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Undergraduate Student Opinions on Emergency Remote Teaching during COVID-19 Pandemic. A Case Study*

GÁDOR INDRA HIDALGO[1,**], FERMÍN SÁNCHEZ-CARRACEDO[2] and DANIEL ROMERO-PORTILLO[3]

[1] Chemical Engineering Department, Universitat Politècnica de Catalunya, Av. Diagonal 647,08028 Barcelona, Spain.
[2] University Research Institute for Sustainability Science And Technology, Universitat Politècnica de Catalunya, Campus Nord, c/Jordi Girona 31, 08034 Barcelona, Spain.
[3] Faculty of Social Sciences, Universidad Pablo de Olavide, Ctra. Utrera, km. 1. 41013 Sevilla, Spain.
E-mail: Sánchez-Carracedo: fermin@ac.upc.edu, Romero-Portillo: drompor@upo.es

The COVID-19 pandemic has shaken education around the globe due to the sudden closure of schools and universities. Undergraduate students have suffered the confinement while continuing their courses by Emergency Remote Teaching (ERT) from home. The objective of this research is to determine the opinions on ERT versus face-to-face classes of students enrolled in the Bachelor's Degree of Industrial Technology Engineering at the Universitat Politècnica de Catalunya-BarcelonaTech (Spain). An end-of-semester online survey was sent to all the students enrolled in the 19/20 spring Chemistry subject. The students' comments were analyzed using the constant comparison method. Six categories were created using an inductive method and student responses were classified according to these categories. In general, the results show that these students prefer face-to-face classes rather than the methodology used during the ERT. They also prefer classes via video-conference if remote teaching is required. There is a diminished perception of socialization with both instructors and peers. Some students positively value that their autonomous learning has improved, and would like to continue accessing the material online even if face-to-face classes were resumed. They also state that completing weekly exercises helped them stay connected to the subject and to sustain learning, and thank instructors for the efforts made to adapt the methodology to the exceptional situation. The information gathered will enable teaching staff to design a remote teaching methodology that meets students' needs better than ERT, should further confinement be required by the authorities due to health emergencies or other types of catastrophic events.

Keywords: Emergency Remote Teaching; COVID-19, opinions; student survey; constant comparative method; inductive method

1. Introduction

Due to the COVID-19 pandemic, during March 2020 many education institutions around the world cancelled face-to-face classes and switched to remote teaching, as cases of infection in the population rapidly increased. UNESCO estimated that 1 billion students were affected by the school and university closures due to COVID-19 pandemic [1].

This new situation, called Emergency Remote Teaching (ERT) (and learning) is considerably different from regular online education [2]. Every subject being taught had to be changed to remote methodology. Technical resources were also lacking. For example, the majority of lecturers had no access to specific electronic devices designed to record videos, nor the training to produce those types of videos from scratch at home.

In Europe, the Spanish government established a mandatory lockdown; face-to-face classes were cancelled on March 13, 2020, and replaced by ERT. Without the time for proper planning, and with the university semester already five weeks old, both students and teaching staff had no choice but to adapt to this new situation. Confinement in Spain was especially tough for students as they could only leave home to go grocery shopping, visit the pharmacy, attend a medical appointment or walk the dog. Children under 12 years old were not allowed to go out except for medical emergencies. Many first-year college students found themselves in an unprecedented situation: due to the pandemic, for several months they were confined to their homes with siblings and parents, often in small flats in crowded cities like Barcelona or Madrid. In addition to the pressures imposed by these exceptional circumstances, they had to contend with the added strain of fulfilling their class assignments. Furthermore, evaluation of their work had to be adapted to these new conditions, and this unknown factor was another source of stress for students, who had to study and complete their assignments without knowing how final exams would take place.

The uncertainties of the situation also affected university teachers, who had to plan ahead without knowing whether the course would be resumed or if remote learning would last until summer. In order to train teachers and help adapt to this situation, the

** Corresponding author: chemicontact@gmail.com

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Sciences Education Institute of Universitat Politècnica de Catalunya-BarcelonaTech (UPC) devised a series of remote courses to provide lecturers with the knowledge and resources to prepare online tests, voice-overs on PowerPoint slides, and even videos mixing camera shots and slides. This was vital for a rapid transition of courses to an ERT methodology.

At the UPC, first-year students enrolled in the Bachelor's Degree in Industrial Technology Engineering study a subject in chemistry during the spring semester, which is traditionally taught face-to-face like the other subjects in the degree. The subject has 4.5 ECTS credits, accounting for a 15% of the total semester credits. Due to the pandemic, face-to-face classes were replaced by PowerPoint slides with embedded audio explanations. In these voice-overs, professors included explanations similar to those they would give in class to address theoretical concepts. Solved exercises were prepared as models for the practical part, and documents with extra information based on students' doubts were made available for all students. All the material was made available on the online campus ATENEA, the UPC Moodle-based platform. Students were asked to hand in weekly exercises via the online campus and the solutions were subsequently made available after the due date. Given the extraordinary circumstances, asynchronous activities were preferred over synchronous ones, since not all instructors and students were able at all times to connect to and follow the remote classes. The evaluation of the Chemistry course before and during lockdown semester is shown in Table 1.

With this new methodology, students had to keep abreast of the subject by doing the deliverable exercises if they wanted to receive a grade for that part. Moreover, the fact that students had no pre-established timetable, and were left to their own devices to study the material whenever they wanted, greatly increased their autonomous learning. They had to be proactive enough to organize their different subjects and personal activities themselves during the time the quarantine period lasted.

Despite all the efforts put into ERT, some students were subjected to unprecedented stress; some may have lost family members and had no idea when the situation was going to end, while others may even have somatized their uncertainties. For this reason, what students remember above all when asked to recall this semester is probably their psychological state of mind; how they felt while learning chemistry rather than the chemistry concepts themselves. Once the semester is over, it is important to analyze what has happened from all the points of view, and that includes the students' perspective. This will allow us to identify strengths and weaknesses and keep on improving ERT methodology for future needs, as this remote methodology will probably be needed in the future, either for the next semesters, or for other types of catastrophes such as those that have occurred in the past [3].

Table 1. Side-by-side comparison of the evaluation before and after the COVID-19 pandemic

Regular Face-to-face course	19/20 spring semester lockdown course
60% final exam	60% final exam (online)
30% mid-term exam	40% weekly deliverables (online)
10% In-class exam	

Teachers' opinions are usually easier to determine, and can contribute to the overall view of the course [4,5]. Student feedback can be obtained in several ways, either interviews [6, 7] or by surveys [8–11]. It is important to use the feedback obtained from students in order to modify the course in a positive way. This can be achieved by devising a strategy or a specific methodology to analyze and subsequently be improved [12]. Several studies on student's perspective during lockdown have been carried out and are key to understanding the situation in different parts of the world [13, 14].

Bearing all this in mind, during the spring of 2020 a project was carried out to study the opinions of first-year students of the Bachelor's Degree in Industrial Technology Engineering at the UPC Barcelona campus. Students were asked about their opinions on ERT methology in comparison to the methodology during the first five weeks of face-to-face classes of their Chemistry subject.

2. Method

The research question of this study is as follows: What opinion do students have about Emergency Remote Teaching versus the face-to-face classes of Chemistry subject?

To answer this research question, two objectives were defined:

1. Survey students at the end of the semester using an online survey with an open-ended question for gathering their opinions.
2. Analyze their comments using a qualitative methodology.

2.1 Instrument: Survey with an Open-ended Question

For the first objective, an online survey was used as the instrument to obtain student opinion. Students were asked for their opinions about Chemistry ERT in comparison to the face-to-face classes they fol-

lowed during the first five weeks of the semester, which they could provide by contributing comments in an open-ended question.

The survey was sent to all the students of the Bachelor's Degree in Industrial Technology Engineering in the Barcelona campus who were enrolled in the 19/20 spring Chemistry subject. The QuestionPro survey online service was used to distribute the survey to these students. The survey was open for 5 days, from May 11 to May 15, 2020, and was sent via an email containing a personalized link. On the last day of this period, a reminder was sent to those students who had not yet responded. The responses could be tracked in order to determine the identity of these students thanks to the personalized link. All the students were informed about the purpose of the survey and the fact that the data collected would be treated confidentially.

2.2 Sample

The students in the Chemistry subject are usually divided into nine class groups, three of which have a class in the afternoon (after 2 p.m.). Five different instructors taught the subject during the aforementioned semester. Afternoon groups (G60, G70 and G80) tend to have fewer enrolled students than morning sessions (G10, G20, G30, G40 G50 and G90). From all the students enrolled, those who made comments voluntarily make up the sample n = 45, which represents 12% of participation. Students of first year are mainly aged 18–19 years old, and usually have little experience as autonomous learners, as in previous courses during high school the syllabus is very structured. When students reach college, they face a new scenario where their academic performance is not closely monitorized by a tutor, and students rely on themselves for constancy and perseverance in their studying. The Emergency Remote Teaching further increased their feeling of freedom and anonymity as no physical classes were taking place. All these aspects have an influence in the results obtained, which would probably be different if the participants were Master students or undergraduates from final courses.

The very nature of this work entails some limitations. First of all, it is confined to a small sample representing less than 15% of the enrolled students. The sample is not aleatory but stems from a self-administered survey, as only students who answered the survey voluntarily are taken into consideration. The characteristics of participants are unknown, and may consist of highly motivated students, those experiencing more difficulties, or simply those who were more easily available at the time the survey was issued. In any case, no information exists about the opinions of the other students who did not participate in the survey. Secondly, the sincerity and openness of the participants are key factors to take into account, as well as the objectivity of students when separating their opinions on Chemistry from other courses in which they were enrolled during the same semester. Finally, the survey was conducted before the final exam, which certainly affected the impressions of a few students, whether it be in a positive or a negative way. However, this factor can be regarded an advantage as it avoids bias of the results.

2.3 Definition of Categories

For the second objective, a qualitative analysis of the students' comments was carried out using the constant comparison method [15]. The comments were long and contained various ideas, so each idea/sentence was analyzed separately. In a first round, 10 comments were analyzed by separating each phrase or idea (textual unit), and categories were created as they were identified (inductive methodology). The rest of the comments were then analyzed and classified according to the predefined categories. All the comments that did not fit into any of the initially predefined categories were grouped into a new category referred to as 'Miscellaneous'. After allocating all the comments to the predefined categories, those classified in the category 'Miscellaneous' were reviewed again, with the aim of identifying possible new emerging categories [16]. The inductive character of this methodology is what gives it its name.

Once all the comments had been assigned to categories, these categories were revised and those that essentially contained the same topic or overlapped to a great extent were unified. The inductive application of the constant comparison method for the definition of categories has led to the creation of 5 categories plus 'Miscellaneous'. One of these categories was then divided into subcategories. This process is schematized in Fig. 1. The resulting categories are summarized in Table 2.

The comments included in Category 3 were then classified into new Categories 3a, 3b and 3c. Finally, comments within each category were studied to identify the main ideas and opinions of the students.

3. Results

This section displays and discusses the results from the study. First a general overview of the comments is described, and then the qualitative analysis is presented by using the constant comparison method.

3.1 Overview of the Comments

Before going into details about the students' opinions, the results of the participation in the survey are presented in Table 3.

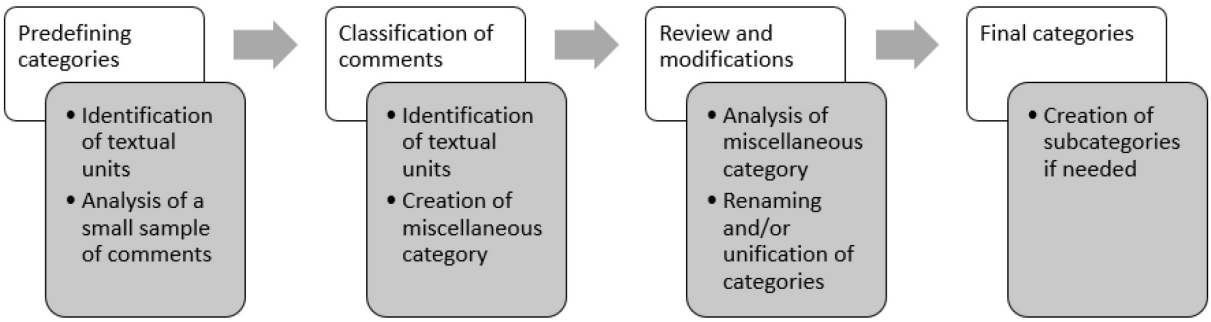

Fig. 1. Diagram of the methodology process.

Table 2. Categories created by inductive constant comparison analysis

	Category	Description
1	Feedback.	
2	Adaptation of the subject methodology.	
3 3.a. 3.b. 3.c.	Preference for type of class: face-to-face / remote.	Opinion on face-to-face classes / remote classes. Opinion on the documents with recorded audio. Opinion on video-conference live classes.
4	Exercises.	
5	Learning impressions.	
6	Miscellaneous.	

Participation by leaving comments in the survey was 12%. In general, participation varies from group to group. With the first email, 80% of the responses were obtained, while the remaining 20% were obtained thanks to the last-day reminder. This shows that sending a reminder is important for maximizing participation.

Furthermore, it is possible to analyze the number of allusions made to the different categories, understood as independent textual units. In other words, students' comments can be more or less extensive and usually refer to topics from multiple categories, which would count as more than one allusion.

It seems logical that the more comments a group makes, the more allusions to the different categories exist. However, in some groups the ratio between these two factors is different. This is because some comments are very short and only refer to one idea/category, while longer comments generally convey a more complex message that can be broken down into different categories.

Different groups comment more on some topics than others. For instance, Groups 50 and 90 have contributed more extensively to Category 2, while in Group 60 this category has not been mentioned. One may also observe that in the last row of Table 3 certain groups have made the majority of allusions, while others barely contribute. Therefore, there is a heterogeneity of comments considering both the group where they originate and the category they fall into.

Fig. 2 shows graphically the number of textual units in each category.

Categories 2 and 3 gather much of the attention, while Categories 1 and 5 are the least referred to, just behind the 'Miscellaneous' category. Category 3 collects the highest number of comments. Here, students mainly talk about their preference for remote or face-to-face classes, their opinion on the face-to-face classes of the Chemistry subject, or their thoughts on the slides with audio explanations or videoconference-style lectures. This variety is due to the great amount of comments belonging to this category.

Table 3. Student participation in the survey

	Group	G10	G20	G30	G40	G50	G60	G70	G80	G90	Total
	Number of comments	8	5	6	1	8	5	3	2	7	45
Number of textual units	Category 1	3		1	1	2		1		1	9
	Category 2	1	1	2	1	5		1	1	4	16
	Category 3a	3	3	3		4	3			3	42
	Category 3b	4	2	1		2	1	2		1	
	Category 3c	3	1	1		2	1	1		1	
	Category 4	2		4	1	4	1	1	1		14
	Category 5	3		1		2	2			1	9
	Category 6	2	1				1			1	5
	% of textual units	22%	8%	14%	3%	22%	9%	6%	2%	13%	100%

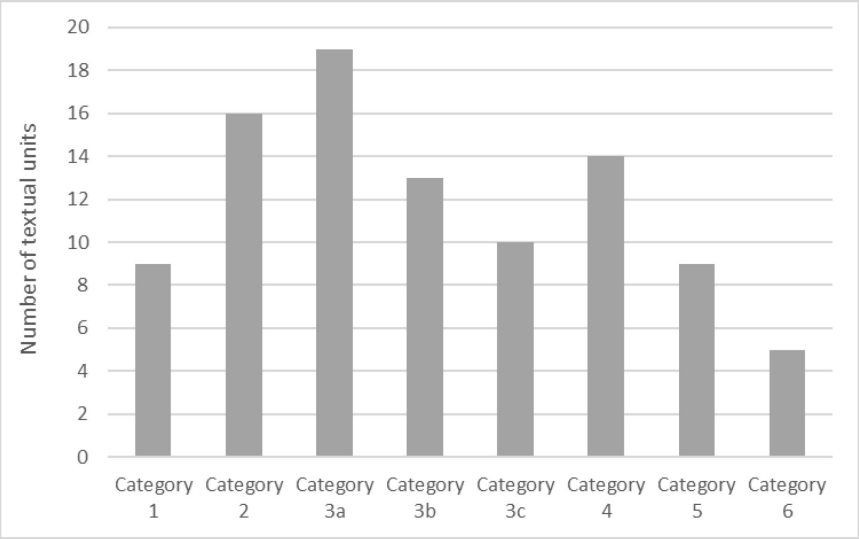

Fig. 2. Number of textual units in the comments for each category.

3.2 Constant Comparison Analysis

This section presents a summary of the most relevant comments made by students in the survey. The different ideas were categorized as detailed in the Methods section. At the end of the included quotations, the class group of the student who wrote the comment is indicated. It is common for the same student to express ideas belonging to different categories.

3.2.1 Category 1: Feedback

20% of the comments expressed students' thoughts on the feedback they received during the ERT period.

The students positively value the speed of the teachers' responses: *'The answers by email from the professors are almost immediate, even if it is Sunday'* (G40), and consider that in Chemistry there has been more teacher involvement than in other subjects: *'In Chemistry there has been more feedback with the teaching team than in other subjects'* (G10).

However, they allude to the lack of efficiency of email communication, either due to a lack of dynamism or difficulties in expressing or understanding the teacher's feedback: *'I have tried to send emails to my teacher, and although he answers me instantly, asking questions by email barely allows me to partially solve the doubts due to how undynamic the method is'* (G70); *'Yes, I can ask by mail but, if the teacher takes a long time to answer, I have already found the solution by myself'* (G10); *'In my opinion, there is a lack of contact with the teacher for asking questions, because many times the explanations are not clear by email'* (G10); *'In my case, I have sometimes asked by email, but my doubts were not solved'* (G90).

Moreover, even though the solutions of the exercises they handed in were made available immediately to the students, several of them mentioned that the feedback of their grades was received too late, which prevented them from knowing in due time how they were getting on with the subject: *'For example, the tasks do not provide me with constant feedback since I do not know how I am doing until a long time after when the unified grade is available. I don't know the grade for each of the tasks'* (G10).

3.2.2 Category 2: Adaptation of the Subject Methodology

36% of the comments coincide in pointing out how well the teaching has been resolved despite the health emergency, thanking the efforts made by the teachers to adapt the methodology and the assessment: *'I highly value the efforts of the teaching staff of Chemistry'* (G30); *'I would like to thank all the efforts that teachers are making'* (G20); *'I think that the way the assessment of Chemistry has been carried out due to the situation in which we find ourselves has been the most appropriate. Sincerely thank you for how you are managing the course in these circumstances'* (G70); *'I think the teachers have managed this subject well and I really appreciate it'* (G80); *'It is a difficult situation that is overcome with continuous assessment. Thanks to the help of all the teachers, this is possible'* (G90), or even comparing the subject of Chemistry with others that took place the same semester *'In my opinion, the way this subject is evaluated during these times is very good for the student, especially when compared to other subjects'* (G50); *'I think the subject is getting along well, comparing it to others'* (G30).

3.2.3 Category 3. Preference for Type of Class: Face-to-face / Remote

This category is divided into three subcategories since it concentrates a large part of the comments (69% of the comments refer to ideas in this category):

- 3.a. Opinion on face-to-face classes / remote classes.
- 3.b. Opinion on the documents with recorded audio.
- 3.c. Opinion on video-conference live classes.

Regarding the subcategory 3.a., – opinion on face-to-face classes versus remote classes –, the general idea that most of the participants have expressed is that ERT is not comparable with the face-to-face classes that were held during the first 5 weeks of class: *'Remote classes are not effective'* (G20).

In particular, they emphasize the importance of human contact with the teacher as a facilitator of learning: *'We must take into account the great importance of face-to-face classes and direct contact with teachers when understanding new knowledge and exercises'* (G50); *'To me, there is nothing that makes understanding concepts better than a face-to-face class'* (G10).

Furthermore, some express that face-to-face classes promote the resolution of doubts, and consider that contact with peers is also key to learning: *'I think that being able to do face-to-face classes brings the human touch that engineering studies need. Without being able to ask the teachers during the class, or seeing how the expert gives us the instructions to solve the problems [...] it cannot be achieved in any other way than through face-to-face classes. Furthermore, thanks to colleagues, a better consolidation of knowledge is also achieved'* (G20).

Specifically, what they value most about face-to-face classes is that they can solve doubts when they appear during the explanation: *'The face-to-face format allows us to solve doubts that we had not even raised yet, either thanks to a question from a colleague or due to a clarification from the teacher during the explanation'* (G30); *'Now we do not have the supplement of the clarifications that the professor gave or doubts that could arise at that time. In my opinion, it is always better to be in contact with the teacher to be able to solve doubts on the spot'* (G60).

The students also state that, with the face-to-face methodology, the lecturer can guide the explanation towards what is most important: *'It is very difficult to keep up with the rhythm and know how to focus the study on the most interesting part of the subject. Knowing how to focus on the topic that matters most can only be done if a teacher guides the subject where it is convenient'* (G10); while other comments remind us that this remote teaching has been an emergency solution and that it does not correspond to the course the students have enrolled in: *'I think that face-to-face classes are necessary. There are other online universities and I have never considered following this kind of education'* (G90).

Despite this apparent unanimity in the opinions, we found some comments that show another perspective. Some students consider that this situation has benefited them and that it has advantages for some profiles of students who do not have as much time available to attend face-to-face classes: *'I like the freedom that we have by being confined, I think that it personally benefits me and I wish that the great activity that has been carried out in ATENEA could be maintained. I would like to continue doing remote classes for longer, until after quarantine, since it would benefit people who for other reason, are unable to attend class, and control the pandemic if this situation continues or if there are any further outbreaks'* (G90).

Other students conduct a self-analysis exercise and reveal that this methodology has made them more proactive: *'It seems good to me to study the subjects remotely because it helps me to take the subjects more seriously and to act on my own initiative than if a teacher covered everything in class'* (G10). They also state that ERT has allowed them more freedom to organize study time in a more personalized way: *'I find it more comfortable to study everything on my own and focus on what I find more challenging'* (G60).

Analyzing in more detail the subcategory 3.b. – opinion on the documents with recorded audio – we find clues that help us to understand what has failed or identify what triggered the feeling that remote classes do not measure up to traditional classes. The face-to-face classes were replaced by the same PowerPoint slides that were to be used in the classes, with an audio explanation added on each slide. Most students say that this material was not enough to enable them to understand the concepts: *'The presentations with voice accompaniment would have been very good if the explanations had been better. I have found them insufficient in some aspects'* (G50); *'The presentations are not enough to learn the agenda, which leaves me with many doubts'* (G10). Some students think that the problem resides in the fact that the audio is a simple reading of the PowerPoint slide itself: *'The voice material is not useful because it just reads the presentation'* (G20); *'The presentations are made to be explained and that has not happened'* (G50).

However, others find correct the explanations included in the presentations, but identify the resolution of exercises as the bottleneck for under-

standing the subject: *'PDFs with audios are good enough for understanding the theory, but problem solving with a pdf file is not enough'* (G70); *'The presentations with voice are very useful, but sometimes, when doing the exercises, the execution is difficult'* (G30). Several comments refer to the fact that they consulted Internet videos to understand how to solve exercises, since the presentations with voice were insufficient: *'In the same way, Chemistry is a subject where constant practice is needed, but if you have no idea how to solve exercises it slows you down a lot. I get more help on YouTube from people who upload their videos for solving exercises than from voice presentations'* (G10).

A single-sentence comment reveals different ideas about what the students would have preferred during the ERT: *'To improve the methodology of remote teaching, I think it would be good if YouTube videos were made explaining the concepts together with step-by-step exercise resolution, and not just reading PowerPoints'*(G90). This comment introduces a recurring idea about remote live classes, which we detail below.

The last subcategory 3.c. – opinion on video-conference live classes – completes the information on the students' opinions about their preferences for a certain type of class. Many students suggest conducting classes by video-conference as a substitute or a complement to the slides with voice accompaniment: *'It would be good if classes were held by video-conference'* (G20). This is especially important for the direct contact that facilitates the resolution of doubts: *'I think that it would have been better to do the classes by online video-conference, since the concepts would have been explained more naturally and fluently, the exercises solved more carefully, and interaction with the teacher would have been much more direct, although it was not bad at all'* (G30); *'I think that the way to do the classes would be through video-conference, so that we can ask questions directly'* (G50).

This lack of contact with the teacher is evident in the comments that refer to more opportunities to ask questions: *'The availability of visual contact with the teacher would be perfect during the problem solving when you do not understand something or think why is the teacher doing that, or why is it wrong? (. . .) Doing virtual classes would favor both learning and assessment'* (G10). Lack of contact also seems to be closely related to solving exercises: *'I think that video-conference classes are needed to solve exercises and doubts, or at least videos of problem solving step-by-step and with justifications'* (G70).

Comments reflecting student discomfort in this situation have also been found. Some students feel that the quality of teaching has not been the same as that in a regular face-to-face course: *'I think that remote classes should be done with the same content and similar to that in the face-to-face classes. That is what we have paid for, not only for taking the exam'* (G60).

One comment is striking because it positively values the fact of having the material specifically created for the remote classes, even when the contact classes are being held: *'There is nothing as good as face-to-face classes. However, it is nice to have remote presentations and recorded classes, and it would be very good to continue having both available online when we return to the face-to-face classes'* (G50). This comment seems to reflect the preference for face-to-face classes, but without losing the advantages of extra explanations on the virtual campus ATENEA and the possibility of consulting them as an extra resource.

3.2.4 Category 4. Exercises

31% of the comments refer to ideas concerning the delivery of exercises or the solved exercises that were available to students on the virtual campus.

Participants generally state that handing in exercises regularly helps them keep up to date with the subject, and they value it positively: *'The truth is that having to submit a task every week forces you (in a good way) to develop the subject to a greater extent and reflect more when solving exercises. If there had been no deliveries, perhaps I would not have done as many exercises. Thank you!'* (G50); *'The initiative to establish weekly tasks is good'* (G30). In addition, they also consider that a continuous assessment option is better than the frequent exams they had to do in other subjects during the semester: *'Handing in exercises has motivated us to keep up with the subject, and not having to do exams all the time, which overloads us with work'* (G70); *'I find the assessment methodology of Chemistry very good as it's not all exams. Therefore, you learn how to do things and not how to do exams'* (G40); *'Carrying out tasks weekly [. . .] seems to be very correct to me'* (G50).

Additionally, several students have expressed their liking for this more continuous assessment, since it avoids all the weight of the final grade coming from the exams: *'I like it because more deliveries and assignments are made, and we are not evaluated only on two exams'* (G10), and they propose that the delivery of exercises should be maintained beyond the remote course: *'I would keep these types of tasks even in normal situations, and it would be very good idea to do it in many other subjects'* (G30).

Despite positively evaluating the delivery of exercises, students are critical about the clarity of the solved exercises available to them: *'The problem is that the published solutions are quite short. So I*

don't know whether or not I'm doing things in the right way' (G50); *'I would like to have more explanations about how the exercises are done. In the end, I end up doing the exercises by comparing them with those already solved, and I don't really know/understand how they are solved'* (G30). They also request a greater quantity of solved exercises in order to be able to follow the course properly: *'It would be good to have all the exercises solved in order to check that we are solving them correctly'* (G60); *'In all the subjects, I felt the lack of access to solved exercises. (. . .) This makes it difficult to follow the agenda daily'* (G80). These comments reflect that one of the reasons why some students feel they do not understand the concepts, or why they have so many doubts, is because there have not been enough exercises or they have not been explained clearly enough.

3.2.5 Category 5. Learning Impressions

Regarding the impressions of learning during this period of confinement, several comments refer to difficulties or a reduction in learning caused by the ERT: *'Understanding things that I could not understand in the face-to-face classes has been much harder work for me'* (G60); *'It seems to me that I am not keeping up to date with the subject, I am not learning. Although I do my part, it is becoming very difficult for me' (G10); 'I feel that remote teaching is more difficult for me'* (G60); *'When putting it into practice, there have been problems that have been disastrous for me'* (G50).

Some students attribute these difficulties to the rate at which the subject has been covered: *'I think that the progress of the subjects has been too fast and there has not been enough time to assimilate some concepts of certain subjects such as Chemistry, for example'* (G90).

Another surprising factor is that some students have encountered computer problems that they were unable to solve: *'I do not know why it is not possible to reproduce the voice of the presentations. Therefore, it is quite difficult for me to follow the theory only with PDFs files and solved exercises'* (G30); *'The only material we have are the presentations with voice accompaniment, and I (trying on three different computers) still have not been able to listen to any'* (G50).

Despite having been given the instructions about how to access the recordings on the PDF or PowerPoint documents, some students reported IT issues and were referred to the UPC computer service. However, those students who did not report their difficulties were not working in the same learning conditions as the rest.

Altogether, 20% of the comments contain ideas that fall into this category.

3.2.6 Category 6. Miscellaneous

Finally, some comments that do not fall into any of the previous categories, but reflect the student opinions and reflections, are highlighted in this Section. One comment indicates that some students felt overwhelmed by the amount of work they had to do, and were not able to separate study time from other activities when being in lockdown at home. This could be because no coordination between the different subjects was carried out. This caused the work peaks to overlap: *'I would like to ask that the schedule be fulfilled, since we have to be prepared to work 24 hours a day, 7 days a week in order to hand in tasks; that is, we cannot even disconnect a little during the weekend'* (G90).

Lastly, another comment reflects the concerns of many students about subjects in which the ultimate objective seems to be to pass instead of learning: *'Perhaps it is possible to pass the subject since you can easily obtain 40% of the grade. It doesn't take that much to solve the exercises correctly (apart from time) with the help of the internet and the notes on the side'* (G10), while a further comment demands that the requirement is relaxed due to the circumstances: *'Take into consideration the situation when grading student work'* (G20). Since the objective of students is usually to pass, and the objective of the faculty staff is that students learn, it is worth mentioning the importance of designing the subject in such a way that if the students learn, they pass, and there should be no other way to pass without learning.

4. Discussion

In general, the comments reflect that the vast majority of students prefer face-to-face classes, which allow for better resolution of doubts, since the ERT methodology lacks human contact with either teachers or peers. This loss of student social presence is reported to have a negative impact on students [17]. Moreover, in the face-to-face class periods at the beginning of the semester, students believe that it was easier for them to determine which parts of the syllabus require more attention, because teachers usually emphasize what is most important during those sessions.

Nevertheless, some students state that this arrangement is beneficial for them because it gives them more time and freedom as well as stimulating them to adopt a more proactive attitude towards learning. It is interesting to observe how the health emergency has had positive side effects, such as that some students positively value that their autonomous learning has improved. These students would probably benefit the most with a flipped classroom methodology, a topic that has been extensively studied [18].

Many students consider the presentations with audio as not enough to cover the agenda, since they regard such presentations as a mere reading of the slides. Other students remarked that audio presentations were suitable for the theoretical classes, but they were insufficient for understanding the execution of practical exercises. Students also stated that the problems solved in PDF files left them with many doubts, and therefore resorted to external sources like internet videos to understand the agenda or to solve the exercises.

Unanimity is observed in the positive assessment of the weekly delivery of exercises through the ATENEA campus because it encourages constant practice and keeping in touch with the subject. However, students complain that the feedback received in the form of delivery grades arrived late. This shows that students are quite dependent on numerical grades to know if they are learning, rather than on self-assessment by comparing their exercises with the corrected versions, which is an issue that needs to be tackled if we wish them to be autonomous learners [19]. In addition, students consider that email is not an efficient channel for resolving doubts, although many of them praise the speed of response and availability of the lecturers when they were required.

For all these reasons, the learning impressions have been impaired. Several students commented that they experienced difficulties with which they did not know how to cope, sometimes due to computer problems or to the excessively rapid pace of the semester.

Despite all these difficulties, and given the exceptional circumstances, many students consider that the situation has been well managed, and thank the professors for the efforts made. Furthermore, the Chemistry subject emerges favorably when compared to others, especially due to the involvement of the teaching staff and communication with the students, as well as the way the assessment has been adapted on the basis of weekly exercises instead of continuous exams.

Even when the face-to-face classes restart, several comments indicate the advantage of maintaining the regular delivery of exercises as well as the availability of extra material on the ATENEA virtual campus, where solved exercises or theoretical concept explanations are available.

A generalized request refers to holding the classes via video-conference if remote teaching becomes necessary again, since students positively value visual contact with the instructor during the class. In addition, this type of remote class allows queries to be made directly to the teacher on the spot, because their doubts or those of their classmates can be resolved immediately. This is especially important for problem-solving classes, and students consider it as an option that more closely resembles a face-to-face class. It may be that if students had had better material available, their opinions about the distance classes would have been different, as they would regard them as a good option with higher flexibility.

Furthermore, normal online teaching is not the same as that conducted during a pandemic, where students experience very restricted mobility and are unable to carry out their normal activities in terms of outdoor sports, leisure, and face-to-face socialization.

From all of the above, it is deduced that the ERT methodology adopted as a consequence of the health crisis has not been optimally implemented. The introduction of new technologies in class without a period of adjustment and instruction can disrupt learning [20]. The feedback received from the students through the survey, and a self-evaluation of the work undertaken by the teachers, should provide us with information about how to proceed, should it be necessary to return to distance teaching. Encouraging continuous assessment and providing students with sufficient feedback in due time are crucial for maintaining connection. Classes imparted with elaborate videos (prepared in advance and subject to internal quality control), and sessions by video-conference aimed at solving exercises and questions, appear to constitute a winning combination for transmitting knowledge remotely to students. Analyzing the gaps and areas of improvement are a key step to guarantee the sustainability of quality remote classes in the future.

This exceptional situation has also exposed student weaknesses. In many cases, they present difficulties when adapting to new situations, and lack study habits or skills for managing their own (autonomous) learning or for organizing their time. Some students have been unable to ask for help when they needed it; for example, when encountering computer problems or experiencing doubts about the topics they were unable to solve by using the available resources.

For this reason, it would be interesting to include in the first year of the degree a specific subject that developed the skills they will need throughout their careers and in their professional future. This could consist of advanced computer skills, time management techniques, study habits, autonomous learning, how to search for information on the internet, how to prepare oral presentations, tools to manage stress and so on. It is also very important to ensure that all students have the necessary tools to guarantee equity in the accessibility of learning materials.

Table 4 collects some good practices that could

Table 4. Good practices to be maintained after normality is recovered

Facilitate the availability of teachers for student's consultations
Recordings on important topics available online for students
Wide range of solved exercises
Foster student collaboration
Periodic assignments to give frequent feedback to students
Specific problem-solving classes, and resolution of doubts
Courses on useful transversal skills for students

be beneficial to maintain once education returns to normality.

As may be gleaned from the results and the discussion, generally speaking, the answer to the research question is that students prefer face-to-face classes to the Emergency Remote Methodology they have experienced in the Chemistry subject during the spring semester of 2020.

5. Conclusion

The COVID-19 pandemic is the first global crisis in recent times to have had such an enormous impact worldwide, and its full effect on politics, the economy and society as a whole are still unknown. However, what is already foreseeable is that our approach to university education must change in order to adapt to this new digital era in a highly globalized world. Spanish first-year undergraduate students have been subjected to a strict lockdown lasting for several months, during which time they have had to continue with their demanding studies by means of the Emergency Remote Teaching methodology.

The research question raised in this study was the following: What opinions do students have about Emergency Remote Teaching versus the face-to-face classes in the Chemistry subject?

In order to answer this question, student opinion was gathered at the end of the semester using an online survey with an open-ended question to which they could leave their comments. These comments were analyzed using the constant comparison qualitative approach. Six categories were created using an inductive method, which revealed the main topics students that were addressing in their comments: feedback, adaptation of the subject methodology, preference for the type of class, exercises, learning impressions and a final miscellaneous category for divergent topics.

In regard to the Chemistry subject, the students in the survey reported that they preferred face-to-face classes rather than slides with audios, or even classes taught by means of video-conference if remote teaching is required. On the part of both instructors and peers, there is a diminished perception of socialization, which students find as a key factor in learning, as it helps them to clarify doubts and collaborate with other students. They also state that delivering weekly exercises helped them to remain abreast of the subject and to sustain learning, and thanked instructors for the efforts they made to adapt the methodology to the exceptional circumstances.

These opinions are those of students studying for the Bachelor's Degree in Industrial Technology Engineering in relation to a chemistry subject, although we believe they could be similar to those of other undergraduate students in an analogous situation. However, in order to validate this statement, it is necessary to replicate works similar to this in other university environments. The methodology described in this paper can help other researchers to replicate the experiment and validate that the results found can be extrapolated to other environments.

The information gathered in this study enables teaching staffs to plan ahead for a remote teaching methodology that meets students' needs better than ERT, should further confinement be required by authorities as a result of a health emergency or other types of catastrophic events.

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Gádor Indra Hidalgo received a Bachelor's Degree in Chemical Engineering at Universitat de Barcelona (UB) and a Master's Degree in Chemical Engineering with polymers specialization at Universitat Politècnica de Catalunya (UPC-BarcelonaTech). After working at several national and multinational companies, she joined UPC where she lectured at the ETSEIB campus and took part in research projects. Her research interests include education, analytical chemistry, food packaging, polymers and public health.

Fermín Sánchez-Carracedo received a Master's degree in industrial electronics for the E.A. SEAT in 1981, the BS in computer science in 1987 and the PhD in computer science in 1996. The last two degrees were obtained at Universitat Politècnica de Catalunya (UPC-BarcelonaTech). His fields of study include computer architecture, innovation in education and education for sustainability. Since 1987 he has been lecturing in the Department of Computer Architecture from UPC-BarcelonaTech, where he has been an Associate Professor since 1997. He was a course instructor at the Universitat Oberta de Catalunya (UOC) from 1997 to 2010 and Vice-Dean for Innovation at the Barcelona School of Informatics (FIB) from May 2007 to June 2013. Since July 2013 he has held the position of Deputy Dean for Innovation at FIB.

Daniel Romero-Portillo. Bachelor's Degree in Sociology and Political Science. Master of Arts in Current Democracies: Nationalism, Federalism and Multiculturality. He is currently developing his PhD at Sociology department at Universidad Pablo de Olavide. His research interest focuses on collective identities, political behaviour and quantitative methods. His professional activities focus on strategic planning and public policy evaluation.