RESULTS OF A UNIVERSITY EXPERIENCE, COMPARING FACE-TO-FACE, ONLINE AND HYBRID TEACHING IN A CONTEXT OF SARSCOV19

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Abstract

The irruption of sarscov19 in the spring of 2020 was a challenge for everyone, particularly university teaching, where solutions had to be improvised urgently. Technological resources and online teaching played a fundamental role, and the involvement of students, teachers and administration led to an acceptable outcome. After the first impact of the pandemic, new alternatives compatible with the protocols of social distancing and health security were proposed in the planning for the academic year 2020-2021. As in many other universities, a synchronous hybrid learning (SHL) model was offered at the Universitat Politècnica de València (UPV), combining online learning and face-to-face (F2F) activities. In the SHL model, some students attended classes in-person (the room capacity limited the number according to the minimum distances between people required) and stream for the rest of the students, who followed the class simultaneously. In addition, the classes were recorded to enable their asynchronous use. SHL was only used when the conditions were favourable. Vulnerable teachers were teaching entirely online in their groups. When the number of students in a group was small enough, teaching was fully F2F, maintaining the online option only for vulnerable or confined students. The laboratory practices followed a similar hybrid scheme. The tutorials were attended by email or videoconference, and the exams were preferably in-person, with ad hoc solutions in the cases of confined or vulnerable students. Between February and June 2021, a pilot experience was carried out in the Electricity course of the degree in Electronic Engineering and Industrial Automation at the UPV. Three groups were taught with a different methodology: online, SHL and F2F teaching. Planning, academic resources, and evaluation were the same in the three groups. All three followed active flipped classroom methods. In this paper, the student's academic outcomes and the results of opinion surveys conducted on the activities are presented. Results are analysed in terms of the three groups/methodologies showing reasonable doubts about the SHL model where, the academic results and the student's opinions are significantly lower than the other two methodologies. These results could help to decide the best methodological solution if we had a similar situation in the future.

Keywords: synchronous hybrid learning, sarscov19, flipped classroom, students' academic outcomes, opinion survey.

1 INTRODUCTION

Many studies have shown that active learning, including flipped classroom (FC), provides a series of benefits to the teaching-learning process [1], [2]. One of the most important is that it promotes autonomous, self-conscience learning and favours life-long learning.

The improvement in information and communications technology has led some educational institutions to combine online instruction with F2F classes. It has the advantage of providing students with more flexible modes of participation that go beyond the on-campus/online dichotomy [3], [4]. The COVID-19 pandemic cancelled all face-to-face (F2F) classes during the 2020 spring. Teachers and students had to get quickly adapt to the new situation, and the FC model favoured the transition from face-to-face teaching to the virtual model. The strategy in the pre-class activities was maintained, whereas the in-class activities moved from face-to-face teaching to synchronous online, with few modifications. In a previous study, we found a positive perception of the students regarding their adaptation to the new situation [5]. Later on, during the 2020/2021 course, the social distancing measures forced to replace the F2F with virtual (V) or synchronous hybrid learning (SHL) depending on specific conditions.

Traditional F2F teaching involves the interaction between students and teachers. Online learning facilitates teaching and learning using online methods without the F2F contact. SHL represents a mixture of both as part of the students are in class and, simultaneously, remote students participate in F2F class

through web conferencing. SHL was a difficult challenge, as teachers had to teach the F2F and the remote courses simultaneously. The main difficulties come from managing the online technology and promoting interaction between the two cohorts.

Raes et al.[6], after a systematic review, showed a cautious optimism about SHL that faces several pedagogical and technological challenges. It offers benefits to learners in terms of flexibility, but there are technical and pedagogical challenges in implementing this approach. During the instruction in these new learning settings, the teacher needs to pay attention to both locations in addition to performing specific operational actions on the teaching and learning platform. It was found that the teacher or instructor presented a heavier mental load, which is referred to as hyper-zoom or hyper-focus. In general, it has been found that when implementing synchronous hybrid learning increases the difficulties of activating and engaging the remote students to the same degree as the students attending face-to-face. Li et al. [7] also appreciate the problems in the online scenario reducing active interaction when compared with F2F. Although they stated that a good use of information technologies could lead to meaningful teaching and learning experiences, 76% of the teachers and 56% of the students reported that the home environment hindered their learning.

Some other authors [3] highlighted the advantages and challenges to face in SHL. Most of the students participating in the study stated that they learnt at least as much, if not more, in the SHL class as compared to their regular F2F courses. Romero-Hall and Vicentini's study [4] revealed that hybrid synchronous instruction improved the study habits of distance learners. On the other hand, they found that the main challenges SHL faces are the interactions, relationships, and communication exchanges between distance learners, their F2F counterparts, and the instructor. They also pointed out the effect of technical issues on the participation of the remote students. Raes et al. [8] presented the results of an experimental within-subjects design study comparing the students' learning experiences as F2F versus VL students in the pure or hybrid setting, SHL.

Butz and Stupnisky [9] applied self-determination theory to investigate the relationships among students' needs, satisfaction, motivation, and achievement in SHL environments. Their results showed that online students reported significantly lower levels of relatedness than their on-campus counterparts. The findings suggested four themes that affect synchronous hybrid learning: peer relatedness, technology influence, instructor impact, and program structure. Arispe and Blake [10] studied the personality and cognitive factors that determine the course outcomes in a hybrid non-synchronous course. They found that these blended courses are a good option for strongly self-motivated and autonomous students. The quantitative data revealed that conscientiousness had a positive correlation with final grades.

This paper compares three groups of the same subject, Electricity of the Electronic Engineering and Industrial Automation degree at the public university *Universitat Politècnica de València* (UPV). In 2020-2021, one group was taught F2F, the other was online, and the third followed the SHL model.

1.1 Research questions

RQ1: How do the learning settings affect academic results?

RQ2: How do the learning settings affect the students' perception?

RQ3: What is the effect of quizzes on students' motivations?

2 METHODOLOGY

The electricity course is taught in the second term of the first year of the Electronic Engineering and Industrial Automation degree. The total number of enrolled students during the academic year 2020/21 was 155, and 143 of them followed the course regularly. Students were divided (according with their preference) into three groups where different methodologies were followed. Group 1 followed a F2F traditional method with 22 students; Group 2 followed an online method with 69 students, and Group 3 followed a SHL methodology with 64 students. Students with higher pre-univesity grades choose the group first. Students in the three groups had the same age on average, and the gender was randomly distributed. The methodology was not known when the students choose the group and it was not the same in all the course subjects.

The three different methodologies had some common features that were followed in all groups. All groups had access to the PowerPoint presentations and a collection of videos about theory and problems methodology. All groups worked solving and presenting problems in class, played with gamification tools like Kahoot and attended in person to the laboratory classes.

On the other hand, several differences can be found in the methodology depending on the group. F2F group followed the traditional methodology where all classes were in person while groups 2 (V) and 3 (SH) broadcasted the classes by means of Microsoft Teams (R). In SH group, part of the students followed the class in person and part of the students followed the class at home while all students from V group were at home. In all groups tutorships using email and Teams were used frequently, while in F2F and SH groups, tutorships were also in person. Some additional tools were exclusively used in V group, such as, group online tutorships and synchronous webcam to show hand-made explanations.

The rest of the features of the course like evaluation remained the same for the three groups were online and in person tests where used. The individual work of every student in the final grade was a 65% while the teamwork had a weight of 35%. The individual work consisted of 3 written exams (50%) and 6 online tests (15%). The teamwork consisted of 6 laboratory reports (25%) and 6 solved problems explained in class (10%). So, the final grade was obtained using a variety of evaluation methods to balance their influence in the final grade.

The written exams were taken in person and all groups solved the same exam. The evaluation was made by the lecturer who taught the group. The online exams were made at home at similar dates in every group, but not at the same time. Every student had a different exam with its own questions. The laboratory reports were elaborated by 6 students working with two different experimental setups to obtain general conclusions. The problems were solved by the same team that elaborated a document with the resolution that one of the students presented in class.

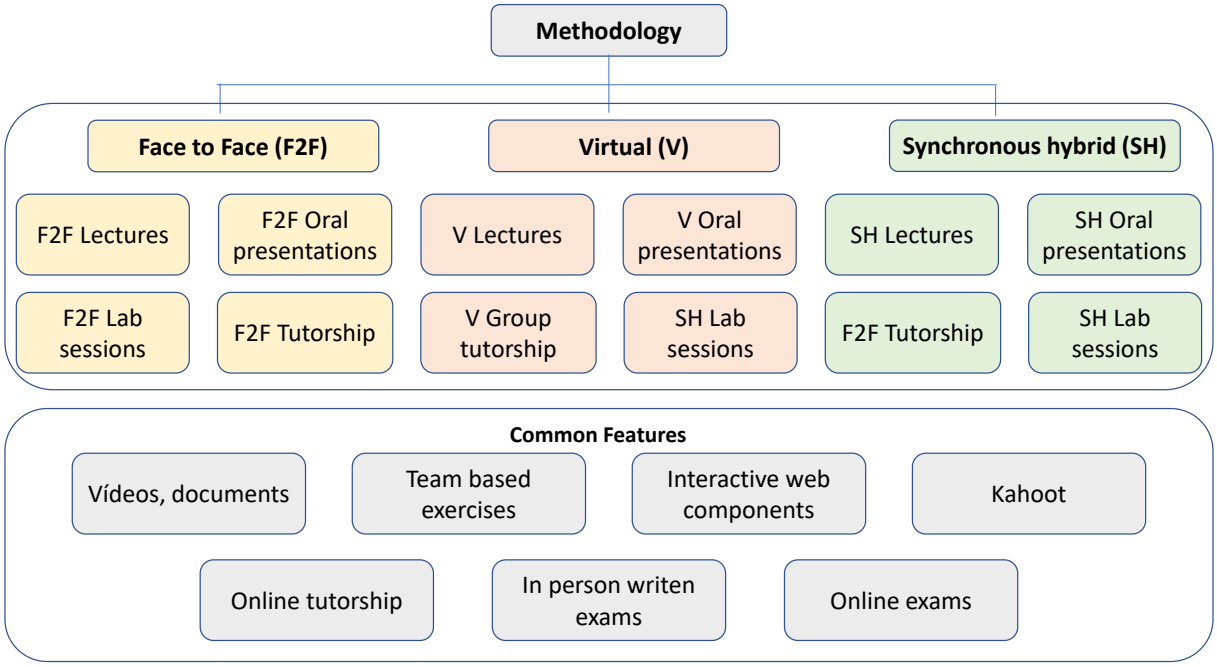

Figure 1. Differences and common features in the methodology of the three groups.

3 RESULTS

3.1 Students' academic results analysis by group.

The first result that we obtained shows how only an 86% of the enrolled students in the three groups (F2F, V and SH) are taking all the examinations during the year 2020-2021. This percentage is smaller than the one registered in the same course in the previous 5 years, which has been between 94 and 98%. Regarding the differences between groups, the higher number of examined students (92.9%) appears in the online group (V), showing a similar value than in the pre-COVID years, while in the SH group the percentage was 80.3%. On the opposite, the highest percentage of dropouts in students appears in the F2F group, were only 70.4% of the students took the examination, being this value well below the average of the previous years.

Regarding the analysis of the academic outcomes, differences between groups clearly arise. The average grade of the course and its standard deviation for the three groups is shown in Table 1.

Table 1. Average grades (AG) of the course and its standard deviation (SD).

Group	AG	SD
F2F	7.0	1.1
V	6.5	1.4
SH	5.5	1.5

It can be noticed how the grade in F2F is higher than in V, and SH, with SHL model presenting the lowest grade of all three groups. In order to analyse this tendency, an ANOVA test was performed for the average final grade (AG) for each group. Its applicability was verified by the Levene test, which showed the homogeneity of the variances of the average final grade. As a result, significant differences between the grades of the different groups were shown ($F(2,130) = 11.76$; $p<0.001$).

To get to the bottom of these differences between groups, an orthogonal contrast was made, finding differences between F2F and V with SH ((AG(F2F), AG(V))>AG(SH), $t(2,130) = 5.05$;$p<0.001$).

To understand the reasons for these differences in grades, an analysis of the grades obtained in each of the evaluable activities in the course has been carried out: written exams, online exams, laboratory practices and problems solving (in teams).

Academic results of the different evaluable activities carried out in three groups are shown in Figure 2. Except for the online exams, the same beforementioned tendency is shown, being the grades in the F2F higher than in V and SH.

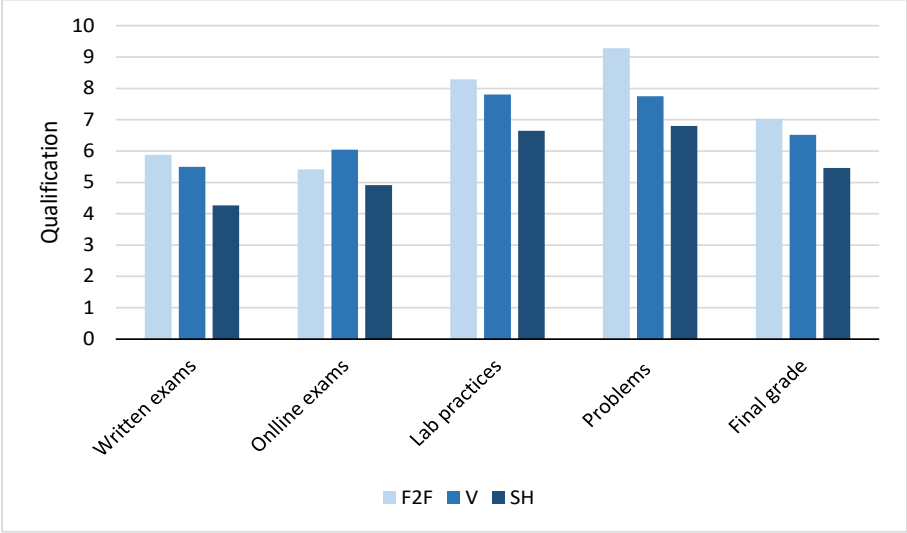

Figure 2. Academic results by group.

Despite the general dispersion in the qualifications, it seems that the greater differences appear in the activities where they work in teams: problems and laboratory practices, showing worst grades in the SH model than in the other two. The relation between the grades in these activities and the final grades has been analysed and no linear correlation was shown. The regression analysis of the data shows that there is no linear correlation between any of the evaluable activities performed in teams and the final grade. Linear correlation coefficients of those regression analysis are shown in Table 2.

Table 2. Linear correlation coefficients ρ^2.

	Individual evaluation	Team evaluation
F2F	0.95	0.3
V	0.91	0.2
SH	0.87	0.5

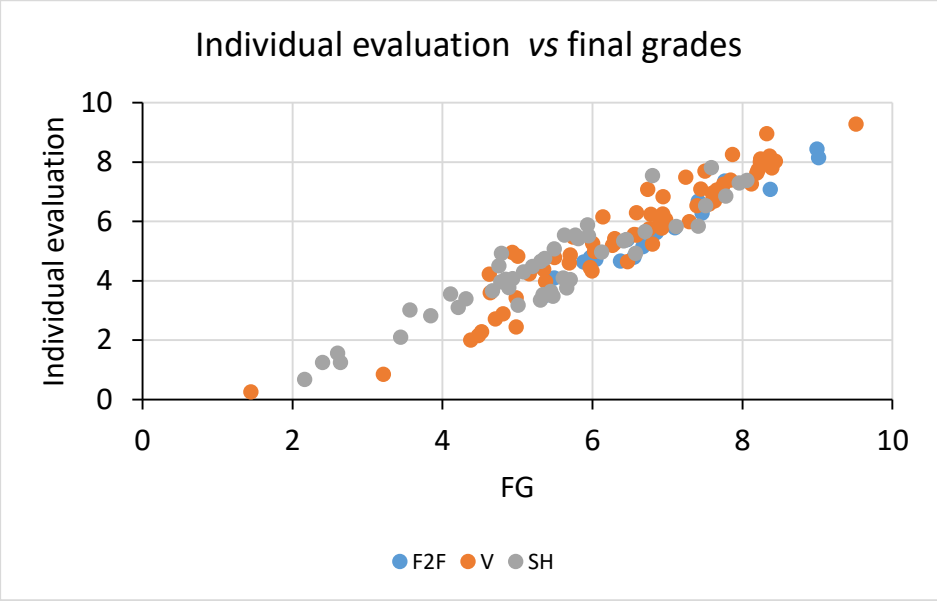

Figure 3. Individual evaluation versus final grades.

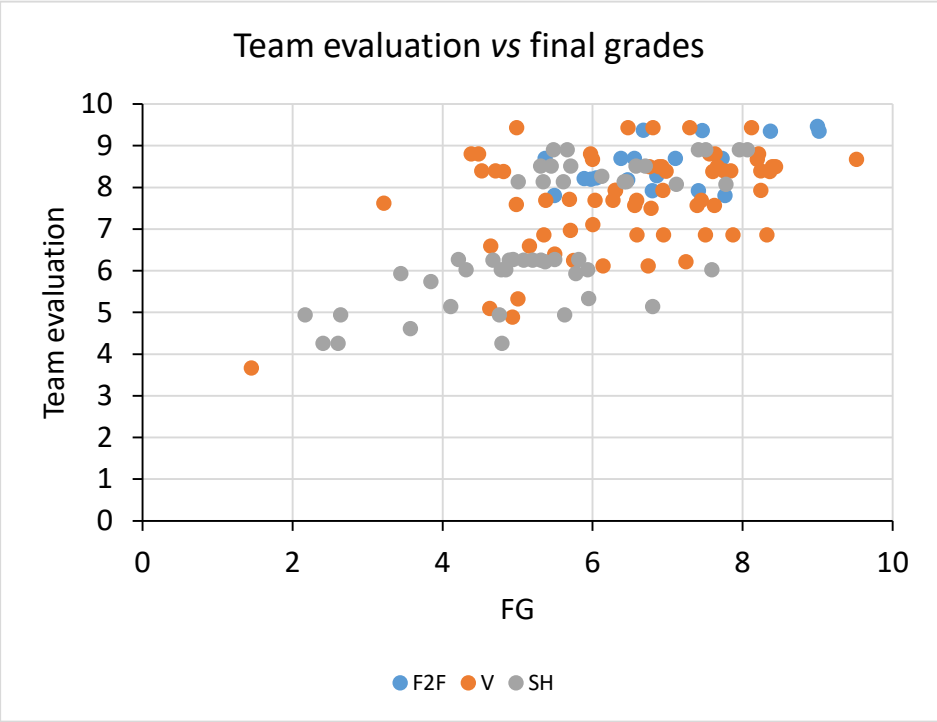

Figure 4. Team evaluation versus final grades

3.2 Opinion survey

3.2.1 About the course

After the students were asked about the subject, their answers were similar in the F2F and virtual groups, above those obtained in the synchronous group. There is an exception in the assessment about the utility of the subject knowledge in later courses, in which the three groups coincide.

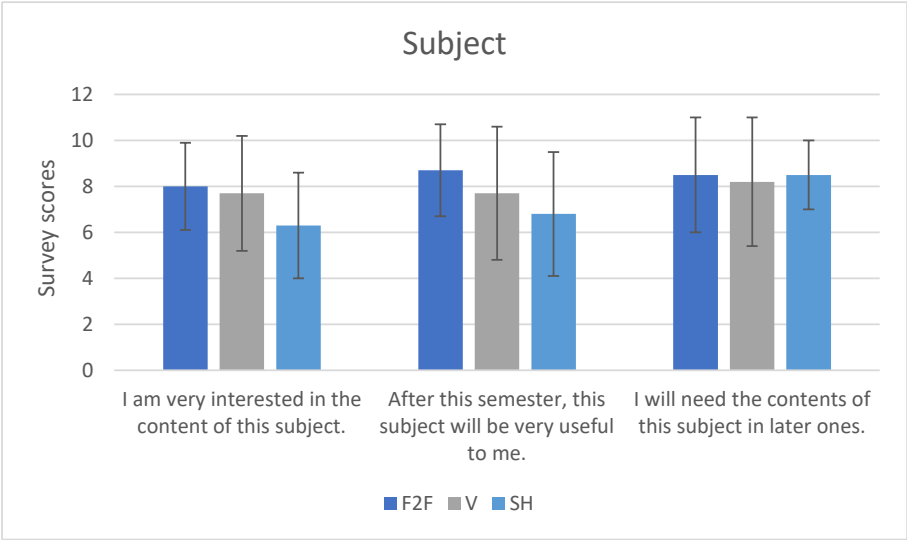

Figure 5. Importance of the course seen by the different groups

When asking them about the reverse teaching methodology, the differences were significant ($F(2,104) = 24,27$; $p<0.001$). F2F group made the best rating followed by V ((F2F),(V))>(SH), $t = 6,84$;$p<0.001$). The very low assessment made by the synchronous group stands out, as they flatly rejected the methodology and the possibility of its use in other subjects.

3.2.2 Methodology used in class

When asking about methodological aspects, in which the three groups coincide, the results are very similar in the F2F and V groups, significantly above those obtained in SH ($p<0.01$) for the three aspects shown in Figure 6. In all cases is ((F2F),(V))>(SH);$p<0.001$), being the t value of the same order for the three questions.

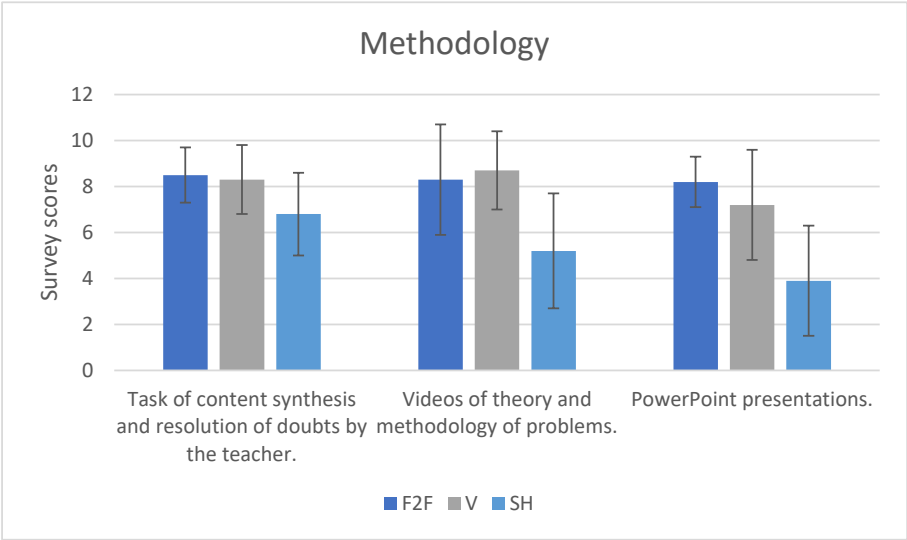

Figure 6. Opinion on some aspects of the used methodology.

A key point in the methodology used is teamwork. In this case, the valuations of F2F and V remain similar, although with lower ratio (around 7), very close to the values presented by SH. The average evaluation in all cases is higher than 6.5 points, both for teamwork and for peer evaluation and presentation. It should be noted that the presentations of V were all online, and those of SH were face-to-face and broadcast in streaming. There are significant differences in the results of the three questions represented in Figure 7 ($p<0.05$), being always ((F2F),(V))>(SH);$p<0.05$).

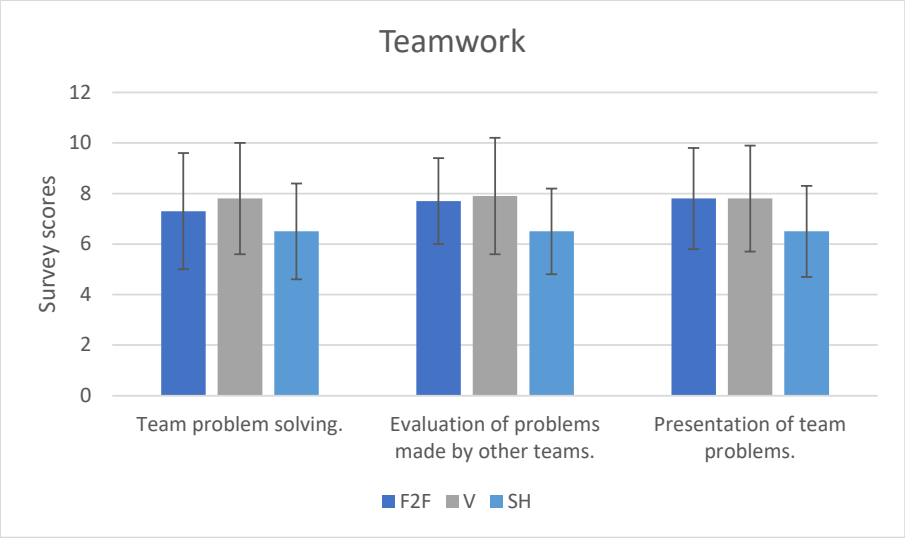

Figure 7. Opinion about the teamwork.

The hybrid model of the laboratory practices, common to the three groups, does not seem to work in the case of monitoring and carrying out the online practices. They both present a lower evaluation in the three groups compared to face-to-face practices.

On the contrary, the use of gamification activities has been very well received in all three groups. This type of activity works the same regardless of whether the teaching is face-to-face or not showing a high acceptance rate.

All classes, in addition to being broadcast in streaming, were recorded so that students could follow them at any time (asynchronous teaching). Recordings are significantly better valued than streaming classes ($p<0.01$). In both cases, groups F2F and V make a similar assessment, while SH shows a much worse ratio ((F2F),(V))>(SH);$p<0.001$). In particular, the streaming of classes in the classroom has a very poor rating (average of 2 points).

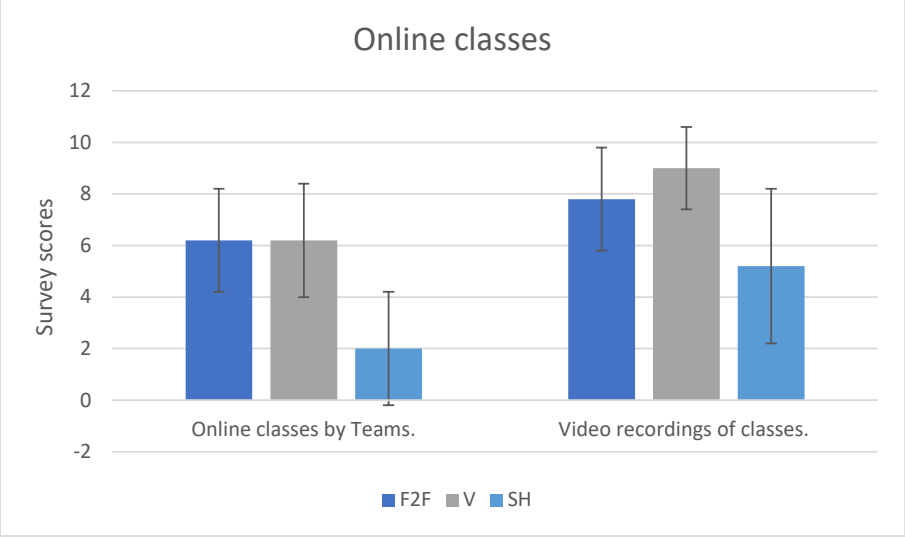

Figure 8. Opinion about the online resources.

The personalised tutoring has been replaced from face-to-face to online format by Teams. The treatment between students and professor, although not the same, was quite like the conventional face-to-face tutorials with direct interaction. The three groups value tutoring in a similar way, in the three proposed models: by email, online by individual Teams videoconference and in small groups with no significant differences between groups. The average grade, close to 8 in the three models and in the three groups, implies a good acceptance of this activity by the students. Most of the tutorials, around 80% of the cases, have been performed by email, and the other 20% of the time, online tutoring was carried out.

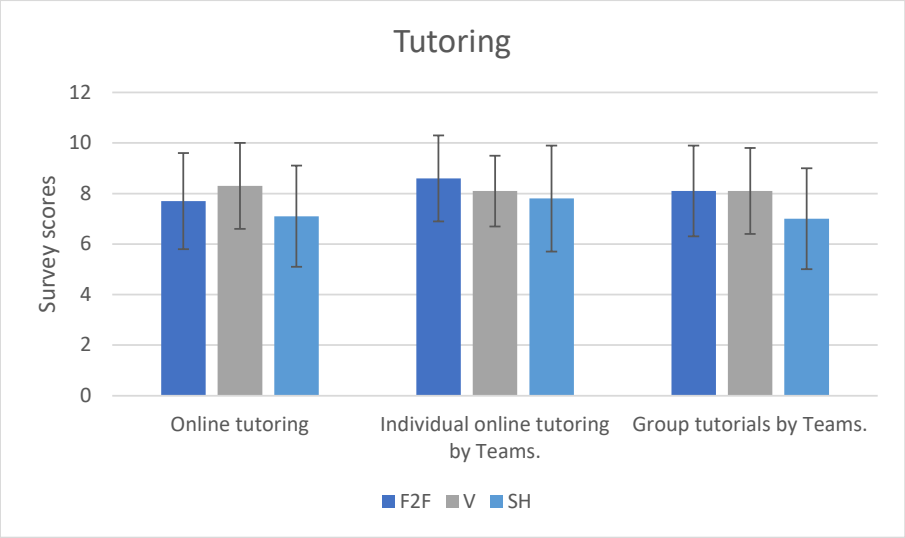

Figure 9. Opinion about tutoring.

In the online group they had to create new resources equivalent to certain teaching tools in the classroom: underlining, highlighting, highlighting and writing on the blackboard or transparency, showing electrical components or images, quotes from books... In other cases, an annotation or the resolution of a doubt had to be improvised online, with a format equivalent to the blackboard in a face-to-face class. The new elements that have been introduced, thanks to the use of a webcam and a touch screen, have been well accepted by the students, with an average rating of over 8 points.

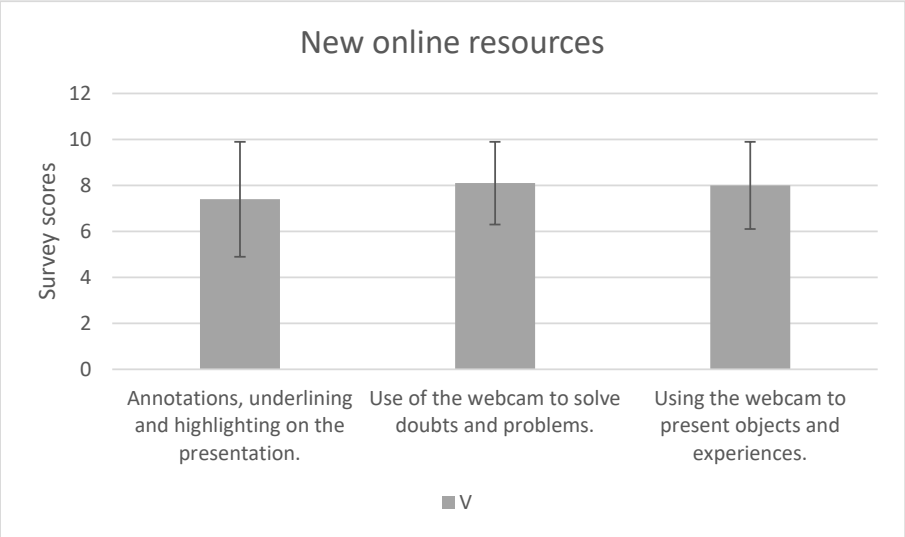

Figure 10. Opinion about new online resources implemented in the V group.

3.2.3 The new semi-confined scenario

There are important differences in the assessment of the student's adaptation to the new COVID19 situation. In the assessment of teacher's work, and in the overall functioning of the subject. V and SH are very critical of their work, with a very low evaluation of SH. SH also gives a poor assessment of the teacher's work and the overall functioning of the subject. This result contrasts with the uniformity in the assessment of the resources available to them to work, both at home and at school where, for the three groups, the assessment has been high.

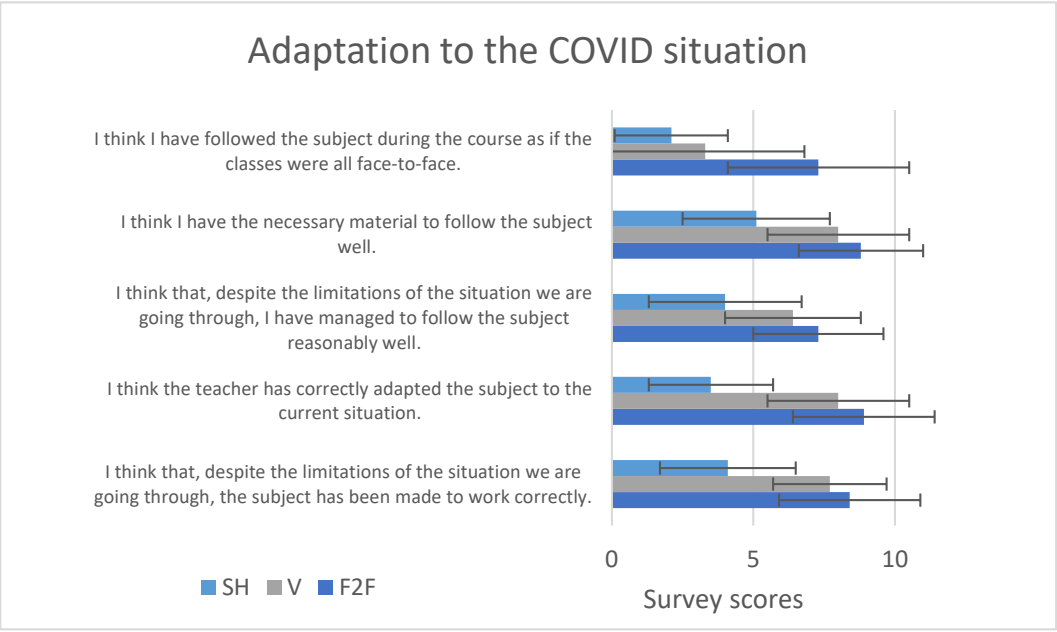

Figure 11. Opinion about the student's adaptation of the COVID situation.

3.3 Open-ended questions

In the open-ended questions of the students' survey, the students were asked to describe the subject's strengths and the points that should be improved and, when appropriate, to make proposals for improvement.

3.3.1 Subject's strengths

In this question, group V had the highest number of responses (28% of the students who followed the subject), and group SH had the least (less than 20%). The three groups highlighted the teacher's work as the subject's strength and, particularly, the tutorial work, resolving doubts quickly and efficiently in the three teaching modalities. In group V, interest in the subject and the importance for later ones appeared, while in group SH, the advantages of teamwork were highlighted. The misunderstanding of some students when talking about the methodological characteristics of flip teaching could also be highlighted.

3.3.2 Points that should be improved and proposals for improvement

Participation has been very high: 93 students answered this question of 111 students answered the survey. The reference to excess work and the accumulation of evaluation tests was recurrent. The proposal to improve the online laboratory practices was also frequent, particularly the presentation of the video practice made by the teacher. In the V group, they asked that the classes be face-to-face. In SH, a third of the students who answered the question disagreed with flip teaching: "I prefer to give the theory in class and do the exercises at home". They were also dissatisfied with the streaming of the classes: "the class is made for those who follow it in face-to-face, on the blackboard and in-class slides, without taking into account video and audio problems for the students that follow the class in streaming." Some of them said that, with these classes in streaming, they felt disrespected. Also, in the SH group, students proposed to improve the material both in the organisation and in quality and quantity.

4 CONCLUSIONS

The hybrid model, as initially proposed, has been shown to be unsuccessful, from the point of view of academic results and students' perception. This could be due to the possible increase in fatigue, due to the effort required, both for students and teachers.

The improvisation of a hybrid model such as the one proposed at the UPV in the case studied has provoked an important discomfort among the students. They have clearly expressed disagreement in the opinion survey, focused on the teaching work and the hybrid model itself. Consequently, a new hybrid teaching model should be prepared, based on the experience of COVID-19, for other possible similar situations in the future. The two main aspects to be taken into account are the technological issues (that today are not good enough), and the interactions between distance participants.

No correlation has been detected between the academic results obtained in the individual activities and in the ones developed in teams. It should be analyzed whether it corresponds to the use of different unrelated competences of students, or to a problem of the methodology used to evaluate the teamwork.

The academic results of the groups F2F (traditional face-to-face methodology) and V (online methodology) are similar, showing that these two methodologies could be considered equivalent (both of them using flipped classroom) in a normal academic context.

ACKNOWLEDGEMENTS

Authors would like to thank the Institute of Education Sciences of the Universitat Politècnica de València (Spain) for supporting the Teaching Innovation Group e-MACAFI and for the financial support through PIME Project PIME 20-21/220 and PIME Project PIME/2018/B25.

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