Analysis of the university teaching influenced by the COVID-19 context: some lessons learned

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Abstract- The health crisis caused by the SARS-COV-2 virus produced a drastic change in teaching in March 2020, when face-to-face teaching was forced to become online teaching. It led to changes in teaching methodologies, teaching materials and evaluation methods. The objective of this study is to determine which of these changes in the on-site university have been positive and should be sustained over time. To this end, a survey has been carried out among the students of different courses of the degrees taught at the E.T.S.I. Minas y Energía (E.T.S.I.M.E) of Universidad Politécnica de Madrid that allows us to know how the pandemic has influenced the use of didactic materials, what type of teaching modalities students prefer, and what resources they use the most during the study. Although class notes and slides remain the preferred resources among students, they showed great interest in class recordings. Other traditional materials, such as bibliography or tutoring, are less used by students. As for teaching methodologies, opinion is polarized. Therefore, it is necessary to make an effort to efficiently combine tele-teaching methodologies and didactic resources to face-to-face teaching, generating asynchronous resources without detriment to traditional face-to-face activities.

Keywords: Materials management, higher education, COVID-19, distance learning, student survey

1. INTRODUCTION

Educational innovation, as any other innovation, aims to change and improve (Sein-Echaluce, Fidalgo-Blanco & Aviles, 2017). In other words, promotes methodological and technological changes in other to develop new learning processes and/or new evaluation methods considered better than the previous ones. To carry out and validate innovation some requirements must be fulfilled such as establish a proper planification, define a results prediction and determine the control indicators which will provide information regarding the changed produced by the innovation (Fidalgo-Blanco, Sein-Echaluce & Garcia-Peñalvo, 2018).

The ideal scenario for change takes place through educational innovation, aiming to improve teaching, however this scenario hardly occurs. In this context, the general education situation dramatically changed during 2020 spring, when 188 countries, among which was Spain, closed each single classroom to prevent COVID-19 disease propagation. This health measure affected 91.3% of the world's student population. In a situation where students cannot attend face-to-face lessons, the only viable alternative consists on adapting traditional education to online education (Basilaia & Kvavadze, 2020).

However, COVID-19 disease forced a fast transition from face-to-face teaching to online education, a transition that did not allow the required planning. Because of that, in most cases the transition consisted only meant a change in the location, changing to online teaching and increasing the use of information and communication technologies (ICTs), whose implementation had already been carried out during the previous years. Therefore, from a pedagogical point of view, education during the pandemic has not been on-line education, as the immediacy of response did not allow the use of the proper online education methodology nor the planning prior to the start of the academic year, which are the two essential factors for it to be considered online education (Fidalgo-Blanco, 2020).

Regarding digitization, it should be noted that pandemic has promoted population's digital skills, which has increased exponentially. However, specifically in the university environment, the fact that the application of digital technologies met the educational requirements during this period, does not mean that institutions, teachers and students were fully prepared to carry out this digital transformation imposed by the situation, revealing the existing deficiencies in this field (García-Peñalvo, 2021).

During this emergency situation experienced by COVID-19, it was necessary to give a prompt response and there was no time to verify the quality and effectiveness of the teaching methods adopted, as the main objective was to save the educational process and continue it in any possible format (Basilaia & Kvavadze, 2020). However, the new teaching strategy imposed by the situation should not have produced student's worse results (George, 2020). Therefore, it is interesting to find out which methodologies applied generated the same (or better) performance of student. In this context, only after applying these methodologies, it is possible to assess what has been done, drawing conclusions about what can and should remain implemented and, on the other hand, what should be improved to increase its effectiveness.

2. CONTEXT

As it has been mentioned, the health crisis produced by SARS-COV-2 (COVID-19) forced a drastic change in the

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educational methodologies of Spanish face-to-face universities. Most of them went from an eminently face-to-face education to a completely online education and, afterwards in a second stage, to a semi-face-to-face "hybrid" system. This situation caused changes in teachers' teaching methods. This resulted in a change in the way they gave their lessons, generated teaching materials, evaluated content, etc. The immediate consequence was a change in the teaching-learning process. Some of the introduced changes have been very positive and will remain in the coming years, however, some others have resulted into learning difficulties. Some examples of these improvements whose implementation could be maintained over time are automatic evaluation systems or the use of digital platforms to speed up project deliverables and test corrections. In order to differentiate the positive methodological changes (so they can remain implemented), from the negative ones, (so they can be improved), it is necessary to obtain a feedback from students, knowing their impressions and opinions. Analyzing the target audience, in this case the students, allows choosing the methodological options that improve the teaching-learning process with an increasing predisposition to the consumption (sometimes asynchronous) of audiovisual and digital content in combination with face-to-face teaching methods (lecture, practical lessons, problem solving sessions, etc.). As other previous research noted (Aguado, 2020), students are reluctant to only online education, mostly prefer face-to-face teaching together with other online support tools.

Because of that, an opinion survey has been proposed, through which it is expected to know the changes that took place due to the pandemic regarding the students use of teaching materials. In addition, given the incorporation of new methodologies and resources, it is intended to determine the reception and perception of utility by the students. Nevertheless, these materials must also be analyzed from the learning point of view. Teachers have limited time, so it is essential that they direct their efforts to methodologies and teaching materials that are really used and taken advantage of. At the same time, it is intended to discern between the measures adopted by the health situation that must be maintained and those that do not produce learning improvements.

The opinion survey was carried out in the Technical School of Mines and Energy (Universidad Politécnica de Madrid) to the target group described in table 1. Four degrees participate, Degree in Energy Engineering (DEE)., Mining Engineering (DME), Geological Engineering (DGE) and Energy Resources, Fuel and Explosives Engineering (DERFEE).

Table 1 Survey simple size

Year	DEE	DME	DERFEE	DGE	TOTAL
1st	154	119	—	—	273
2nd	211	107	—	—	318
3rd	156	29	64	7	256
4th	294	84	129	11	518
TOTAL	815	339	193	18	**1365**

3. DESCRIPCTION

In the Technical School of Mines and Energy, during the years leading up to 2020, although innovative methods and technologies had been incorporated into many of its subjects, a traditional teaching style prevailed. For example, the Moodle Platform was already essential for the subject's management but also to ensure dynamic communication between lecturers and students. However, despite this being the official management platform, many major professors are unaware or have little knowledge of this platform versatility and continue to opt for traditional methodologies in master classes, leaving aside Moodle operability. This circumstance is in line with previous research, in which it was highlighted that low technological training, coupled with major professors lack of knowledge, influence the low frequency of use of some of the interactive activities available. For example, in Moodle, some of the least used features are chat, the wiki and the questionnaire, among others (Hernández, 2015). It is also interesting to note that training directed towards major profesors in this matter influences an exponential increase in the use of these tools (Andone, Ternauciuc and Vasiu, 2017). The health crisis that caused the cancellation of face-to-face classes in March 2020 abruptly triggered teaching to move from the classroom to different online platforms. This implied the need for a fast adaptation of the materials and tools available that would help students to continue learning in a distance mode, , forcing lecturers to generate new digital materials and to use these tools more than before, since some of them had used little until then or, even, they had never used before (such as Teams, Zoom, BbCollaborate, etc.)..

As a result of this situation, the students had contact for the first time with some digital resources, such as recorded or asynchronous online lessons. In addition, teaching changes also meant changes in the student's study methodology. In order to know the opinion of the students, once the situation returned to normal, it was decided to design an opinion survey through which the students management of the teaching materials will be analyzed in two scenarios: before and after the pandemic. The survey will result in a guide that can be considered in the preparation of the teaching materials and the methodologies to be used for future courses. The survey carried out is made up of three blocks, which are described below:

Block 1 - Student profile: The questions that make up this block (1-5) will define the student profile.

Block 2 - Management of teaching materials: The questions in this block (6-13) intend to comprehensively analyze the differences perceived by students before and after the 2020 pandemic in terms of the management of available teaching materials.

Block 3 - Analysis of specific materials and teaching modalities: In the last block, we seek to know the general preferences of the students regarding teaching modality, especially after having experienced the change in education last year.

The survey was responded by students of various courses and degrees taught at the Technical School of Mines and Energy (table 1) and aims to understand the changes produced by the pandemic in the study materials, in addition to knowing the opinions of the students regarding the different teaching modalities, so learning can be improved.

4. RESULTS

The number of students who responded the survey were 87, that represented all four degrees taught at the Technical School of Mines and Energy. As mentioned before, the survey is

divided into three blocks which results are shown in the following subsections.

A. Block 1: Profile of the students

According to the responses analyzed, 66.7% of those surveyed are men. This result is to be expected when dealing with technical degrees. The students are aged between 19 and 28 years, among which the majority were born in 2001 (20 years), with 33% corresponding to first- and second-year students. Furthermore, 64% of the respondents had a university entrance grade higher than 9 (on a scale of 14). Finally, 59.5% of students have pending subjects from previous courses, even though a third of the respondents are between the first and the second year. In addition, 65.9% have at least one first year pending subject. The results reflect a greater interest in responding by the second-year students, since they were the most affected by the change in teaching methodologies because of the pandemic.

B. Block 2: Management of teaching materials

The results of this block are presented based on the questions, which consider two scenarios: before and after the pandemic.

Questions 6 and 7: How often "did you consult and consult now" the teaching material provided on the Moodle platform?

The responses reflect a clear increase in the frequency with which students consult the teaching material on the Moodle platform. Whereas before the pandemic 58% of those surveyed consulted the didactic material every week, currently it reaches 81%. On the other hand, the percentage of students who only consulted the material when they had a question/doubt has dropped from 25% to 9.5% and those who only consulted it before the exam, has dropped from 12.5% to 6%. The percentage of students who did not consult the material frequently (almost never or never), remains practically constant. These students, who do not consult the didactic material or rarely consult it, stated that before they preferred to consult didactic material from external sources other than the teacher, but after the pandemic, the resource they consider the most interesting is the bibliography. All of them also go to classmates to resolve doubts.

Questions 8 and 9: What kind of teaching material "did you consult and consult now" most frequently?

Questions 8 and 9 compare the type of teaching material consulted by students before and after the pandemic. As can be seen in Figure 1 a), the percentages practically remain constant, so the change in teaching has almost no effect on the type of material consulted by students. However, there is a slight decrease in the consultation of class notes and slides, and an increase in complementary material (both materials provided by the teacher and from other sources). In both cases, the bibliography remains the least consulted material, registering only 3-4%. Analyzing the answers, it has been noticed that this percentage meets the one of students who do not consult the material provided by the teacher never or almost never.

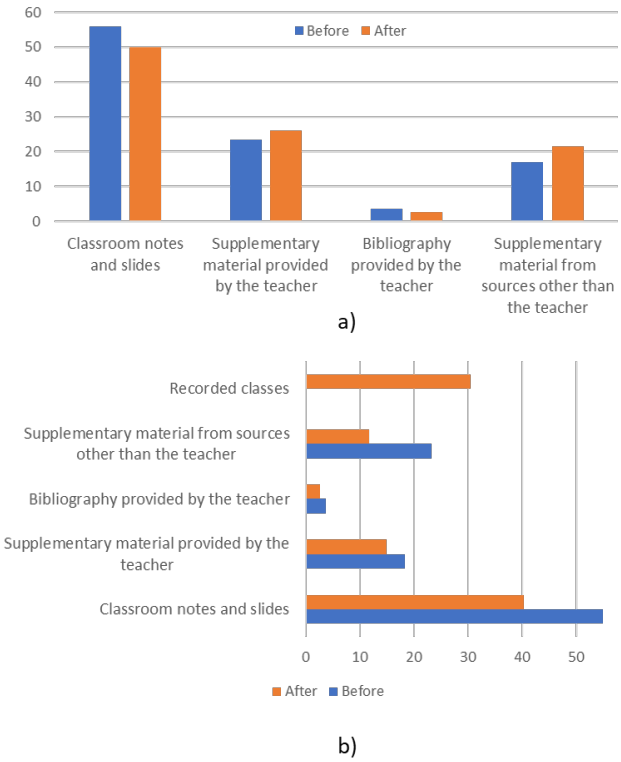


Figure 1 a) answers to questions 8 and 9 (material consulting); b) answers to questions 10 and 11 (most relevant material)

Questions 10/11: What kind of teaching material "did you consider, and do you now consider" more interesting to consult? Reasonably, the students consult the materials they consider most interesting, therefore when asking what material is considered more interesting to consult (questions 10 and 11), the answers agree with those offered in questions 7 and 8. Although slightly differences can be observed, the trend completely coincides, especially in the question referring to the pre-pandemic situation. However, in question 10 we wanted to add the option of "recorded lessons" to check the real interest that exists in this type of content. Although this topic is addressed in a specific question later, figure 1 b) already indicates the interest of the students in the recorded lectures. So much so, that the percentage is significantlyclose to that of class notes and slides, which remain the predominant materials.

Questions 12 and 13: In case of detecting a doubt during the study, what action did you take from the following before the pandemic? / What action do you take now from the following?

Questions 12 and 13 seek to determine which sources students use when they find a doubt or difficulty during the study of the contents and whether, the fact of having received online lessons with less personal contact with the teaching staff and with their classmates, had an impact in the decrease of consultations between classmates and with the teacher in tutoring sessions. In the figure, it can be seen how the most significant changes focus on consulting classmates and videos and tutorials provided by the teacher (1 being the previous situation and 2 the current situation). Before the pandemic, students consulted their classmates more frequently, however this percentage decreased by 16.3%. This situation is easy to explain since the health situation has hampered social relations,

however, this circumstance has not reduced tutoring sessions with teachers. On the other hand, an increase of 28% is observed in the consultation of videos and video tutorials provided by the teacher.

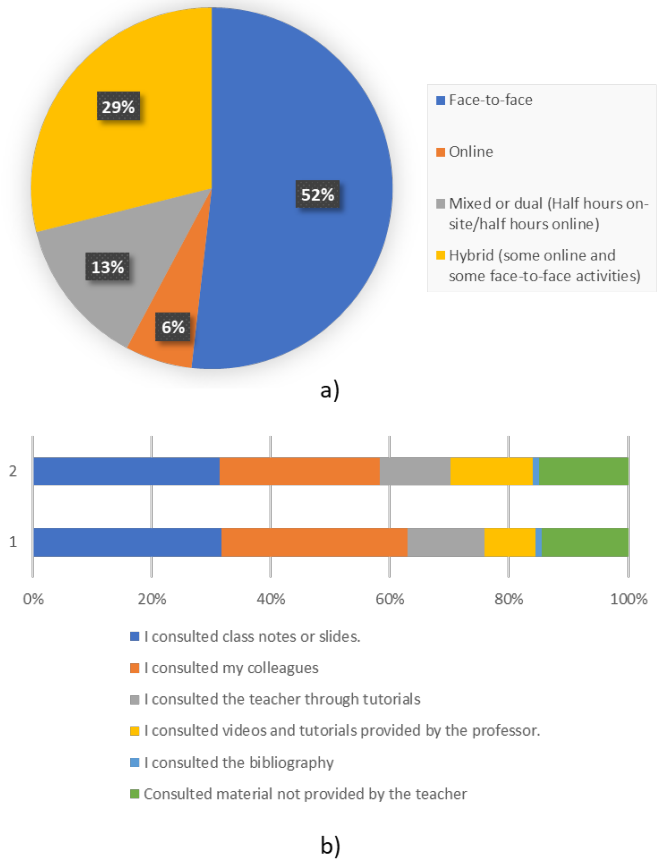


Figure 2 a) answers to questions 12 and 13 (actions when finding doubts); b) answers to question 14 (educational method)

C. Block 3: Analysis of specific materials and teaching methodologies

Question 14: If you had to choose only one teaching model, what would it be?

Figure 3 b) shows the preferences of the students surveyed with regard to the mode of teaching, showing a strong preference for the face-to-face mode. However, this data (52%) barely exceeds half of the responses. It is worth noting the high percentage of students who prefer hybrid teaching, which in this study has been defined as combined teaching, in which some activities are done face-to-face and others online. When compared with the mixed or dual mode (half face-to-face and half online) this percentage is halved. From these data we can extrapolate the polarisation of opinions between the face-to-face and the combined mode (both hybrid and mixed).

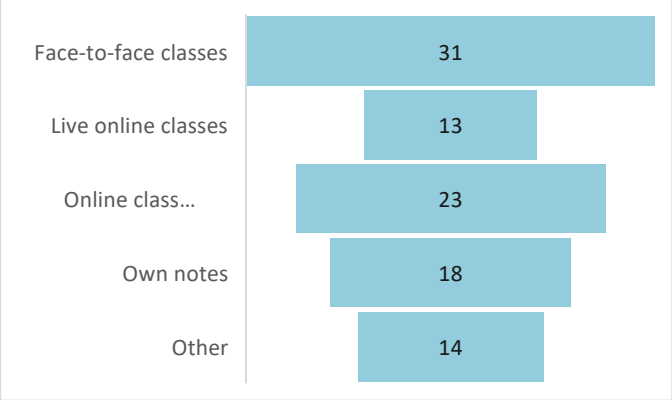
Question 15: Would you say that the health situation caused by Covid has improved the contents and materials on the Moodle platform?

Question 16: Do you now consult more frequently the contents posted on Moodle?

When students are asked whether the change in teaching caused by the health situation has improved the contents and materials on the Moodle platform, 62.5% confirm it has (question 15). This is significant and is a positive consequence that has been observed after the pandemic, as teachers (lacking face-to-face teaching) have been forced to increase and improve additional content. Furthermore, although this has already been reflected in previous questions, question 16 confirms that 80.5% of students now consult the content available on Moodle more frequently.

Question 17: Do you find it interesting that lessons are recorded?
Question 18: Why?
Questions 17 and 18 seek to analyse students' interest in the recorded lectures, and to find out why students find it a valuable resource. To this end, question 18, an open-ended question, was added, which elicited 75 responses and is analysed below. Almost all students (96.4%) find it interesting to record lessons, but what are the reasons?
Many of the answers focus on the specific case of online teaching, as it is difficult for them to follow online classes and having them recorded facilitates learning. According to students, and as recent studies have shown, concentration in online classes is difficult to maintain. This result is in line with a recent study in which, among the difficulties experienced by students in continuing their studies telematically imposed by COVID-19, are that "at home I do not concentrate" and that "it is difficult for me to follow online classes or tutorials" (Kuric, Calderón-Gómez and Sanmartín Ortí, 2021). But loss of concentration does not only happen in online teaching; in studies prior to the pandemic, it was also found that students lost concentration in face-to-face classes due to different factors: peer pressure, environmental conditions and, above all, the use of mobile phones during classes (Mendoza, 2018). Whether during online or face-to-face classes, the loss of concentration on the part of students reduces their learning capacity and, therefore, means a decrease in their acquisition of competences. Therefore, students consider that the possibility of having the classes available and being able to watch them again allows them to repeat the more complex explanations, enabling them to understand the more complicated concepts.
In addition to the above, 54.9% of the responses focus on the use of recorded classes as an additional educational resource, which would be valid even for face-to-face classes. The method of teaching with video tutorials or explanatory videos, problems, etc., is a widely implemented technique (Castells et al., 2019). However, the forced change of teaching experienced in 2020 has awakened interest in this type of resources that students previously did not consult so often. Given that most students prefer face-to-face teaching, it would be interesting to promote this type of resource, especially for those concepts in which the most common errors are detected.
Furthermore, 21.1% of the students confirm the importance of accessing this type of resource when there are timetable incompatibilities.
Only 4.2% of the responses highlight negative aspects in reference to the use of recorded classes. According to these students, being aware that the classes are going to be recorded can lead to loss of attention in the classes. It is interesting to mention some responses, such as the possibility for each student to study at their own pace.
Question 19: Which study methodologies do you prefer?
Question 19 raises the question of online or face-to-face teaching, from the point of view of students' preferred study

methodology. As can be seen in figure 3, there is still a high percentage of students who prefer to work in the traditional way, through face-to-face classes. It is to be understood that the students' own notes can be used in both modalities. Once again, the high percentage of students who prefer to study with recorded online classes (23.5%) stands out. In view of the results, it seems clear that today's students find it very useful to have access to recorded explanations, which encourages all students to be able to follow the course, depending on their learning pace. This model is not entirely applicable to face-to-face teaching systems, but it does leave the door open to supporting teaching materials, in video format, in which explanations of specific concepts are presented. Active methodologies could also be used, such as flipped teaching, which is based on reversing what is done in class and what is done outside the classroom with respect to traditional teaching, i.e. in the flipped classroom, students receive the theory at home (which may be in the form of videos) and then work in class with the proposed activities (Nouri, 2016). This methodology applied in university teaching has been shown to have many advantages, for example, it allows students to learn at their own pace, it encourages students to actively participate, it frees up real class time for more effective, creative and active learning activities, teachers are given more opportunities to interact and assess student learning, and students take control and responsibility for their learning (Gilboy, Heinerichs and Pazzaglia, 2015; Betihavas et al., 2015). Furthermore, Figure 3 shows that there is a lack of unanimity on the part of students regarding preferred study methodologies, indicating a need for student-tailored teaching. This situation could be remedied with appropriate teaching materials to enable students with different paces to follow the classes.



Figur 3: Question 19 answers analysis (study material)

Question 20: Do you consider the material provided by the teacher in the current situation is:

Finally, question 20 is posed in which students were asked to rate the amount of content provided by the teacher in Moodle. 67.5% of students believe that the content is sufficient, meaning that they consider that they have at their disposal all the materials necessary to acquire the competences of their subjects. It is worrying that 26.5% of the students consider that they do not have sufficient materials. The remaining 6% consider that they have too much material. However, despite the fact that the majority of students consider the material available to be sufficient, many consider the organisation of the material to be inadequate. Many responses point to the poorly organised material which prevents them from determining which materials are more important or basic, and which are more secondary and additional.

5. Conclusions

The health crisis has not only brought about changes in teaching but has also led to a change in students' management of teaching materials. Although class notes and lecturers' slides continue to be the most widely used material, the change in teaching has led to a notable increase in the use of additional materials, both provided by the lecturer and from external sources, resulting in an increase in students' autonomous learning. The bibliography is the material that arouses least interest among students, which is in line with their preference for interactive or visual materials.

In this sense, it is worth highlighting the interest in recorded classes as study material, which solves problems such as different learning rhythms among students or possible timetable incompatibilities. In addition, new didactic materials are created in video format focused on the resolution of problems and doubts that are useful not only during guided learning but also during the student's autonomous learning.

During this period, there has also been a decrease in the resolution of doubts through consultations with classmates, as interaction has been reduced to contacts mainly through the Internet. However, it should be noted that this option remains the second most preferred option (after consulting class notes or slides), well above tutorials, which have remained at the same low incidence as before the pandemic. With the change to distance learning, students had more immediate and accessible means of attending tutorials (chats and video calls), yet they did not use this resource.

With regard to the mode of teaching, there was a preference among students for face-to-face teaching (52%) and, almost equally, the combination of face-to-face and telelearning (42%). Within the latter group, there is a strong preference for a combination of face-to-face and distance learning activities. This suggests that students consider that face-to-face activities promote learning, but that more distance activities will be needed in the future. In this sense, the percentage of students who prefer only distance learning is very low (6%), which is understandable given the fact that the university where they study is face-to-face, so that if they prefer only online learning, they could opt for other universities that offer it.

Finally, the health crisis has made it necessary to increase and improve the resources that teachers make available to students. The surveys reveal that most students consider that the number of resources is generally adequate, however, they call for greater organisation and guidelines to help them understand the importance and usefulness of each of the materials available. To this end, when a lot of material is available, repositories could be created and search mechanisms could be used, which would help to know the material better and locate it more easily (Fidalgo et al. 2018).

This preliminary study, therefore, can serve as guidance for lecturers, in the first instance, and for the governing bodies of face-to-face universities, to maintain the strategies and actions that have been most useful to students in their learning during this exceptional situation. As an example of lessons learned, face-to-face teaching could be combined on an ad hoc basis with synchronous online activities that could be recorded for

later consultation by students. Another action to be taken would be to improve the organisation and classification of digital teaching material, which has increased considerably. Finally, the lack or scarce interpersonal interaction between students during the last two academic years could have repercussions in a decrease in the resolution of doubts between classmates, so it is suggested that special emphasis be placed on the recovery of these links in the post-covid era.

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