Peer review as a Tool for Telecommunication Studies Teaching During COVID

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Abstract

The consequences of COVID-19 have had an impact on all sectors, in particular on education. During the last academic year, different teaching methodologies have been applied, many of them of technological nature, in order to mitigate the adverse effects caused by COVID-related confinements. In this paper, we present the implementation of an experience based on peer reviewing in a Telecommunication degree at the University of Málaga. This experience is part of an educational innovation project, and as a useful tool, one of the reasons is that it can be applied in different teaching scenarios. In this work, peer review has been implemented in two semesters of the same subject, belonging to the same degree in two consecutive years, one preCOVID and the other during COVID. Hence, a detailed assessment is provided in order to decipher possible unknowns about the impact that the pandemic may have had on the learning of our students.

Keywords: peer reviewing, telecommunications, COVID-19, teaching, educational innovation

1.   Introduction

The global pandemic caused by COVID has had numerous side effects on our daily lives and there are many areas where the impact has been most far-reaching. In the education sector, in particular in university education, even though some institutions were more prepared for virtual teaching, most have needed some kind of adaptability. This article presents the results of applying a peer assessment methodology to Telecommunications Engineering students. This work is part of an educational innovation project funded by the University of Malaga.

Furthermore, during the development of this project, we have had to deal with this pandemic situation. This issue has allowed the fact of gathering results for the application of peer evaluation in a course prior to COVID and in a course during COVID, allowing us to establish

a comparison of the possible impact of the methodology due to these circumstances. We observe that the results from a global perspective do not show significant differences, in addition to other evidence that we will reveal throughout the article.

During this paper a review of the literature will be done. Peer reviewing methodology consists in the evaluation of students by their classmates, both formative reviews to provide feedback and summative grading of the assessment. This assessment is not recent, in fact it dates back to the work of Mowl in 1996 [1,2], whose aim was to achieve a substantial improvement in the quality of learning and to empower learners, where traditional forms may overlook the needs of learners. This coincides with the initial objectives we set ourselves when we applied for the Project.

This methodology may have different variants in its application, as it can include the participation of learners not only in the final assessment of their work, but also in the pre-setting of criteria as well as in other tasks such as the choice of exam questions [4]. Donaldson and Topping [5] proposed this methodology as part of peer tutoring.

Another aim of this project is to reinforce students' self-assessment skills, in the belief that peer assessment enhances these skills by examining their classmates' assessments, by means of these students gain information about their own performance.

Indeed, many potential advantages of this methodology have been described throughout its short life span. Among some of the most reputable experts on this subject, Brown et al. [4], Zariski [6] and Race [7] rightly claim to give some sense of ownership of the assessment process, improving student motivation. On the other hand, they also describe that this methodology encourages students to take greater responsibility for their own learning, triggered by the intrinsic self-learning nature of the methodology. Another particularly relevant aspect is that the concept of error, previously considered a failure before the application of peer assessment but which with this methodology acquires a more positive character designating it as an opportunity. We also consider of great importance the development of skills to provoke lifelong learning, especially to carry out the evaluation, encouraging deep learning rather than something superficial. And finally, we mention metacognition, for instance, using external assessment as a model for internal assessment of the learner's own learning. In [8] the authors present a work on the application of peer review in medical students in the time of COVID-19.

 This bibliography led us to wonder how peer review would perform in an online teaching environment, as the one imposed because of the circumstances. Precisely in [11] it is stated that within the educational community there is still no exhaustive knowledge of how peer review behaves within these educational environments. We identified that, although some work exists, there are still no studies to analyze the research that has been addressed in this context, analyzing the benefits and disadvantages of the use of peer assessment. We hope that our results will be useful for other teachers who are considering the application of peer reviewing.

Bao [9] proposes six strategies to mitigate the adverse effects of the COVID-19 pandemic on students at Peking University. Among these strategies "strengthening students' active learning ability outside of class" and finally "combining online learning and offline self-learning effectively" can be found. Therefore, as an initial basis we consider that the application of a peer review methodology can be beneficial to develop these two strategies.

As expected, the application of this methodology in real cases opens many doors for further research. We are considering students' perception of the application of this methodology and,

for this purpose, we have prepared some forms that we will apply in future editions of the course. However, we consider of particular relevance the research in [10], which evaluates students' perception about the application of peer assessment in the Flanders framework, specifically focusing on the social aspects that may be concerned by this methodology. This research becomes, doubtlessly, very useful for the elaboration of our future work surveys.

2.   Methodology

In this section it is described how the peer review methodology has been applied to students in their last year at a Telecommunications degree of the University of Malaga. The aim of this section is to show all the fundamental aspects of our experiment in a way that is fully reproducible by the reader.

First of all, a detailed description of the methodology and the different aspects of the application is provided afterwards, the objectives of the experiment are defined and finally a discussion of the results according to the numbers obtained will be conducted.

2.1   Application

As mentioned in the introduction and shown in Figure 1, the same experiment has been replicated in two different years into the same subject, course and degree, corresponding to the academic years 2019-2020 and 2020-2021. Given that we consider a subject corresponding to the first semester, which in the official calendar begins in October and ends in February, and thus the stop of activities and lockdown triggered by the global pandemic took place in midMarch 2020 in our national territory, we can infer that the 2019-2020 course was taught entirely in pre-COVID circumstances and the 2020-2021 course was taught entirely in a COVID context.

Figure 1: Chronogram of the peer reviewing application.
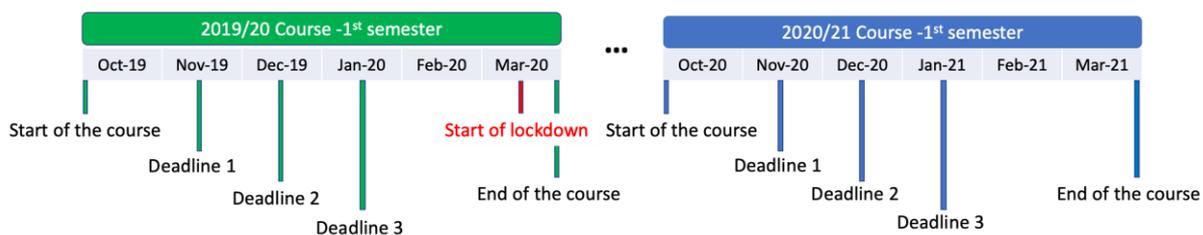
Once these aspects are clarified, the type of peer review implemented is described. It is interesting to mention the fact that, although the activities within the peer review framework were voluntary, all students have chosen to get involved in them. Thus, we have 100% participation in both consecutive years.

As we had planned the implementation of the activities after being informed of their success in other areas, it was decided to implement these activities in some specific assignments in order to avoid overloading students' work as well as the instructor in charge.

A total of 3 activities have been conducted during the course, whose development is sequential as shown by their deadlines (1,2,3) shown in Figure 1. These activities correspond to three parts of the course syllabus which have to meet the following requirements. On the one hand, students must deal with concepts identified by the instructor as fundamental, for instance, every student who means to pass the course must acquire the essential skills related to that part

of the syllabus. On the other hand, the activities should consist of mainly practical exercises that reinforce these essential concepts. Finally, activities must be carried out entirely during class sessions under continuous instructor's supervision.

2.2   Rubrics

It is essential that the instructor distributes a specific rubric for the activity before the activity is carried out, in order to have students precisely informed about the task they are going to address. This describes as precisely as possible how the peers will be evaluated, both during the peer review evaluation phase by their peers and by the instructor himself/herself. Once the activities have been completed, the next step is the evaluation process.

Each student is assigned 3 peer evaluations. The results of these evaluations should be reviewed by the instructor at the end of this phase. So that, when student scores appear that are far away from the score given by the instructor, these values will be discarded. To avoid possible external influences, such as friendship, enmity, etc. It is important to mention that all the data collected have undergone a process of anonymization in compliance with current privacy regulations. For the processing of the results, specific advanced software has been used, such as MATLAB® together with several statistical tools. Given the potential of this tool, graphs have been obtained that show significantly how the premises defined in our thesis are fulfilled in a tangible way within the imposed limitations. We must be critical in all aspects, first of all the students, although they have a similar profile, are dissimilar sets of individuals in both courses.

2.3   Objectives & Motivation

As commented before, this study has been developed in the framework of a Teaching Innovation Project -PIE- (PIE19-209) (https://www.uma.es/formacion/noticias/proyectos-deinnovacion-educativa- 2019-2021/, accessed on 23 February 2021) funded by the University of Málaga. It has been carried out by a group of teaching assistants from different STEM departments of the University of Malaga who have come together with a common goal, once there were recognized different weaknesses in specific learning points considered as essential in the teaching activity.

A period of research and documentation of different methodologies was accomplished, after which we managed to identify the peer review approach. After a training period about the scope of this methodology as well as successful cases, it came up as a valuable tool that could be developed in the context of the call for teaching innovation projects that opens every two years by the University. Once the PIE obtained the positive evaluation by the evaluation committee, in September 2019, the implementation of the project commenced. Although the official start of the project is September 2019, previous work had been conducted since o the beginning of January 2018.

The initial motivation for this project came from a recurrent difficulty for a considerable proportion of students in acquiring the necessary competences in certain subjects. With the consequences of the lack of skills in solving problems that imply minimum requirements for passing problems that imply minimum requirements for passing the subject. In this context peer review could act as a reinforcement activity that can improve the way to achieve the objectives.

Among different aspects to be considered in the implementation of the methodology it has been detected one that overcomes the rest. It is pointed out that in the case of certain problems

proposed as part of the peer review activities, in some cases more than one possible solution may appear. In other words, the solution provided by the instructor does not necessarily have to be one and only. This aspect has led us to realize the enriching nature of the methodology by offering new perspectives that might not have been considered. This is why we firmly believe that this methodology can be of great help to students, both in arriving at different solutions and in the process of understanding the existence of multiple valid perspectives to address the challenges presented.

Often, it has also been observed that it is easier for students to understand what their peers want to communicate than what the teacher is telling them. This is another reason why peer review can be a source to reinforce knowledge and contribute to the students' learning process.

2.4   Approach

This section details the context in which the experiment described in this article took place. In total there were 19 students in the academic year 2020-2021 and 20 students in 2019-2020. The course is called "Network Administration and Security" and even though it is a fourth-year optional course, it is considered as a difficult subject for the students, as it focuses on issues related to cybersecurity, it is new ground for most students.

As is to be expected, the methodology has been adapted to the subject, which is framed within teaching plans pre-established by the Spanish government. We believe that it is of the utmost importance for the successful application of peer review that the natural flow of the subject is not interrupted by the activity itself. It is the instructor's responsibility to supervise this in order to guarantee success.

Since peer review has been applied in the same subject, in the same course of students in two consecutive years (without changes in the subject syllabus), one pre-COVID and one COVID scenario. This allows to study whether there is a possible impact on the application of peer review in a traditional face-to-face teaching context compared to a fully online teaching context, where the proposed hypothesis is that this impact is not appreciable, and that the application of peer review is a very useful instrument both for enhancing the teaching-learning process in students and for their own evaluation in online situations.

The approach used has been structured in three distinct steps; data collection, processing of the data collected and finally the processing of the final results. For the collection of student's data, this can be categorized in three different categories. Firstly, the numerical data of the student's score, both the final grade data and the data of each of the exercises related to the peer review activities, have been used. In order to contextualize this work, it should be mentioned that the Spanish education system imposes a 10-point scale, with 10 being the maximum score, which is the one followed. However, this is applicable to any numerical scale.

Secondly, the scores have been extracted and awarded to the peer reviewers. Students participating in the project have to provide scores to their peers. As already mentioned, in order to homogenize the criteria and so that the student knows which aspects will be considered, a rubric is used. This is provided by the instructors before starting each of the activities and is elaborated according to the evaluation criteria of the task. This allows students to know at all times the rubrics and their associated items and therefore how they will be assessed, both the scores of their peers and those of the instructor in charge.

In this case there was no selection bias as all students voluntarily participated in the peer review activities. In order to assess the effectiveness of the peer review tasks during the course, a

comparative study is carried out on the final exam grades. In the final exam, there are questions in two different categories, some related to peer review activities and others that are not. As noted above, peer review is more effective if it is applied to specific parts of a subject rather than the whole subject. This provides us with data sources that can reveal interesting information about how students have evolved during the teaching-learning process.

Activities considered to be critical within the syllabus and which recurrently cause difficulties for students were selected for the peer review. For this reason, cryptography and firewalls were selected. In the first of these, two laboratory practices are carried out, both of which are two peer review activities. In the case of firewalls, another practical is carried out as the third activity of the project. As emphasized, these tasks were focused on reinforcing the learning process in relation to the critical contents of the syllabus. The implementation of the methodology revealed that, as a side effect, it also allowed students to identify the most common errors in the most critical aspects of the academic subject. This provided students with an extraordinary tool for validating the knowledge they had acquired.

It has to be noticed that there are additional factors to be considered, as solely marks do not guarantee the success of the learning process. In particular, certain causes such as a lack of maturity for the necessary assessment, not taking assessment seriously or having a negative attitude towards it, are factors that can hinder the success of this methodology. It is for this reason that the activities must be intentionally prepared by the instructor, so that they cannot be solved without extensive knowledge of the solving process. In order to arrive at activities that fit this profile, we have to ensure that judging peer solutions is not about comparing numerical results, but about tracking and reviewing the reasoning process to arrive at the complete solution.

3.   Results

Results obtained from the experience are displayed in figures 2, 3 and 4 according to the description given in experiences. There are two groups of data provided in the figures. The first group of data (co-evaluation) is for questions related to the peer review experience; the second group of data (control) is for questions that are not related to peer review experience.

A comparison of the different subgroups of questions, those based on co-evaluation activities and those of the rest of the content from the syllabus and their standard deviation is of interest to check if the student's grades are improving with peer review. Left-hand side (a) diagrams describe the distribution based on the number of students in each range, whereas right-hand (b) side figures do the same but based on the percentage of students. Categories are defined in a scale so that grades range from 0 to 10 as we previously mentioned.
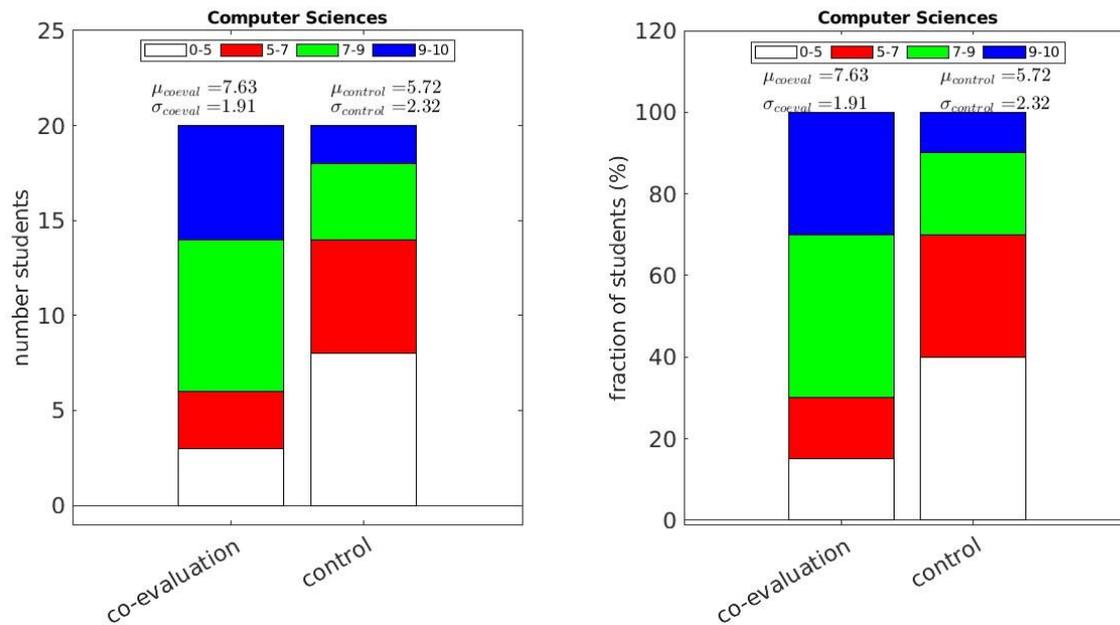
3.1   Pre-COVID peer reviewing experience

As shown in Figure 2, analyzing the results of the 2019-2020 year (pre-COVID) applying the peer review, we observe that the results improve considerably in those contents worked on without peer review activities. The percentage of students who exceed 7 out of 10 in their score improves considerably, and the percentage of students who achieve excellence by exceeding 9 out of 10 is also relevant. On the other hand, it is considered as significant the reduction of students who do not reach the minimum grade of 5 to pass the subject.

Figure 2: 2019/20 course results.

a) *Number of students*   b) *Student Percentages*

Computer Sciences
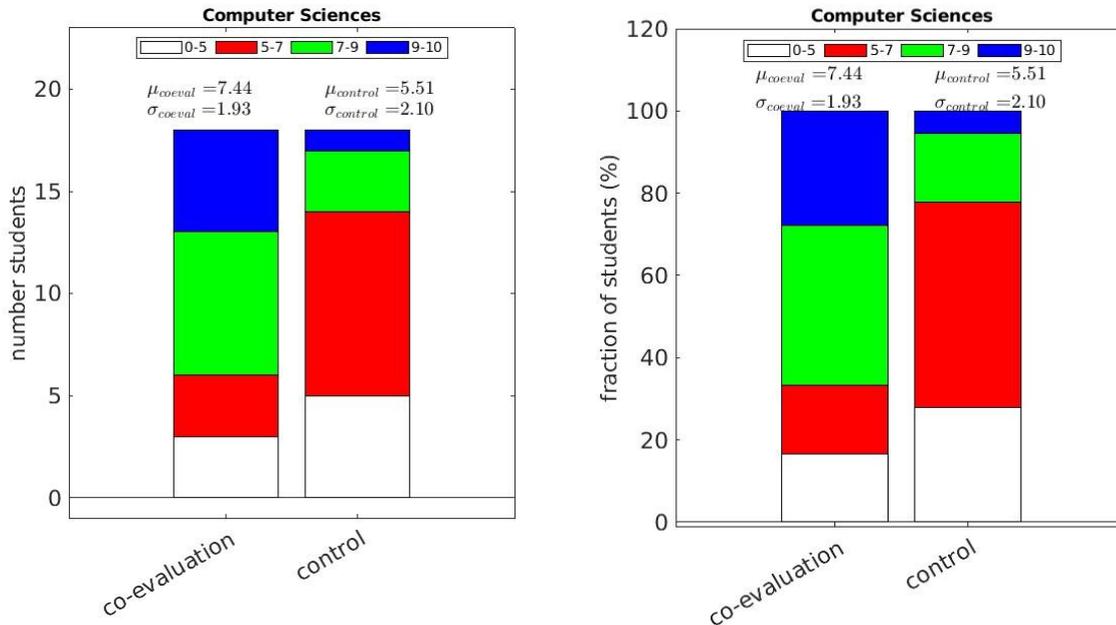

3.2   Post-COVID peer reviewing experience

As shown in Figure 3, we take a look at the results of the 2020-2021 course, which took place in the middle of the pandemic, in which peer review is applied as detailed in previous sections.

Figure 3: 2020/2021 course results.

a) Number of students   *b) Student percentages*

We can see that, as in the previous course, the results improve considerably in those contents worked on without peer review activities. The percentage of students who exceed 7 out of 10 in their score improves considerably, and the percentage of students who achieve excellence exceeding 9 out of 10 is also relevant. On the other hand, a significant reduction in the percentage of students who do not reach the minimum grade (5/10) required to pass the subject to pass is observed, going from a 7 in the control group to 2 in the co-evaluation one.

Making a comparison between the 2019-2020 courses with respect to the results of the students' final scores, we can see how these results are surprisingly similar, despite the fact thar having undergone such a drastic change forced by COVID pandemic, in which the teaching model has changed so much, going from a totally face-to-face to an online scenario with a multitude of adaptations in schedules, syllabus, sessions prepare methodology, etc. Special emphasis is made on how the columns of results in co-evaluation are similar in both years, however it can be seen that in the case of the control column there are some differences, especially in the percentage of students who exceed the score of 9.

By analyzing the situation, it could be thought that the contents selected for the co-evaluation are simpler or even that the questions in the final test referring to this part are more basic. but the instructors' task has been to ensure that this does not happen. This is addressed by keeping the same type of questions for three consecutive years.

3.3   No peer reviewing experience

Figure 4 shows results obtained by students in 2018-2019 course, in which co-evaluation was not applied. As a matter of fact, we have catalogued as co-evaluation those questions of the final test that correspond to the part of the syllabus in which peer review was applied in subsequent courses.

Figure 4: 2018/2019 course results (not peer review)

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*a) Number of students* *b) Student percentages*
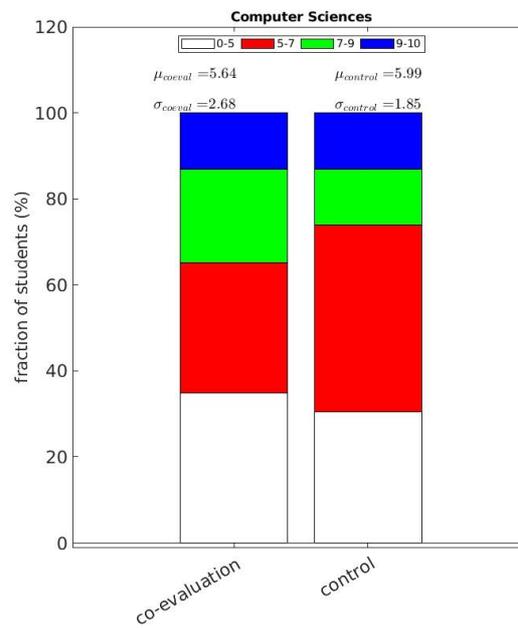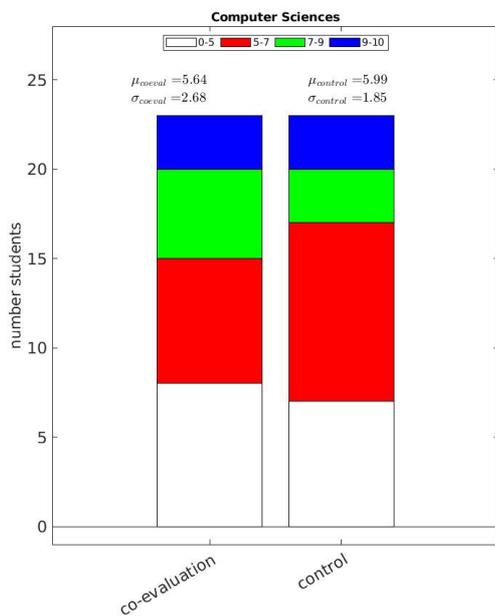
Taking a look at the results, we want to emphasize the fact that although the percentage of questions with a score between 7-9 is slightly higher in those questions related to issues in which peer review will be applied in future courses, the number of students who exceed 5 (minimum score to pass) is also higher in the control column. Therefore, we consider that the level of difficulty for students to answer questions from both sets is similar.

3.4 Statistical results

A statistical analysis has been addressed, see Figure 4. Average and Standard deviation have been plotted for all three experiences. Every experience has two items; "CoEv Questions" stands for the average marks reached in questions related to peer review experience and "Ctrl Questions" stands for the average marks reached in questions related to the rest of the course.

Figure 4: Average and standard deviation

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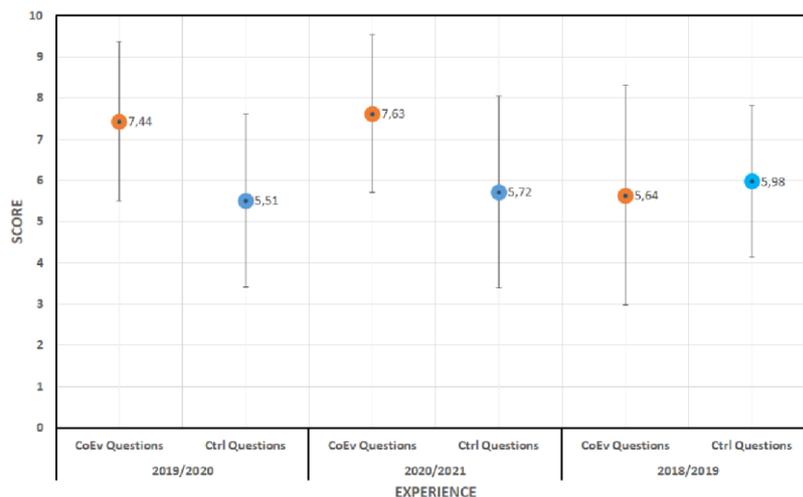
As can be seen from the results, CoEv Questions average show much better results than Control Questions, this leads us to reinforce the idea that peer review experience has a good performance in the students learning process.

4.   Conclusion

The peer review methodology used in education is considered a learning technique in which students proactively evaluate the work of other students, which may be of great interest in these times of COVID that are transforming the prevailing educational models. In this article an empirical evaluation of peer review has been carried out in a subject of the telecommunications engineering degree at the University of Málaga.

This has been performed, in two consecutive years, one pre-COVID and the other post-COVID and establishing both a control and a test group for the adopted peer review methodology. Since the hypothesis defined at the beginning of this experiment was the validity of peer review as an assessment tool on the one hand and as a learning reinforcement tool on the other. Let's see how the effectiveness of the peer review methodology, it has been possible to validate how the experience has improved the results of the students who have participated.

For this purpose, the students' final grades have been taken as a reference. This is reflected in the overall course scores of the participants, with an increase of more than two points (0-10 scale) in the best of cases and of at least one point, but always achieving positive results with respect to the control group.

It has been also observed that the scores provided by the students are very similar to the score assigned by the teacher, except in marginal cases that have been discarded. Therefore, students are able to assess consistently enough according to our results always with the help of the rubric provided by the instructor, which confirms the feasibility of peer assessment as a reliable assessment methodology.

On the other hand, an objective has been to analyze how peer assessment has affected students who have received a completely face-to-face teaching (course 19-20 pre-COVID) and those who have received a completely online teaching (course 20-21 post-COVID). Analyzing the results, it is concluded that the use of peer review has not had a significant influence on the students' final grades. Taking into account the drastic change from face-to-face teaching to online teaching, it can be assumed that the application of peer review has served as a palliative buffer against the possible damage caused by this drastic forced change.

The application of this methodology has shown that students not only assimilate the contents for their first test, but also develop a well-founded criterion for identifying the mistakes made by other students, fostering their critical sense, and identifying the most complex concepts. In fact, this encourages students to develop the ability to identify common errors, enabling them to supplement their knowledge of the course more effectively. It also has a positive effect on the motivational aspect, in our experience we have completed a satisfaction form at the end of the course and the feedback has been positive. the motivational aspect can be considered to be key, especially given the conditions of online learning. From our point of view, this fact is crucial to encourage students to participate in these initiatives, as they clearly improve their academic performance. Therefore, peer assessment can be a main approach to be adopted in the current pandemic scenario where the use of new technologies has become essential in the educational model. Peer review seems in this way to be an advisable complement to the traditional assessment process, which is often considered one of the weaknesses of online

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teaching. As a side effect, peer review provides the instructor with an invaluable source of information to support a more accurate assessment.

This experiment has opened up new study horizons for the author as we have considered aspects such as anonymity in evaluations and how this can be affected, so that the bias of friendship can be mitigated by deploying certain procedures, which guarantee the anonymous nature of the evaluation process.

We propose, as a future study, to apply a procedure to guarantee the random and anonymous assignment of the exercises to be scored after a double-blind review process with the objective of reducing the likelihood that the answers contain any information about the author of the question.

Another open field to continuous improvement is that of rubrics, in order to increase the quality and objectivity of the review process. This will be achieved by redefining their format and instructions, eliminating points that may be considered weak and including new items that may be of interest for the assessment.

4.1.1   Acknowledgment

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