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Hybrid Flipped Classroom: adaptation to the COVID situation

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ABSTRACT

One of the first measures to fight against the COVID-19 pandemic was the confinement of the society and, consequently, the impossibility of providing presence-based training. For this reason, the faculty had to change the training to a completely online model, in a very short period of time and without the possibility of planning the process of change. The COVID-19 remains in our lives and continues to affect the training model. Currently, there are teachers using online training, face-to-face classes and there are even dual models where the faculty teaches both presence-based and online classes at the same time. For this reason, there is a need for training methods capable of adapting to different situations. In this work the Flipped Classroom model (a method used in face-to-face classes to make students more active) has been adapted to a hybrid model which can be implemented in any situation at any time. The model was applied during confinement in programming laboratories and the impact of this model has been measured through the works generated by students during the continuous evaluation. The result has been highly positive because the number of works presented by students the generated academic doubts have increased, as well as the average grades obtained during the continuous evaluation.

CCS CONCEPTS

• **Applied Computing** → Education; Collaborative learning.

KEYWORDS

Educational innovation, active methodologies, impact indicators, flipped classroom, online training

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1 INTRODUCTION

The COVID-19 pandemic has had a global impact, with more than 34 million positive cases and one million deaths [3]. In an attempt to curb the health impact, governments have implemented various strategies, one of the first and most important being the confinement of the population.

In the educational context, confinement did not allow teachers and students to attend classes in person. In the case of Spain, the confinement was carried out once the course had begun and with just over 50% of the training process already completed for the 2019-20 academic year.

Once the confinement and the academic year were over, the institutions have continued working to include the COVID-19 situation in the new academic year agenda.

Furthermore, due to the fact that pandemic outbreaks in many cases exceed expert forecasts, the institutions are working to address this exceptional and rapidly changing situation from the beginning of the academic year 2020-21.

Therefore, the impact of COVID-19 on the learning process can be analyzed from two phases: the emergency phase (the situation caused by the confinement and the suspension of face-to-face classes without prior notice and without time to plan) and the contingency phase (the situation in which, once the academic year is over, the new subjects are prepared for the so-called "new academic normality").

In the emergency phase, from the institutional point of view, the universities worked to adapt the organization to the drastic change originated by COVID-19 [10]. Basically, technological and academic services were the first to offer solutions to the university community itself.

From the technological services, protocols were put in place to verify that online technologies could provide massive support to the entire university community. The academic services organized the classes and the training process to place them in a distance and online context.

Consequently, the faculty had access to technologies and academical organizational processes to adapt to the new situation; a teaching system that before, in many institutions, was completely presence-based.

However, although the faculty had support to make the change, a large majority was not ready to handle online technologies, nor to change their training methodology, nor for the evaluation process [11]. Especially taking into account that more than 50% of the academic year had already passed with the presence-based teaching and there was no previous design for the abrupt change.

For example, in the case of the classic presence-based learning method (that includes a high percentage of lectures and problem-solving sessions) changing properly the method was unfeasible in such a short period of time.

Therefore, the widespread result was to give the same known presence-based classes but with the aid of a videoconference system. The imposed immediacy for the change did not allow planning the subject: choosing a new methodology, preparing the materials and giving continuity to the teaching already given.

However, there are innovative methods that do not involve changing the planning of the subject and can be applied at any time in its development.

One of these methods is the Flipped Classroom model, which was designed for the sessions in the classroom [15], mainly to be more interactive in the master classes [6], laboratories, practical sessions [7] and in the training of generic competences [9] such as teamwork.

In this research, the method of the Flipped Classroom model was implemented during the emergency phase in the programming laboratories of a traditional presence-based subject, making a set of adaptations to be able to apply it to the online mode.

The main goal of this article is to obtain a Flipped Classroom model that can be applied in different situations in a hybrid manner, both in the classroom and online; moreover, a model that can be applied at any time during the course of the subject without the need to change its planning. This model will be called *Hybrid Flipped Classroom model*.

The Flipped Classroom model [16] is an active method that allows students to be more participatory. A manner to measure the active participation of the students is the delivery of academic works [18].

In this article, in addition to developing the model, the students' works during the programming laboratories are analyzed.

The submission percentage will be measured in relation to the number of attendees to the laboratories, the questions asked by students about them and the final grades as well. Handing the works is voluntary for the students but they have a weight of 33% on the final mark of the laboratory.

Then, the successive phases of transformation of the model are described, as well as the proposal of the same. Next, the context of application will be described, as well as the results of application of the model. Ending with the conclusions of the work done.

2 PROPOSED MODEL

Since its creation, the Flipped Classroom model (FC) is based on a generic model defined by the inversion of the location of the two most common processes in training: *lessons* and *homework*.

This model suggests performing the *lesson at home* and the *homework in the classroom* (contrary to traditional teaching). It should be considered that in a presence-based teaching, the *lesson at home* is done to a distance and usually online, and the *homework in the classroom* is conducted in a classroom during face-to-face session.

The main approach of the FC model is based on the idea that if in a face-to-face master-class the students listen to the teachers and perhaps take some notes, then this same process can occur at home [17].

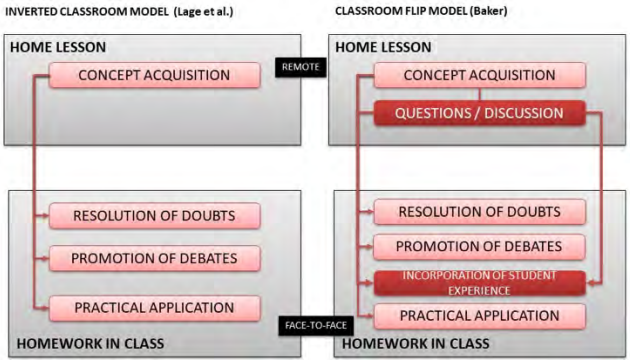

Figure 1: Original model

For example, the students can perform the same actions by watching a video of the teachers, without losing any input. Hence, if students learn the lesson before the class, later, together with the teacher, they can be more active, participatory and collaborative. All these activities allow to apply superior cognitive abilities [2] and the learning results improve [4, 14].

Two models emerged in 2000 [1, 15] and are identical in their main characteristics: *lesson at home* and *homework in the classroom*. However, there are some differences between them, related to the processes in each of these characteristics, they are showed in the blocks of Figure 1

The Lage et al. model [15] was not prepared to be used online (in the 2000s Internet use was not widespread in most households) and, consequently, the question-solving or the debates were included within the process of *homework in the classroom*.

The Baker model [1] did contemplate processes for the students to ask and debate. Both models are widely used today and the term *Flipped Classroom* is usually used in English and *Aula Invertida* in Spanish [8].

One of the main issues with the cited FC models, is the connection and continuity between what is done at home and in the classroom. In previous works, the authors of this article have defined a new model called *MicroFlipTeaching* (MFT) [17].

As shown in Figure 2, MFT presents a high level of continuity between the *lesson at home* and the *homework in the classroom*. This model has been validated through scientific studies and accredited the increase of indicators such as class attendance, the resolution of complex questions [6], the interaction between students [12], peer to peer learning [19] and learning of the teamwork competence [13].

The MFT model incorporates a set of changes both in educational processes and in the scope of teaching materials. From the point of view of materials, instead of expecting the students to attend the class with all the lesson already learnt, it is prepared to only learn part of it.

In relation to the new processes, MFT works with two of the weak points from the former models: 1) maximizing the continuity between the *lesson at home - homework in the classroom* blocks and 2) ensuring the learning of the academical concept that was taught.

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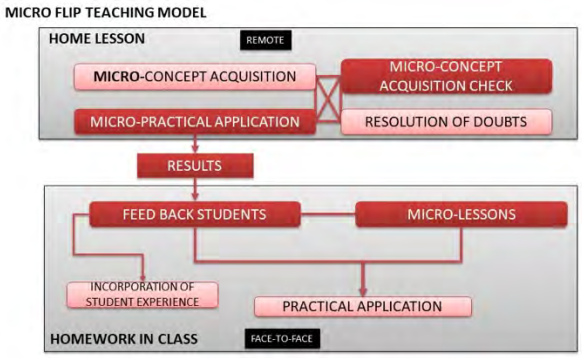

Figure 2: MFT maximizes the connection between the Lesson at home and the Homework in the classroom

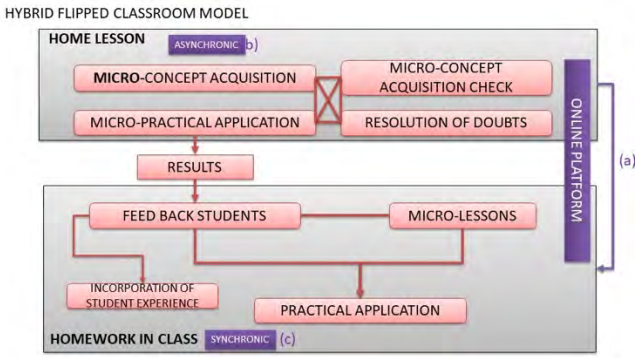

Figure 3: Hybrid Flipped Classroom model

- **1-** Maximizing the continuity of the blocks is done by incorporating an integrated sequence of processes: *Micro Practical Application* (students must perform a micro-task on the concept explained during the *lesson at home*) and *Students Feedback* (using the results of the *Micro Practical Application* to provide feedback to students during the classroom session).
- 2- The "Concept acquisition check" whose target is to help the student to comprehend the concept. This is done through techniques such as: the students fill out a questionnaire and, depending on the results, the teacher provides reinforcement material or ask them questions on specific topics, and they can only continue with the learning process when they answer correctly.

Since the method MFT does not intend for the student body to bring the lesson fully learnt to the classroom, this requires conducting what we call *micro-lessons*. This article shows the adaptation of the MFT model to online teaching and provides a new perspective for the *lesson at home*. Figure 3 shows the new model that is proposed by the name of *Hybrid Flipped Classroom model* (HFC) [5].

In the previous models, the main goal of the *lesson at home* was to have the students learn a concept. In this new HFC model, a novel function is added: the production of information for the faculty to know the learning level of the students during the *lesson at home*. In that way the teachers can make decisions about the strategies and resources to use during the *homework in the classroom*. Figure 3a shows this new target.

The information for knowing what has happened during the *lesson at home* is provided by their processes, together with the data of the online platform itself.

In addition, the division of the blocks based on the attendance in the classroom, by the students and teachers, is changed (traditionally the homework in the classroom were face-to-face and not presence-based the lesson at home).

Instead of using the "presence-based" dimension, the "type of communication" dimension is used. In HFC the communication processes of the model are classified in: synchronous (there is temporal coincidence) and asynchronous (there is no temporal coincidence, in activities such as email, forum, etc.).

From this point of view, in any FC model the *lesson at home* is a mostly asynchronous process, while the *homework in the classroom* is a completely synchronous process.

Therefore, the FC or HFC model are divided in two processes: one asynchronous (Figure 3b) and another synchronous (Figure 3c). Moreover, both processes are performed with online support. The context and situation in which the FC model was implemented will be described bellow.

3 CONTEXT OF RESEARCH

This work has been done in the first year university course called "Computer Science and Programming", which belongs to the second semester of the Energy Engineering degree from the Technical University of Madrid.

The mentioned subject is structured in two main blocks: the theoretical one in the classroom (with an average participation of 70 students/session) and the practical one that is done in the programming laboratories (with an average participation of 35 students/session). The laboratories have a duration of 24 hours distributed in 2 hours per week and the classroom sessions have a duration of 36 hours, also distributed in 2 hours weekly.

The evaluation of the laboratory consists of two parts: one is the continuous evaluation based on the delivery of academical works (22,2% of the final grade) and another is the final test (77,8 % of the final grade). The mark obtained with the works is only valid if in the final test the student reaches a minimum mark of 3 out of 10.

The subject is completely presence-based but, due to the confinement situation originated by the COVID-19, it turned to be online. When the face-to-face classes were disrupted, four of the laboratory sessions had already been given, so the HFC model was implemented during the next eight sessions by applying the case study method. The results of this HFC model are applied to the continuous evaluation part.

4 RESULTS

There laboratory subgroups in the course are six, two for each of the three classroom groups. Two classroom groups (four laboratory subgroups) are taught in the morning schedule and one group (two laboratory subgroups) in the afternoon schedule.

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Table 1: Submission of work in the face-to-face period

% submitted works /total enrollers	Experimental	Morning	Afternoon
T1	49,33	34,23	49,41

Table 2: Submission of works in the online period

% submitted works /total enrollers	Experimental	Morning	Afternoon
T2+T3+T4	59,11	26,23	50,20

At the beginning of the course, students choose the laboratory subgroup from those available in their classroom group. Each laboratory session was presence-based during the four first sessions and the rest was online.

The experimental group is composed of one laboratory subgroup from each morning class group (experimental group with 75 students). The contrast of results is made, on one hand, with the other laboratory subgroups of the morning class groups (control morning group with108 students) and, on the other hand, with the afternoon subgroups (control afternoon group with 85 students). This difference of contrast is made because in the contrast morning group there is a significant difference in the number of students and in the afternoon group it is not significant.

The analysis of results is based on the delivery of works by students, consultations made and the mark obtained in the submited works.

4.1 Works submission

The first work submitted by students corresponds to the period of presence-based training. Table 1 shows the percentage of submitted works in relation to the total amount of students enrolled in the laboratories. The first column includes the submitted works, in this case the first work T1, the second column is the percentage of submitted works in the experimental groups, the third column is the percentage of the submitted work in the control morning group and the fourth is the percentage of the submitted works in the control afternoon group.

Works T2, T3 and T4 were submitted during the period corresponding to the emergency state. Table 2 shows the percentages corresponding to these three works. The columns have the same meaning as the columns in the Table 1

Figure 4 shows the evolution of the number of the submitted works in the presence-based/online periods, of the experimental group and the two control groups (morning and afternoon).

4.2 Online tutoring

A forum for questions was used for each laboratory group. Figure 5 shows number of questions sent by students of the experimental and the control groups (morning and afternoon).

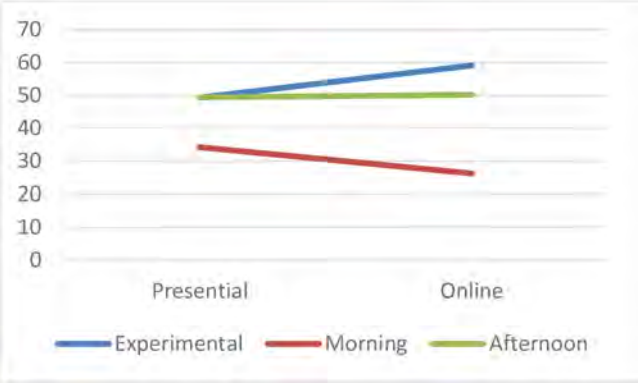

Figure 4: Evolution of the submitted works presence-based/online for the experimental group and the control ones

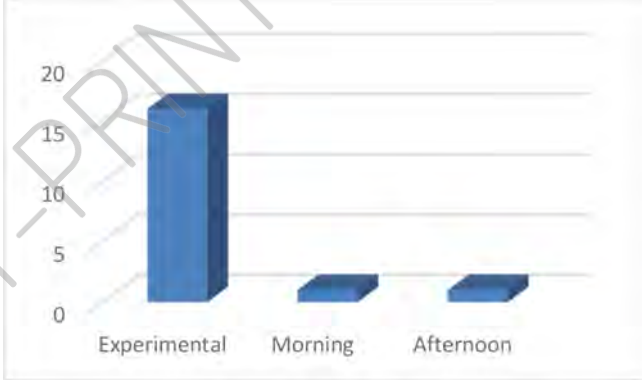

Figure 5: Evolution of the number of students questions for the experimental group and the control ones

Table 3: Academical results

	%tested	%works	Average mark
Experimental	73,33	41,8	7,35
Morning	54,63	18,6	6,37
Afternoon	82,35	42,9	6,32

4.3 Academical results

Table 3 shows in the second column the number of students tested during continuous evaluation (who submitted works), in relation to the number that was actually enrolled in the laboratories. The third column shows the counted works (to take the work into consideration, the students needed at least a grade of 3 out of 10 in the final assessment) and the fourth column is the average mark in the works (out of 10 points).

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5 CONCLUSIONS

With regard to the submission of works, it can be observed that the experimental group shows a significant increasing percentage trend. The growth begins with the application of the Hybrid Inverted Classroom method and is maintained upwards throughout the online period. The control groups show different trends, but in any case none of them grows. One remains and another decreases.

Regarding the online tutoring, there is a significant difference in the number of questions that students ask within the experimental group compared to the rest of the control groups (among them there are no considerable differences).

In relation to the academic results of the control groups' works, the results are almost identical, while the experimental group achieves a higher grade. Although the average grade has a little increment of a 10% over the final mark, the result shows in how high the qualification is, being the only ones to reach an average mark between 7 and 8 over 10.

Concerning the works submission, it can be stated that the HFC method succeeds on rising them as well as the tutoring sessions. The grades can not be fully associated to the HFC method because it was only applied to 70% of the training process.

As future work, evaluation tests should be carried out before applying the HFC method in case it is partially applied in the training process or apply the method in the whole learning process.

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