figure 4

Distribution of Final Exam Grades



	Suspenso	D-	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Cohort 1	0.8%	4.9%	4.1%	2.5%	5.7%	6.6%	2.5%	28.7%	14.8%	9.0%	18.0%	2.5%	0.0%
Cohort 2	19.7%	0.6%	3.8%	4.5%	5.7%	11.5%	8.9%	10.8%	10.2%	10.2%	8.3%	5.7%	0.0%

Table 5

Results of the Professor Assessment Surveys

Question	Cohort 1	Cohort 2
1.The teaching guide clearly establishes the course objectives, the learning outcomes, and the contents.	4,1	4.1
2. The project requirements and grading criteria were clearly explained.	4,0	4.1
3. The project increased my interest in the course.	3,9	4.0
4. I understood the expected level of my work in the course.	4,0	3,9
5. The teacher stimulated my interest in the course.	3,9	4,0
6. The professor's teaching and assessment methods made the course interesting.	3,8	3,9
7. The teacher's classes were well organized.	3,9	4,1
8. The teacher encouraged participation with discussions and other exercises.	4,1	4,0
9. The content of the course was intellectually challenging.	4,0	4,0
Mean	4,0	4,0

reinforcing the hypothesis that the differences between cohorts are not due to the different role of the professor. Unfortunately, since this evaluation was carried out by a third party, it is not possible to determine the significance of the differences using inferential statistics, which would have been useful to determine the statistical significance of these preliminary conclusions.

In the case of student-faculty interaction, the professor assessment surveys completed by the students of the online environment were used, which had three additional questions related to the environment compared to the assessment surveys of the students of the face-to-face environment. The survey was submitted by 30 of the 157 students in the online Cohort 2. Table 6 shows the average results according to the five-point Likert scale for these three items.

Table 6 shows how the ratings obtained in the student surveys on student-faculty interaction in the online environment reflect that the differences in academic performance between the two cohorts do not lie in this question either, since the assessments are equally positive as the teacher assessment results, and even slightly better, so it can also be said that the change of learning environment was not a factor that altered this variable. Figure 6 shows these results visually,

Figure 5

Average Results of the Teacher Assessment Surveys

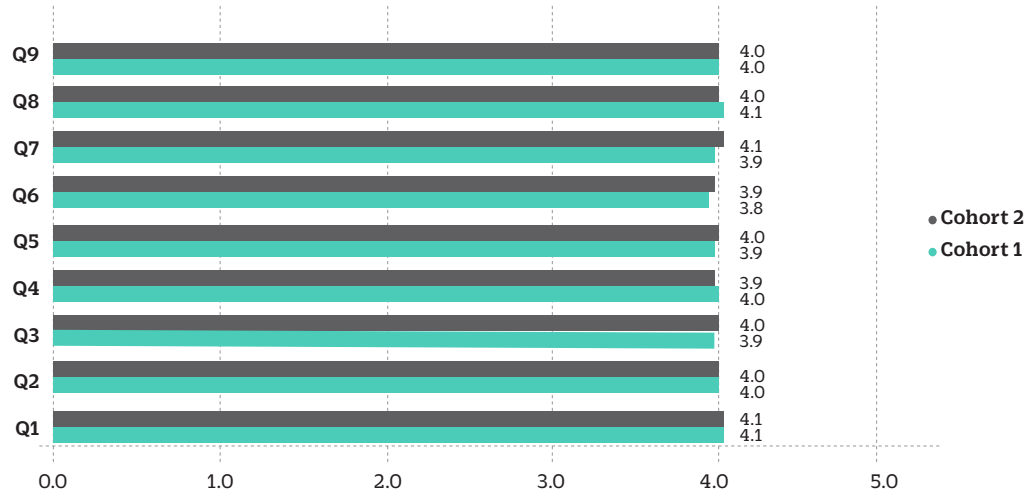


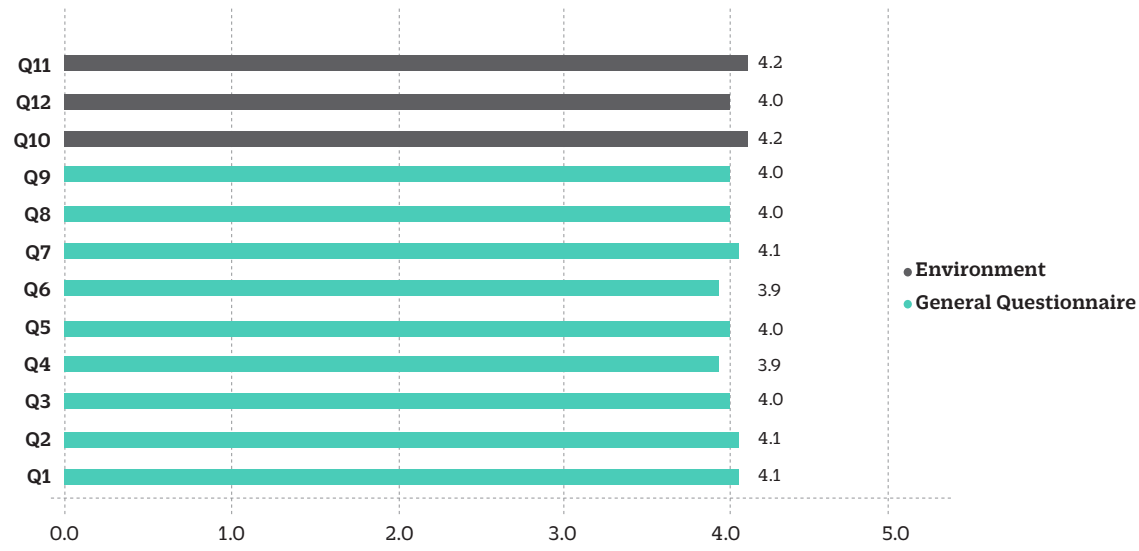
Table 6

Results of the Teacher Assessment Surveys

Question	Cohort 2
10. The teaching guide gave clear indications on how to access the online classes through the virtual classroom.	4,2
11. The online classes facilitated my learning.	4,0
12. Navigation through the virtual classroom was easy.	4,2
Mean	4,1

Figure 6

Average Results of the General Aspects and the Online Environment



integrating the results of the three questions related to the learning environment with the nine items of the general questionnaire to expand the information on which to draw conclusions.

Discusión

Regarding the first research objective, focused on comparing the academic performance of the last cohort of students with a fully face-to-face learning environment and the first cohort with a fully online learning environment, considering not only the final average grade, but also its different assessment components, despite the fact that the success rate is above 98% for both cohorts, a greater concentration of high grades is observed in the case of the first cohort, which moves the distribution of grades away from the expected average, taking as a reference the distribution of grades of the courses in the field. It seems reasonable to highlight a deviation in the distribution of these grades. After considering the different factors that could explain this difference, in line with the conclusions provided by the study of Sánchez-Cabrero et al. (2021a), everything points to the fact that the final exam was uncommon, which may not have been suitable for the learning environment in which it took place. As already indicated, the course was taught in the face-to-face environment for this cohort, but a. a national lockdown was declared a week before the final exam was held, which prevented the examination from being conducted in person.

Given the existing protocol in the faculty for the approval of the final exams (they need to be approved by the department and by an external examiner from a different university), there was no time to redesign and revise all the final exams of all the courses of the degree to adapt them to the online environment. Faced with this emergency, the institution decided to maintain the tests designed for a face-to-face environment, even though they were to be taken online, and all efforts were made at that time to ensure that all students could take the tests from home. In the second semester, both the teaching and assessment activities were designed for an online environment. The institution communicated this decision well in advance, indicating that the decision was final, regardless of the confinement status at the time of testing. In this case, an open book final exam was conducted, assuming that all students could have access to as many sources of information as they could access. Given the characteristics of the test, students were given five hours to complete it, rather than the two hours of the face-to-face exams, which fits with the proposals of Myyry and Joutsenvirta (2015). To ensure integrity, an anti-plagiarism program was installed into the final test delivery system. The results were exceptional, and the final test designed was highlighted by the department, being taken as a reference of the type of assessment desirable in the new environment.

To confirm that the difference in the academic performance results of the face-to-face Cohort 1 was due to the final exam, it suffices to observe the distributions of the grades obtained by both cohorts in the two components that make up the final grade, the project (Figure 3) and the final exam (Figure 4). The great similarity in the distribution of the Project grades shows that the origin of the divergence lies in the final exam. The similarity in the distribution of the Project grades was confirmed in the statistical analysis shown in Table 3. The Levene's test was used to verify the existence of homoscedasticity (equality of variances) in the variables, because depending on whether there is equality of variances or not, two different contrast statistics will be used in the t-test. Considering that equality of variances is confirmed when the degree of significance p value (significance shown in Table 3) corresponding to each F is greater than 0.05, in this case it is confirmed for the Project grade (0.512), but not for the Final Exam (0.03) nor for Final Average (0.015). In the equal variance t-test, the equality is confirmed for the Project grade (bilateral significance = 0.905), while it is rejected for the exam and the final average (bilateral significance = 0).

The relatively high percentage of students who do not pass the final exam in the second cohort is consistent with the historical results in that test. The reason is that at the time of taking the final exam students already know their project grades,

and given that these are generally high, some tend to adjust their effort in preparing for the final test to obtaining a pass in the final average grade (university regulations do not allow establishing minimum grades in the different components of the final grade). As can be seen in Table 4, this translates into a relatively low correlation between project and exam grades (0.209), much lower than the correlation between final average grades and exam grades (0.930), but also significantly lower than the correlation between final average grades and project grades (0.504).

Considering the parity of the rates of success in both cohorts, and explained by the abnormality in the final exam, the results obtained are consistent with the findings of Paul and Jefferson (2019) and Toyne et al. (2019), who found no statistically significant differences between the results of students in the face-to-face and online environments. However, there were statistically significant differences in the final exam, but in line with the study by Sánchez-Cabrero et al. (2021a), differences in academic performance are justified by the circumstances of the design of the test and the teacher's expectations about the assessment, since there were notable changes in this process (different duration of the exam, non-adaptation of the questions to the learning environment, and compensatory measures derived from the special assessment circumstances) that may explain these differences.

The second research objective consisted of evaluating whether the switch in the learning environment has changed the teacher assessment and the student-faculty interaction, and whether these factors have influenced academic performance. The first thing that is striking is the difference in the response rate. In face-to-face Cohort 1 it was 67% (84 out of 125), while in online Cohort 2 it was only 19% (30 out of 157). However, the explanation is simple. In the face-to-face environment, surveys are conducted during the penultimate session (in the absence of the professor), so that all students who are in class at that time take the survey. This possibility does not exist in the virtual environment.

The data obtained from both cohorts are very similar (Figure 5) and clearly show how the students' perception of the quality of the course and the professor hardly varied. In two of the questions the mean assessment was the same; in six, the difference in the results for both cohorts was only one tenth of a point; and in one it was two tenths of a point. The mean assessment was the same (4 out of 5). These results, which indicate that students did not perceive a decrease in quality in the new environment, are in line with the observations of Johnson et al. (2000) in their study, in which they observed very similar results in the evaluation of the teacher in the online and face-to-face learning environment.

Comparing the results obtained with those reported in Johnson et al. (2000), a subtle difference can be appreciated, since in this work a slightly more favorable perception of the professor in the face-to-face environment is noted. In this study, the teacher assessment is the same in both learning environments, which implies a better relative teacher assessment in the virtual environment if we compare it with what we would expect from the previous study. The exceptional context (confinement motivated by a pandemic) in which the teaching-learning process of Cohort 2 took place could be the explanation, since students' predisposition towards the new environment was very positive from the beginning, showing great empathy at all times, and assuming the change of learning environment as the best of the possible alternatives, which fits with the conclusions of Bączek et al. (2021).

The information obtained from the teacher assessment surveys on student-faculty interaction in the new environment is not particularly relevant due to the small sample, since it is limited to three questions. Despite this, the results obtained (mean = 4.1) are consistent with those of the rest of the questionnaire (mean = 4.0). This means that the three analyzed aspects of the new online environment were rated similarly to the rest of the aspects reflected in the questionnaire (Figure 6), which does not alter the students' overall assessment in a statistically significant way, which is in line with the conclusions of Alonso and Blázquez (2009).

Given the limited nature of the information provided by the items in the questionnaire about student-faculty interaction in the new

environment, it might be useful to expand this information with the results of a study carried out at the institutional level. Unlike the data presented so far, in this case the information does not come directly from the students of the course analyzed, but from a study carried out by the institution at the end of the first semester with online teaching to improve its quality, and in which both groups of students and teachers participated. In this study, among other aspects, there was an excessive use of emails to clarify doubts, to the detriment of online tutoring sessions, which were little used by students. The students stated that it was important for the teacher to clearly define the means of communication in their course, without showing a clear preference between email and communications through the virtual platform. Likewise, students gave a positive rating to the poll tool in the online platform during classes, as it helps students to participate more in class and to avoid distractions. Teachers expressed the same opinion in this regard and highlighted the high participation in the chat (to the point of becoming unmanageable at times) as opposed to the low oral participation. The information presented in this initial study may be useful for designing more effective teaching-learning processes in remote environments, as well as for developing new lines of research.

The change of learning environment brought about by the pandemic has not had a significant influence on the learning outcomes in the case presented, although the abnormalities in the academic results of the final exam of Cohort 1 in the classroom evidences the importance of adapting all the elements of the teaching-learning process to the environment in which it takes place, including the strategies and instruments for assessment. The quality, measured through the assessment surveys of both the teacher and the course submitted by the students, has not been affected by the change of learning environment, and the student-faculty interaction is not perceived in a more negative way in the virtual environment than in the face-to-face one. However, it is important to pay attention to the variety of means of communication that are introduced in the online environment (email, messaging through the virtual campus, chats, forums, video-tutorials), since the coexistence of different alternatives can generate confusion among students and alienate them from the process.

The main limitation of this study is that it was conducted after an incidental event and therefore it has not been possible to include and control all possible methodological variations between the two learning environments. Demographic data on age and sex are not available, and in the questionnaires answered by the students, the average results available do not allow the appropriate inferential statistical analyses to be performed. As a result of the limitations described above, the study could be extended in the future by intentionally controlling and extending the variables of both environments from the beginning of the research.

It could also be of interest to extend the research by incorporating the results of future cohorts taking the course in its original face-to-face format, and to analyze to what extent the change of format initially experienced (from face-to-face to virtual) as a result of the pandemic may influence the configuration of the teaching-learning process at the moment when the face-to-face format is resumed. Likewise, the analysis of the results in other courses of the same academic program would provide greater solidity to the conclusions obtained.

Finally, its contribution to the comparison between face-to-face and online teaching and assessment, both at the theoretical and practical level, should be highlighted. At the theoretical level, it has been confirmed how online teaching can guarantee learning and development of competencies at the same level as face-to-face teaching, including the quality of student-faculty interactions. On the other hand, at a practical level, it should be emphasized that the assessment processes must be adapted to the evaluation modality in order not to introduce variations in the results. The greatest risk in assessment does not lie in the evaluation modality, but in the decisions made by professors, who may introduce their bias related to expectations and fears about the examination.

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