FLIPPED CLASSROOM IS NOT FOR EVERY KIND OF STUDENT

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Abstract

Flipped classroom is a teaching strategy which has been greatly studied and utilized in various types and areas of teaching. Basically, it means that classes start being taught reverse to traditional classes. The teacher or instructor sends contents to students before lectures, adding the fact that students must study the subject matter before attending class. The advantages are clear: the time that each class takes with the teacher and classmates starts being used not to explain the subject, but for more complex questions which may be put only after clear knowledge of the subject.

For this teaching strategy to work it is necessary that students do their homework, and that the teacher sends the correct and interesting study materials to students.

In a phase of state of emergency-teaching or mixed teaching (presently and distance) caused by the COVID-19 global pandemic, flipped classroom started being much more used, namely in higher education and in areas such as IT.

In this article we analyse 78 students of two IT courses, finding what type of students consulted the study materials sent by the teacher before lectures: we compare the characteristics of students, namely gender, age, course, attendance to classes (synchronous distance classes and laboratory classes at the university), as well as final classifications (divided into 4 levels and dropout). Thus, we will get to know for which type of students the effective use of the flipped classroom strategy may cause efficient learning and who are the students who will never do their previous homework.

Keywords— Flipped classroom, COVID-19, e-learning, programming fundamentals.

I. INTRODUCTION

Flipped classroom is a strategy that has been widely used in different teaching-learning subjects at the university [1]. The model consists of inverting the traditional order of lectures. In this way, students have, before class, access to materials in order to study the subjects that will be taught in class. These materials can take various forms (like videos, texts, or MS PowerPoint documents). Often, small online tests are also created to assess knowledge of the subject. The advantages are clear: face-to-face classes (or at least classes with a teacher if we think about distance learning) are more useful because students have already had previous contact with the subjects. Classes are reserved for discussion, questions, and application of previously acquired knowledge. For the student, there is then the possibility of studying the subject at his own pace (time and space that suits him) and the time with the teacher is better used to solve doubts. For the instructors there is the possibility to propose more interesting dynamics and resolution of exercises, not wasting time with classes only to transmit knowledge, because students have had previous contact with the subject. The concept of flipped classrooms aims to invert the way content is taught and applied. In the traditional format, the contents are usually presented in the classroom and later applied to homework, but in the inverted format it works the other way around: the contents are learned by the students before classes and the application of the knowledge is done in the classroom with the accompaniment of the instructor.

Teaching-learning programming fundamentals to novice students has been subject of several investigations and articles with the objective of reducing failures and dropouts, as well as improving teaching-learning [2] [3]. Flipped classes are one of the possible strategies [1] [4] [5] [6] [7] [8] [9]. This article reports the experience of using inverted classes during a semester in the Covid-19 pandemic, in which the theoretical classes were taught digitally. For several weeks, the theoretical classes were on Mondays (two hours) and laboratory practices (2 + 2) on two other days of the week. The teacher sent students (weekly on Saturday morning) a summary of the previous week, via MOODLE, as well as a schedule of what would happen next week. In that same notice, links were presented one or two files that the student should read before classes. These files contained a part of the material to be taught in the following week, but, above all, proposals for exercises for reflection by the students. For example: when starting to present arrays, there is a benefit for students to think ahead of what they are used for, or at least to feel that they are a solution to a problem that could not be solved without the use of arrays. Before the class in which the arrays were presented, a file was placed with two very simple exercises: first to read the name and age of several people, calculate and write the age average and the name and age of the elders; second as the request in the first exercise and that at the end of the exercise write

which people are below the average age. It is noticed that the first part of the exercise is very simple to solve using simple variables (alphanumeric variables for the name and name of the oldest, integer variables for age, sum and older age and a float variable for average), but if we need the name and age of each person after calculating the average age, it is necessary to use a structure that until then students did not know - the array. In this way, students realize that they need arrays or at least know that they cannot solve the second problem with simple variables like the ones they used up to that moment. In such cases, when students arrive at class, they have already thought about the problem or, better yet, they have already researched how they can solve the problem. What is intended is that students attend classes willing to learn and already awake to the need for new knowledge.

This paper is divided into a literature review on flipped classes, the explanation of the methodology used, the results, the discussion of the results and the final conclusions.

II. LITERATURE REVIEW

Flipped classroom is a strategy that has been widely used in different teaching-learning subjects at the university [1]. The dynamics of this teaching-learning technique is to invert the traditional order: students have contact with new subjects before the classroom, using videos, texts, or other material, as well as small online tests to check their knowledge. In this way, the face-to-face classes are reserved for discussion, doubts, and application of previously acquired knowledge. There are great advantages: each student learns at his own pace and during classes and interactions with the teacher, so he can make better use of time, achieving an application of the knowledge he previously acquired. In this way, the instructors can propose dynamic classes and solve more interesting exercises, not wasting time with classes to transmit knowledge. The concept of flipped classrooms intends to invert the way content is taught and applied. If, in the traditional format, the contents are usually presented in a face-to-face class and later applied to homework, in an inverted format it works the other way around: the contents are learned by the students before classes and the application of knowledge is done in the classroom with the accompaniment of the instructor. There are several definitions: “educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom” [10] or “specific type of blended learning design that uses technology to move lectures outside the classroom and uses learning activities to move practice with concepts inside the classroom” [11].

Existing research compares traditional classes with inverted classes [12] [13] [8]. In these experiences, different technologies are used: some use Coursera MOOCs [14], Microsoft PowerPoint Documents [13], others use YouTube videos [15], others make videos and put them on the teacher's YouTube channel [16], others use links embedded in pages [17] [18]. There are those who use Facebook [19] [20], MOODLE [21], blackboard [22], TeachBack and Spinoza [23] [24] or WordPress [17]. Most teaching-learning dynamics go through online versions of the course textbook [25] and videos before laboratory classes [5] [7] [4] [8]. Videos are usually created by the instructor or chosen by him, but there are cases where students are encouraged to look for videos that fit the given subject [20]. Some articles report multiple-choice quizzes over the video material [15] or at the beginning of classes [26]. Inverted classes are generally used as a teaching-learning strategy, but in some cases Partially Flipped Classroom Model is used [27]. There are pedagogical techniques that are used, such as Pair Programming. Think-Pair-Share, Contingency Plans [27], Peer Instruction and Team-Based Learning [28], group activity and discussion [29], Problem-Based Learning [30], peer instruction [22], pair programming [7]. Different objectives are referred, as programming self-efficacy and academic performance [31], check for different acceptance by gender [32], or compare different technology [23] [24].

The materials must be very efficient (viewing long static videos can be boring and course overwhelming [5] and Gate-check video quizzes are not sufficient to improve the grades of students in a flipped CS1 classroom [15]), the students must do their previous work and the instructor must be able to understand what is the best support that he can give to his students. The responsibility for learning is on the student's side so students can work towards mastery of the material [33]. Students generally perceive the online lectures as helpful [34]: self-study gives more motivation to study programming and it is appreciated more by the students who like self-pace [35]. Some papers refer that students prefer inverted classroom rather than traditional lectures [6] and that the students’ enthusiasm for the course increased over the semester [7]. Drop, Pass and Failure Rates compare to traditional lectures [7] [9], but significantly higher grades on the exam are the inverted offering compared to the traditional offering [8], as the inverted offering encourages students to “go big or go home” [9].

III. METHODOLOGY

The experience that we report in this article happened with a curricular unit of programming fundamentals in two technology courses (informatics and informatics engineering) during the COVID-19 pandemic. This curricular unit has 6 hours of classes per week: two distance classes in a synchronized way (using the MOODLE and ZOOM plates) on Monday and four hours of laboratory classes (2 + 2) at the university. The semester had 12 work weeks (excluding the two weeks of Christmas break) and was divided into two parts: the first part for algorithmic thinking using top-down, algorithms and data tracing; the second part for coding in a programming language (Python for one course, C for another course). The first lecture was used to present the unit, as well to start the course. In weeks 2 to 6, small tests were done on MOODLE at the beginning of lectures and an exercise to submit in the last half hour of the second laboratory practice class. The resolution of the small MOODLE tests to check the knowledge of the previous week and the practical exercise of the class were placed by the Teacher in MOODLE, as well as the classifications obtained by the students. The two tests (valued at 35% each) were scheduled for weeks 9 and 12. In weeks 7, 8, 10, 11 and 12 materials were placed in MOODLE for students to think about the problems that were later the subject of discussion in lectures. In this way the students, since they read these materials, were able to perceive the class material. This would be ideal, however in each class it was noticeable that only a few students had read and thought about the proposed problems.

At the beginning of the semester, a survey was conducted in MOODLE to get to know students, their characteristics, motivations, and previous knowledge. We used the variables number, gender, year of birth and course. To find out which students access the proposed materials in three weeks, we use the reports from the MOODLE platform. Classifications of students at the end of the semester (average of the six best five MOODLE tests and five weekly exercises of the laboratory practical class) * 10%, written test and practical test (each evaluated at 35%), as well as two phases of group work (10% each). We also consider the presence of students in theoretical and laboratory classes, with 60% attendance being the minimum established (by pedagogical council) for the student to be approved in a curricular unit during the academic period.

IV. RESULTS

The sample consists of 78 students, 6 female and 72 male. 58 students from the Computer Engineering course and 20 from the Computer course. 66 students were aged 18, 19 or 20 and 12 students were aged between 21 and 27 years.

We monitor three of the proposed documents, which we will call D1, D2 and D3, available on the curricular unit's page on MOODLE. We consider having access to a document between the date of sending the email (Saturday morning) and the theoretical class on Monday. 66 students accessed at least one of the documents, which means that 13 students never did their homework beforehand. D1 was accessed by 29 students (37.18%), D2 was accessed by 54 students (69.23%) and D3 by 40 (51.28%). 25, 24 and 16 students access one, two or three documents - which means that only 20.51% of students always do the work before class and 16.67% of students do not access any documents.

Female students: two students did not access any documents, one student accessed one document, three students accessed two documents, and none accessed three documents. For males, the numbers are 11, 22, 23 and 16, respectively. In the table below we can see these numbers: absolute form and percentage.

Table 1. Documents accessed by gender.

Gender - Documents accessed	0		1		2		3	
Female	2	33,33 %	3	50,00 %	1	16,67 %	0	0,00%
Male	11	15,28 %	22	30,56 %	23	31,94 %	16	22,22 %

From the Informatics course: six students did not access any documents, four students accessed a document, six students accessed two documents and four accessed three documents. The computer engineering course numbers are 7, 21, 18 and 12, respectively. Table 2 shows these numbers in detail.

Table 2. Documents accessed by course.

Course - Documents accessed	0		1		2		3	
Computer engineering	7	12,07 %	21	36,21 %	18	31,03 %	12	20,69 %
Informatics	6	30,00 %	4	20,00 %	6	30,00 %	4	20,00 %

Regarding students over 20 years old: five students did not access any documents, one student accessed one document, three students accessed two documents and three accessed three documents. Regarding students aged between 18 and 20, the numbers are 8, 24, 21 and 13, respectively, as we can see in the next table.

Table 3. Documents accessed by age.

Ages - Documents accessed	0		1		2		3	
>20 years old	5	41,67 %	1	8,33%	3	25,00 %	3	25,00 %
[18, 20]	8	12,12 %	24	36,36 %	21	31,82 %	13	19,70 %

Students with less than 60% classes attendance: three students did not access any documents, one student accessed a document, two students accessed two documents, and none accessed three documents. The numbers of students with class attendance of at least 60% are 10, 24, 22 and 16, respectively, as shown in table 4.

Table 4. Documents accessed by class attendance.

Class - Documents accessed	0		1		2		3	
<60%	3	50,00 %	1	16,67 %	2	33,33 %	0	0,00%
>=60%	10	13,89 %	24	33,33 %	22	30,56 %	16	22,22 %

Half of the students with a grade equal to or greater than 15 accessed the three documents and 37% of the students who dropped out or missed the last test did not consult any documents. The complete numbers are shown in the following table.

Table 5inal grade., Documents accessed by final grade.

Final grade - Documents accessed	0		1		2		3	
>=15	0	0,00%	3	37,50 %	1	12,50 %	4	50,00 %
[10, 15[	0	0,00%	9	45,00 %	8	40,00 %	3	15,00 %
[5, 10[	4	18,18 %	5	22,73 %	10	45,45 %	3	13,64 %
<5	0	0,00%	3	75,00 %	0	0,00%	1	25,00 %
DropOut	9	37,50 %	5	20,83 %	5	20,83 %	5	20,83 %

V. DISCUSSION AND CONCLUSIONS

The results presented in the previous section demonstrate that a large part of the students do not previously prepare for lectures when the necessary materials are made available and the teacher encourages them to do so. 13% of the students in the sample did not access any of the three documents considered in this article and only 20.51% of the students accessed the three documents. This study tries to understand if there is a type of student who does the previous work and which type of student never does the previous work.

If we look at the tables in the previous section, we find that the type of student who accesses all the proposed materials will be a male student, aged 21 to 27, with regular attendance (greater than or equal to 60%) and that scored from 15 out of 20. On the contrary, the student who never accesses the proposed previous work, is a female student, aged 21 to 27 years, with no attendance and who will abandon the course unit missing the last test. The variable course was not significant for the study.

The percentage of students who do previous work does not exceed 70% in any of the three documents - which may mean that it is difficult for a teacher to assume that all students have prior knowledge of what will be covered in the lectures.

Flipped classes have been the subject of several studies that point out great advantages for this dynamic. This paper aims to see if this really happens. To benefit from the use of the methodology, it is necessary that a large percentage of students fulfil what is intended, otherwise, it is no longer beneficial because the teacher needs to expose the material that the class is focused on. In these cases, the teacher has two alternatives: either presumes that everyone has read the materials (at the risk of a large part of the students not perceiving anything at all) or presents the contents of the class (and the students who fulfilled the agreement, doing the work from home, will feel that they are listening to the material they have studied again).

In fact, we can conclude that flipped classes do not work for all types of students.

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