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Original Research Article

Improving an online higher education pharmacology course based on students' perception

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ABSTRACT

Background: The COVID-19 pandemic outbreak transformed education thoroughly. Our in-classroom Pharmacology course had to be adapted precipitously into a completely online modality. Hence, we aimed to evaluate its efficacy for learning and improve it based on our students' perception.
Methods: Semi-open questionnaires were designed and applied at the end of the 2020 and 2021 courses to assess students' satisfaction on the following fields: eLearning platform, lectures, synchronous discussion section, asynchronous collaborative work, and assessments. Data from the first online course was analyzed and evidence-based improvements were performed for the 2021 course. Quantitative comparison of cohorts was carried out. Furthermore, students' perception from the last in-person course (2019) was analyzed.
Results: The 2019-course questionnaire demonstrated a good acceptance towards an incipient use of the virtual campus. Comparison of the complete online cohorts revealed a significant increase in positive answers in six items: complementarity of lectures with discussion sections (85% vs. 100%), teaching strategy (30% vs. 84%), adequacy of faculty's role (47% vs. 79%), pre- and post-class activities (30% vs. 55%), wording of exercises (30% vs. 55%) and assessments (50% vs. 97%). Moreover, a modification of the students' requests expressed in the comment section was observed.
Conclusions: Custom-designed semi-open questionnaires used to evaluate students' perception and receiving feedback on the Pharmacology course provided high quality information to promote student-oriented changes that allowed for an improvement in the teaching-learning process.

Keywords: Online education, Students' perception, Teaching-learning improvement, Pharmacology education, Online questionnaires

INTRODUCTION

The COVID-19 pandemic had a great impact on education worldwide, transforming traditional in-person education into full remote online instruction.[1] In Argentina, higher education was mandatorily remote during 2020 and 2021 and hence the Pharmacology course delivered at the School of Pharmacy and Biochemistry (University of Buenos Aires) had to be adapted to this modality. Pharmacology is a core course to obtain the degree in Biochemistry which consists of twenty-eight lectures (2 hours each) and twelve problem-based discussion sections (4 hours each) delivered along the second semester in the fourth year of the career. Before the pandemic, a trend towards optimizing the use of online resources was already occurring by recording in-classroom lectures and uploading them for asynchronous remote access. Also, a virtual campus based on the eLearning platform Moodle

v3.11 was available but mainly as an information repository. Ergo, the course was delivered principally through in-person lectures and discussion sections. Moreover, in 2019 the curriculum had been modified and consequently problem sets as well as discussion sections were redesigned. In that instance, a specific survey was conducted among students to collect their opinion on the new core knowledge and the use of the virtual campus.

Our teaching strategy involves a blend of the traditional and the flipped classroom which had shown to successfully retain the best features of each of the learning paradigms.[2] Lectures are delivered by professors as didactic lectures preceding the discussion sections, which are tutored by the teaching assistants.[3] Both formats are planned to be complementary, with lectures providing enough basic knowledge on each topic for students to attend the discussion section and build significant knowledge. Our faculty has the tradition of applying problem-based learning which has also been used as a strategy to teach Pharmacology by other Universities.[4-6] Even though the superiority of active over traditional lecture-based learning in Pharmacology has been recently demonstrated in several studies we support a hybrid format.[7,8] Not only student-centered activities are prioritized in problem sets but also collaborative learning is highly encouraged, and students work all along the course within a group of partners. Collaborative learning has also shown benefits for learning in higher education.[9] In turn, the assessment of students' learning in 2019 consisted of a first individual written exam in the middle of the semester and a group oral presentation at the end of the course. Due to the solid evidence supporting this teaching strategy, faculty decided not to change it because of the pandemic but rather adapt it to a completely virtual environment and evaluate students' satisfaction. It is important to consider that online teaching has its own characteristics that differentiate it from in-campus education. Even though both take place within a formal education institution and its completion leads to a degree, online education implies the physical separation of the faculty and students which nowadays communicate synchronously or asynchronously through the worldwide web.[10] To meet that goal, numerous resources have been developed and eLearning platforms are one of the most widespread technologies since they are facile to use and enable deep learning environments.[11]

Hence, as a consequence of the lockdown, discussion sections were held on a weekly basis through a synchronous meeting using a video conference platform. A week before the meeting, students were provided with bibliography, a two-way live stream lecture (also recorded and uploaded for free access) and a problem set. Cases and problems were distributed to the working groups (three to five students) to be solved before the synchronous meetings. Students were expected to work as a group asynchronously by means of free online collaborations tools. Later, they had to present the responses to their peers with a slide supported presentation. Teaching assistants led the discussion and clarified any concept if necessary. Once the discussion section took place, some extra non-compulsory activities were opened in the eLearning platform for further practice. In addition, the assessment of students' learning was carried out in two instances but modifications were done compared to 2019. The first assessment consisted in writing a monograph about a specific drug covering all its pharmacological profile, while the second one was taken at the end of the semester through a classical assessment questionnaire comprising the second half of the curriculum. Lastly, questionnaires to collect students' opinions are put in place every year at the end of the courses in accordance with the evaluation policy of the School of Pharmacy and Biochemistry since they are recognized instruments to improve the teaching-learning process.[12] In this context, we hypothesized that student-centered end-of-semester surveys would help to understand the new scenario of online education and improve the teaching-learning process. Hence, for this study we created specific semi-open questionnaires which allowed us to apply evidence-based changes into the next cohort. Also, we analyzed pre-pandemic surveys that had influenced some decisions taken for the first online course. Therefore, we present the results of modifying a course based on students' perception and discuss the usefulness of implementing such a strategy to enhance the teaching-learning process.

METHODS

Semi-open questionnaire-based surveys were distributed electronically to the students that completed the pharmacology course delivered at the School of Pharmacy and Biochemistry (University of Buenos Aires) during the years 2019-2021 after each semester. Students participated in an anonymous and voluntary manner, and the number of total students who completed the course and the number of participants were recorded. The surveys were accessible in the eLearning platform for three weeks after the course had finished and then were closed. Students were told about the survey by the teaching assistants during the last synchronous online meeting and two extra reminders were sent via virtual campus to encourage participation.

The surveys consisted of a structured questionnaire followed by a comment section in which students were invited to freely provide suggestions and opinions on the course and the faculty. The questionnaire used for evaluation of the in-person course (2019) was custom-redesigned to better evaluate full online education (2020-2021). In 2019, the survey consisted of five-points Likert scale questions with categories being: 1. Strongly agree, 2. Agree, 3. Neutral, 4. Disagree, 5. Strongly disagree. In 2020-2021, the questions were reduced to a four-point scale eliminating the "neutral" category due to the high number of students that chose "neutral" which difficulted analysis (Figure 1). The questionnaires were designed by the authors to comprise the main fields of each course (eLearning platform, lectures, synchronous discussion section, asynchronous collaborative work, and assessments) and provide specific information to enhance

education. Additionally, in the survey conducted in 2020 an extra comment section was included for suggestions regarding the eLearning platform content, since it was the first time this tool had a key role in teaching. Only comments with a frequency of appearance over 10% of the total answers were considered for analysis.

Statistical analysis

Descriptive statistics were used for data analysis and results were expressed as a percentage of positive answers of the Likert scale ((1 + 2 / 3 + 4) * 100). A quantitative comparative analysis was carried out between surveys performed in 2020 and 2021. Student's t test was applied to compare each item between surveys and p values <0.05 were considered statistically significant.

RESULTS

Students' perception towards the in-classroom pre-pandemic course

The semi-open questionnaire-based survey was conducted among 117 students and 61 answers were collected**,** which implies a participation of 52% of the total students. The Likert scale questionnaire (Figure 1A) demonstrated a good acceptance of the virtual campus.

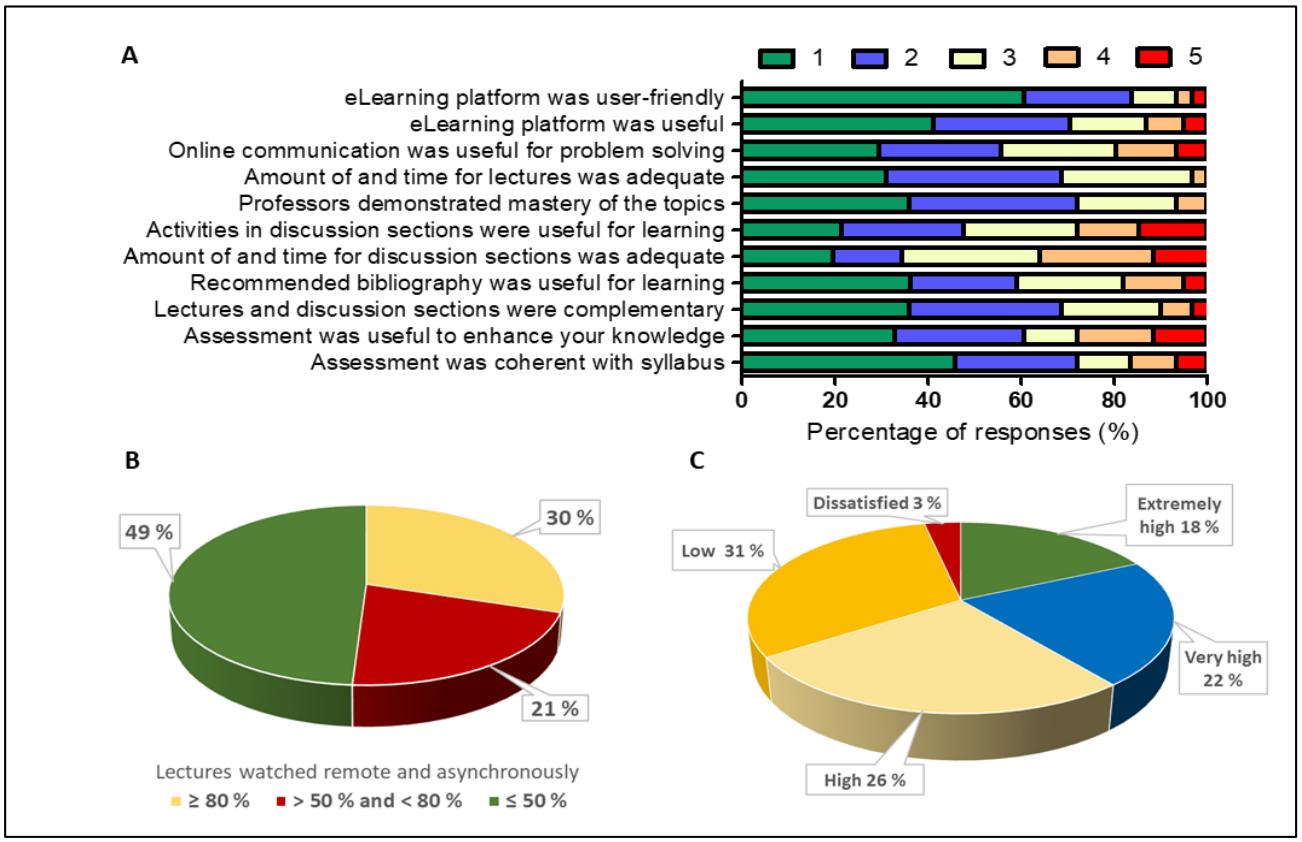

Figure 1: Students' perception on the last in-person pharmacology course before COVID-19 pandemic, A) Questionnaire designed as a five-point Likert scale with categories being: 1. Strongly agree, 2. Agree, 3. Neutral, 4. Disagree, 5. Strongly disagree, B) Percentage of students who watched more than 80%, between 50% and 80% or less than 50% of the lectures asynchronously and remotely, C) Overall satisfaction with the course.

When considering the net percentage of positive answers, excluding the neutral position, students qualified the eLearning platform as useful (71%), user-friendly (84%) and a good means of communication with the faculty (56%). Video-recorded lectures were available via the virtual campus to be watched remotely and on-demand. Approximately one third of the students (30%) watched more than 80% of the lectures online and 21% of the students took advantage of this modality for more than 50% of the lectures (Figure 1B).

Regarding lectures, the items "amount and time of lectures" and "mastery of professors on the topics" obtained over 75% of positive answers (Figure 1A). For discussion sections, the less positive perception was concentrated in the amount of time they had to discuss the activities (34%) and the usefulness of the activities themselves (48%). Perception on assessments, complementarity between lectures and discussion sections, and bibliography was mainly positive (>50%). When asked about the overall satisfaction on the course, approximately 70% were between highly and extremely

satisfied (Figure 1C). The open comment section also reflected the low acceptance of the activities (Figure 2A). The burden of activities was the most repeated comment with specific mention of the number of papers to read and problems to discuss. Moreover, many students did not recognize the flipped classroom and peer-listening as fruitful strategies for learning. The delay in having the recorded lectures available online hindered them from having an introduction to the topic before the discussion section. Hence, this impaired complementarity between lectures and discussion sections, and a theoretical introduction from the in-classroom teaching assistants was demanded. Also, requests were placed for a more formal assessment modality than a final oral presentation. Although a minority, a few students preferred the student-centered strategy instead of the traditional classroom.

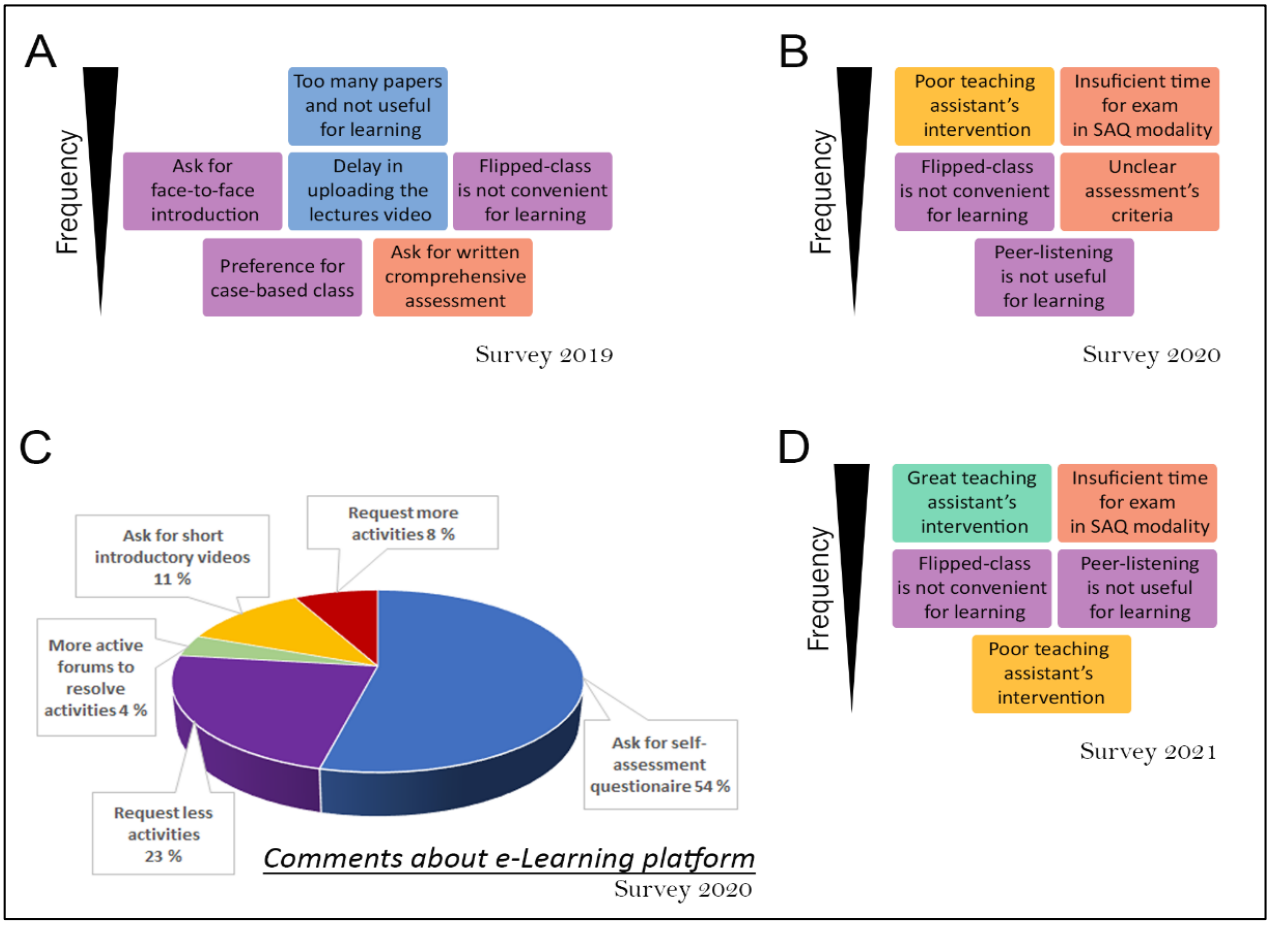

Figure 2: Students' comments in the open section of the surveys; comments collected in the open section of the surveys are shown in decreasing order of frequency for the year; A) 2019, B) 2020, C) Suggestions collected in 2020 regarding the content of the eLearning platform are shown as percentages of frequency and D) 2021.

Students' perception on the first full online course in 2020

In the 2020 end-of-course survey, 62 students from a total of 103 gave their feedback, which represented a participation of 60%. Results from the Likert-based questionnaire are shown in Table 1. In line with the results obtained in 2019, 87% of the students found the eLearning platform well organized. Lectures were delivered both synchronously through a video conference platform and recorded to be available for asynchronous attendance. While 47% of the students found it useful to attend synchronously, 98% of them agreed that having access to recorded lectures was convenient. Moreover, students recognized that lectures were a crucial component of the course since 85% of students found complementarity between lectures and discussion sections, and 76% affirmed that lectures were useful for solving problem sets in the discussion section. Regarding the discussion section, 73% of the participants found the curricular topics of professional relevance. However, only 30% of the students thought that the teaching strategy was useful to understand these topics whereas the role of teaching assistants during the online meeting was considered positively by 47% of the students. As for the students' role, 52% stated that the oral presentation of activities was useful for learning and only 16% considered that peer-listening was useful for comprehension. In terms of asynchronous activities, 84% of the students affirmed that they worked in groups to solve the compulsory activities in a collaborative manner,

but only 30% found the extra activities profitable. Focusing on evaluation, 79% of the students stated that the assessment criteria was clear and 60% that wording was precise. When asked about the modality of evaluation, 43% of the students preferred a monograph over questionnaires and 57% the other way around. It is worth noting that only 50% of the students found the assessments useful for learning.

Table 1: Comparison of students' opinion on the pharmacology full online courses.

Field	Evaluated item	% of positive answers		P value
		2020	2021	
eLearning platform	Adequate organization	87	87	1
Lectures	Synchronous lectures were useful	47	47	1
	Access to recorded lectures was useful	98	100	0.37
	Lectures and discussion sections were complementary	85	100	<0.05
	Lectures were useful for solving discussion exercises	76	84	0.31
Synchronous discussion section	Curricular topics were of professional relevance	73	82	0.31
	Teaching strategy was useful to understand the topics	30	84	<0.001
	Teaching assistants' role was useful for learning	47	79	<0.01
	Oral presentation was useful for learning	52	55	0.76
	Peer-listening was useful for learning	16	5	0.089
Asynchronous collaborative work	Activities were solved as a group	84	87	0.69
	Extra activities were profitable	30	55	<0.05
Assessments	Assessments' criteria were clear	79	84	0.55
	Wording of statements was precise	60	92	<0.001
	Monograph was preferred over assessment questionnaire	43	42	0.92
	Assessment questionnaire was preferred over monography	57	58	0.92
	Assessments were useful for learning	50	97	<0.001

Results are expressed as percentage (%) of positive answers ((1 + 2 / 3 + 4) * 100) in a four-point Likert scale. The statistical significance was calculated using Student's t-test and *p* values <0.05 were considered significantly different. Total answers were 62 in 2020 and 38 in 2021.

The open comment section (Figure 2B) showed that more than 30% of the students were concerned about the little intervention the teaching assistants had during the discussion section. Other frequent comments were related to the "limited time to complete the questionnaire of the second exam", "the inconvenience of teaching strategies for learning", the fact that "the aims of the evaluation were unclear" and that "peer-listening was not useful as part of the learning strategy". Finally, the analysis of the suggestions for the eLearning platform (Figure 2C) revealed a strong demand (54% of the suggestions) on creating self-assessment questionnaires (SAQs) at the end of each discussion section. Then, 23% of the suggestions were related to the reduction of the number of activities, 11% to the addition of introductory videos, 8% to the addition of activities and 4% to the addition of interactive forums.

Students' perception on the full online course in 2021

Considering the results from the 2020 end-of-course survey, we applied some modifications to the 2021-course. SAQs were added at the end of each unit and other extra activities were revised. Hence, usefulness of SAQs was evaluated in the item "extra activities". Furthermore, teaching assistants were asked to highlight the main idea after students' presentations and outline the core concepts at the end of the meeting. Assessments were comprehensively reformulated taking into account form and content. Namely, questions were modified to improve the wording and to better fit an online modality. Besides, questions were revised by more members of the faculty to guarantee the assessment of core topics. In 2021, 38 students out of 86 answered the survey, representing 44% of participation (Table 1). A higher percentage of students found that lectures and discussion sections were complementary compared to the previous year (85% vs. 100%, $p<0.05$). In addition, the teaching strategy was now considered useful for learning by 84% of the students (30% vs. 84%, $p<0.001$) and teaching assistants' participation was appreciated positively by 79% of the participants (47% vs. 79%, $p<0.001$). Moreover, there was a statistically significant increase in the positive perception of the extra activities (30 % vs. 55 %, $p<0.05$). Regarding assessments, students' positive impression increased both in the wording of the statements (60% vs. 92%, $p<0.001$) and in the consideration of the assessment as a tool for learning (50 % vs. 97 %, $p<0.001$). Interestingly, none of

the items received significantly worse qualification in 2021 compared to 2020. As for the free comment section, the comments about the teaching assistants were now positive, highlighting their intervention. However, according to students, the teaching strategy remained an obstacle for learning and peer-listening was still not helpful in facilitating understanding (Figure 2D).

DISCUSSION

The high acceptance in 2019 towards the use of the virtual campus indicated a fertile soil for what was going to come (Figure 1A). In that sense, Fidalgo et al reported high receptivity to distance education in undergraduate students who never experienced or had little experience with online education.[13] As lectures do not require compulsory attendance and are usually delivered at inconvenient times, there has always been a proportion of students who were unable to attend. To solve this issue, in 2019 the School of Pharmacy and Biochemistry engaged in a program to record and upload lectures in a free access format in line with the benefits of distance education, such as independent and self-paced study.[14] Even though half of the students watch more than 50% of the lectures online (Figure 1B), the delay in having access to the recordings limited the number of students watching them online according to results in the comment section. This fact was acknowledged by the faculty, but it was out of their competence to fix it. However, in 2020 and 2021 professors were in charge of lecture videos and they were available before the discussion sections. Surveys conducted during these two periods reflected students' positive appreciation of the recordings of the lectures (Table 1). Even when some students highlight the usefulness of synchronous lectures, they all agree that the recordings are a key resource to have access to all lectures. Accordingly, a recent meta-analysis highlights how important it is for students to have access to pre-recorded video lectures.[15] In fact, this methodology should be considered in future teaching proposals so that lectures can be recorded and in-classroom hours be used for interactive activities and discussion.

In the survey conducted in 2020, students proposed to add SAQs in each unit. This perception could arise from a lack of opportunities to corroborate their knowledge before exams. It has been shown that SAQs assists students to take an active role in their learning process and promote self-directed learning.[16] Also, it serves as a revision tool to study for assessments.[17] As in 2019, students also asked for a reduction in the number of the activities and the addition of short explanatory videos before each unit (Figure 2). These requests could arise from the extensive curriculum and problem sets that characterizes our Pharmacology course, which hinders their ability to prioritize what to study. Klisowska et al also found that the excess of learning material is considered a disadvantage of distance education.[18] Hence, we identified that the abundance of reading material and problem sets may prevent the effectiveness of self-directed learning. Moreover, it may also be the reason why they ask for SAQs to recognize the assessment objectives. Therefore, in 2021 SAQs were added to every unit and their purpose was consequently evaluated in the survey (Table 1). We attribute the significant increase in positive answers in 2021 with respect to 2020 in the category "Extra activities were profitable" to SAQs since other pre- and post-discussion section activities were hardly ever completed by students (data not shown).

In 2020, the surveys showed that students asked for higher participation from teaching assistants during the presentations of their peers, which is in accordance with a study carried out by Savkar et al., who identified that facilitators play a key role in the process of active learning.[19] Based on the results from 2020, faculty was encouraged to improve their skills and competences as teaching assistants for a flipped-classroom teaching strategy. This meant, apart from redesigning problem sets and pre-class educative material, re-educating themselves in the principles of the flipped-classroom with focus on putting in place active listening strategies during the meeting and being aware of students understanding.[20,21] Besides, for the next course, teaching assistants were indicated to briefly introduce the objectives of the class, actively clear students' doubts and highlight the important facts after their presentations. They were also asked to clarify exam modality and expected outcomes. As a result, students' perception towards the role of teaching assistants significantly improved in 2021 and found the interventions of educators useful for learning. For students, the flipped-classroom requires the completion of out-of-class activities which are time-consuming and, as it was said previously, in 2019 and 2020 students requested to reduce the burden of mandatory work before the synchronous meeting.[22] This emphasizes the need to critically select and organize studying material to avoid an overload of work to students and subsequent discouragement.

Also, this teaching strategy relies on students' self-regulated learning skills, so tools to improve this skill might be provided.[22] Consequently, we added short introductory videos to each unit to explain the learning objectives and the series of activities they were expected to perform. Interestingly, 50% of the students did not watch them (data not shown) indicating they are not used to this kind of classes and instructors should dedicate more time to explain the modality. Common to both surveys, students did not find listening to their peers profitable (Table 1), which is a key characteristic of this type of learning strategy. Students are accustomed to passive explanation and feel more comfortable when educators explain.[22] Even though the flipped-classroom strategy has proven to provide more in-depth knowledge to students, it has been observed that students from other contexts do not easily embrace this design either.[23] In terms of the evaluation process, it is noticeable that half of the students preferred a monograph over assessment questionnaires and the other half the other way around. This shows the heterogeneity of students' preferences regarding

assessments methods and encourages educators to include different modalities when evaluating students' learning. Positively, in 2021 assessments were considered more useful for learning than in the 2020 course. Even though the structure of assessments was the same, we hypothesize that the refinement in questions and experience of the faculty from the previous year enhanced the overall experience.

Finally, further studies on this matter could comprise a survey conducted at midsemester. This would allow for more accurate perception on the topics of the first half of it and would include the opinions of students that left the course before its end. Another limitation of the study derives from the general organization of the course. Even though all the students take the same Pharmacology course, they are divided in groups coordinated by the same teaching assistants along the whole semester. Since the survey was conducted anonymously and voluntarily, the design of the study did not allow us to detect difficulties or positive aspects of each group. Moreover, students' performance on the exams was not compared between cohorts so we could not draw conclusions regarding the impact of the modifications on their academic achievements.

CONCLUSION

The use of an eLearning platform in 2019 and the evaluation of its acceptance from students via a semi-open questionnaire revealed the positive attitude of students towards virtual environments and underpinned the construction of the fully online courses of the next years. Moreover, custom-designed end-of-course surveys to evaluate fully online courses allowed us to identify aspects to improve in the first of these online experiences from the students' perspective. While the structured questionnaire exposed conformity or disconformity about general items, the open comment section allowed students to be precise with their requests. Interpretation by the faculty of the results provided the foundations to promote student-centered modifications while still retaining the central aspects of our hybrid teaching model. Ergo, we found this tool very useful to transform our course into a fruitful teaching-learning experience with the ultimate aim to improve higher education.

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