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Design of Virtual Modules for the Development of Flipped Classroom in Programming

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Abstract

This article presents the design of virtual modules for teaching the logic of programming through the flipped classroom. Five modules comprising the different programming structures were developed through 37 videos with different lengths, which will allow to know the appropriate time for the development of a more effective class, allowing the student to review and engage with the topics of the subject. Although it requires more work on the part of the teacher to develop the material, a greater understanding of the subject is achieved when reviewing and analyzing the concepts and exercises present in the development of each of the classes.

Keywords: Flipped classroom, Learning, Educational video, Programming logic.

1. INTRODUCTION

The flipped classroom teaching strategy has proven to be positive for learning in low-performing students [1], because the material can be reviewed at different times through the support of materials such as videos stored on platforms such as Moodle. The flipped classroom requires more commitment on the part of the student, because it must perform an immersion in the subject and even occupies more time to present the different requirements of the teacher, which is why it is combined with a strategy where the teacher must support with further instructions before focusing completely on the autonomy of the class in the student [2].

The flipped classroom model has disadvantages such as time duration, wrong contents or lack of animation, that is why the first classes present a proposal that must continue to improve based on the experiences and suggestions of the evaluated group [3]. Due to the Covid-19 pandemic, teachers had to adapt their classes virtually [4]-[6], that is why in the creation of the flipped classroom different stages had to be developed starting with the objective of the class where the student should have participation, and the material to be followed in all classes is listed. The activities can range from questionnaires to group tasks, achieving a high variety in the material and methodologies used for learning. It also presents the advantage of using resources through links on WhatsApp, videos on YouTube or documents in magazines, among others. One of the advantages is that the student feels more valued and has the possibility of asking questions on a more regular basis due to the reflection they make of the material and resources available [7], [8]. The creation of the work materials through videos can also be implemented in sessions before and after classes, allowing the development of exercises in laboratory practices, with which not only reinforces leaving the material for review at home also strengthens with instructions in the classroom [9], using applications such as Lessons with which allows the student to go at their own pace. Students show a satisfaction rating of 7.9 out of 10 with the new flipped classroom model.

The disadvantage of the flipped classroom may be mostly due to the aptitude of the student, who must commit to listen and review the videos of the classes beforehand to obtain a deep learning approach, otherwise they end up with a superficial learning, which is why the reviews by the teacher of the time and number of students who reviewed the material is fundamental for the motivation of learning [10]. It has been proven that if students review the material prior to class, their grade can improve by almost 27% when compared to the grade of traditional classes [11]. It is also noteworthy that older students show greater progress in learning due to their commitment and the time they can devote to review the study material, which can be a good method to use in distance education [12]. One of the initiatives is in the area of mathematics where the teacher must solve problems almost face-to-face due to the complexity of the topics, however, it can motivate and develop critical thinking and problem solving skills with the previous understanding of mathematical concepts, demonstrating that it can be combined with other methodologies for its implementation [13].

This research develops the design of virtual modules for teaching in a first semester programming course, using flowchart and pseudocode tools in the subject of programming fundamentals, with the objective of introducing different tools to design the class material, and determine the time of the videos that students will finally review for learning before attending classes.

2. METHOD

Five virtual modules were designed according to the program planner of the course, which comprise the different units established for learning. The modules are the following:

- Module 1. Introduction to computer science.
- Module 2. Problem analysis and algorithm.
- Module 3. Structure of an algorithm.
- Module 4. Control sentences.
- Module 5. Arrangements.

The virtual modules are composed of several videos, where the content of each one was discussed and selected with the mediation of the students to be developed in each next class, and were created through 4 components (Figure 1).

The first component consists of the presentation and participation of the students of the topic to be developed in the class, in this way the learning can be evaluated through the video, selecting the participation of 5 students that change in each class. The second component is mediated with the participation of the teacher, where the topic to be addressed is expanded, giving greater emphasis on the weaknesses detected in component 1. Component 3 is vital in the creation of the videos that make up the virtual modules, because they are developed through the suggestion of the students, which allows greater participation and selection of the topics where they want to make greater emphasis in the subject. Component 4 is developed by the teacher following the guidelines determined in the previous component.

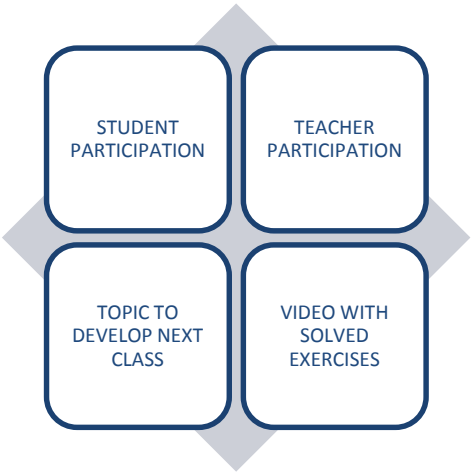

Fig. 1. Components for video development.

According to component 3, the number of videos to be developed per module was defined as well as the duration, presenting 2 types of videos according to the time: if the video lasts less than 12 minutes the student must expand the information for possible evaluation in class, and if the videos lasted more than 12 minutes it was understood that the class is complete in its entirety, without the need for research or evaluation, only to present exercises with problems similar to those presented. The number of videos available for the development of the subject were:

- Module 1: 2 videos.
- Module 2: 1 videos.
- Module 3: 3 videos.
- Module 4: 27 videos.
- Module 5: 4 videos.

The development material is referenced in the Moodle platform of the subject provided by the Universidad Francisco de Paula Santander Ocaña, finding the link to the material which is stored in Youtube, due to the ease of viewing by the devices and connection packages that students have, making it possible to not only enter the course in Moodle, which can help facilitate the visit to the academic material.

For the design of the material, different tools were used that were free or at least had a demo for their use (Figure 2).

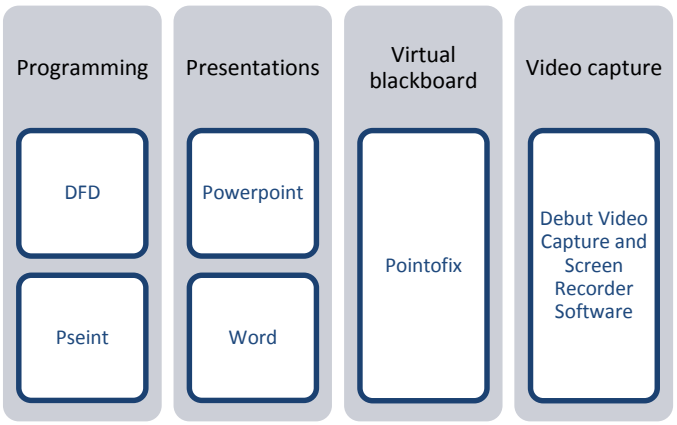

Fig. 2. Tools for content creation.

DFD is a software for the development of flow diagrams by means of an editor and interpreter, which remains free in its version 1.1 with all its functionalities and in Spanish (Figure 3).

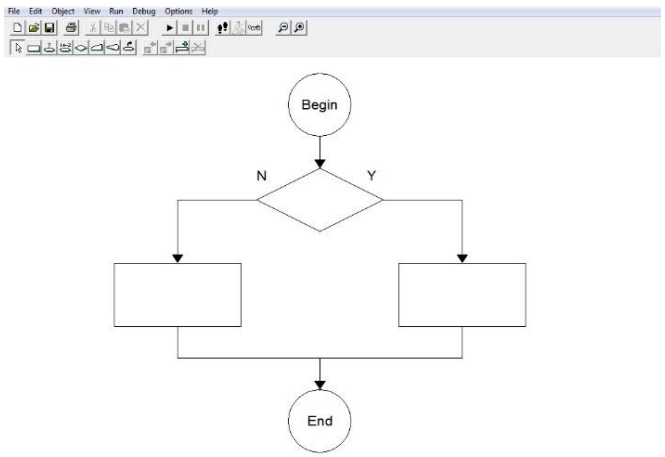

Fig. 3. DFD interface.

Pseint is a programming tool designed for learning programming logic in the Spanish language. The presentation documents are created in popular tools such as Powerpoint and Word, while the virtual whiteboard is managed by Pointofix

(Figure 4), with which you can share everything you write, draw and develop on the computer screen, being a tool that is displayed in the foreground. The video capture and development was done with Debut Video Capture Software in test mode.

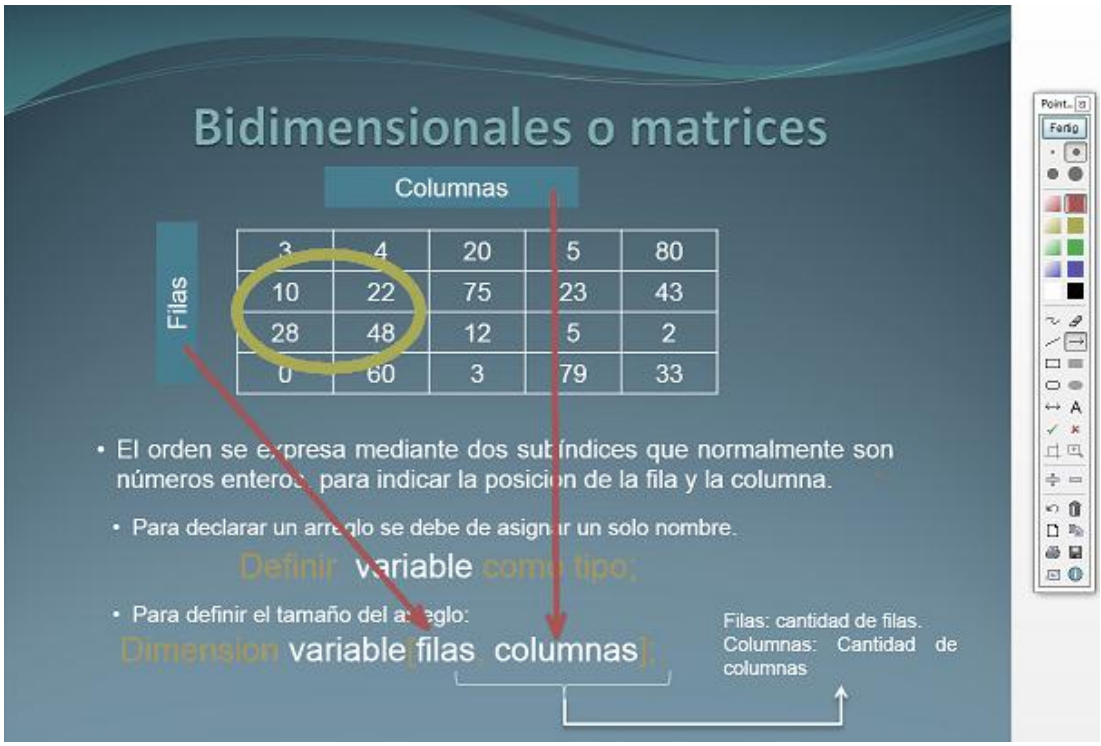

Fig. 4. Pointofix interface.

3. RESULT

Table 1 shows the time of each of the videos. Where the length of time of the videos with greater extension is presented in the videos where each topic is explained in detail, and less time for clarification exercises. The long videos, besides leaving questions for the student to investigate the topic, give more emphasis on the explanation, due to the request of the students who want to have more advanced knowledge of the topic, before immersing themselves in their own learning, however it was demonstrated that the length is not appropriate to maintain an interest in viewing the video, since the short videos were viewed and understood among more students, which is why it is advisable to reduce the size to an average of no more than 12 minutes (table 1).

Table 1. Duration of videos with each class

VIDEOS	TIME
Programming presentation	3
Numbering systems	17.24
Algorithms	20.51
Pseint structure	11.21
Solution analysis and table exercise	18.53
Coding exercise	9.11
Single and double structures, create conditions	23.27
Single and double conditional operation	7.3
Solved conditional exercises	23.3
Solution to exercise 8	12.2
Solution to exercise 9	12.44
Solution to exercise 10	15.23
How the multiple conditional works	21.42

Solution to exercise 14	21.17
Solution to exercise 15	18.04
Solution to exercise 16	21.08
Counter and adder	12.43
Solution to exercise 17	14.08
Desktop test	6.26
Solution to exercise 18	10.48
Solution to exercises 19 and 20	18.44
Solution to exercise 17 structure while	20.35
Solution to exercise 18 structure while	14.42
Solution to exercise 22	8.28
Solution to exercise 23	12.56
Solution to exercise 24	25.46
Explanation of flag variable, exercise 25	23.58
Breaking cycles. Exercise 26	6.47
Solution to exercise 27	12.03
Structure repeat	12.27
Solution to exercise 28	13.15
Structure for	12.14
Solution to exercise 29	9.53
Vector operations 1	21.06
Vector operations 2	15.57
Solution to exercise 38	34.46
Matrix operations. Exercise 39	27.58

In Figure 5, the use of digital whiteboard tools can be observed, just as it can occur in a face-to-face class, so the exercises to expand the topic have been more effective with the difference that the longer videos are viewed by fewer students, regardless of the tools or interactivity used, it is advisable to make an analysis of the problem with less than 5 minutes of duration, leaving enough time for the resolution of the problem.

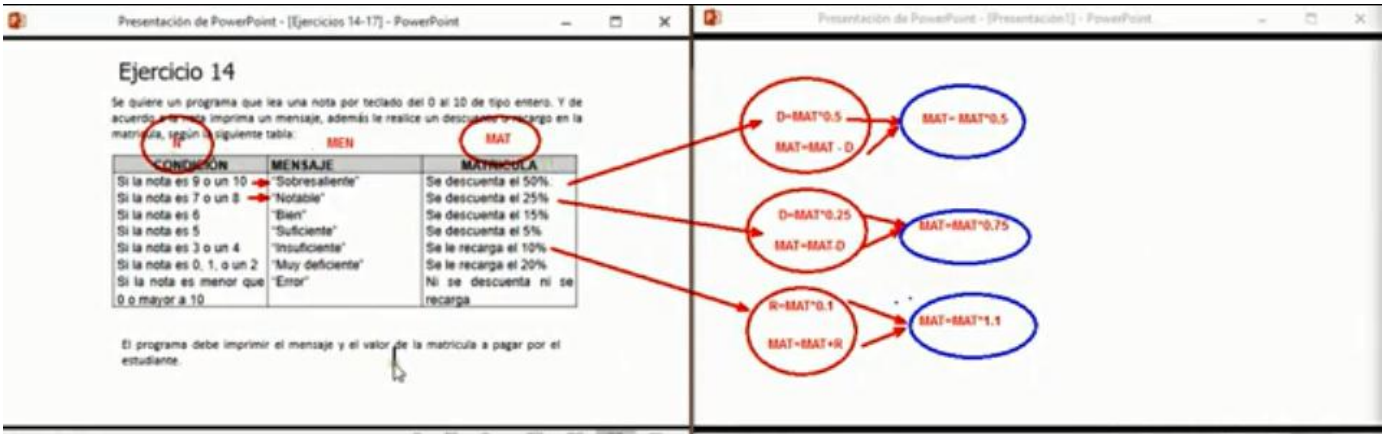

Fig. 5. Problem analysis

Figure 6, shows the coding of the program that delivers a solution to the problem using electronic tables. If the analysis and solution can be divided into different videos, it can improve the student's attention and search for information. In this way the student can follow a pattern to understand, analyze and review the topic to be covered before a given class, making a flipped classroom effective.

The flipped classroom can be divided into time slots to present by the student the stages of solution of the topic to be addressed, which achieves a more effective participation of all students who comprise a class, presenting the same length of the videos but divided into different fragments.

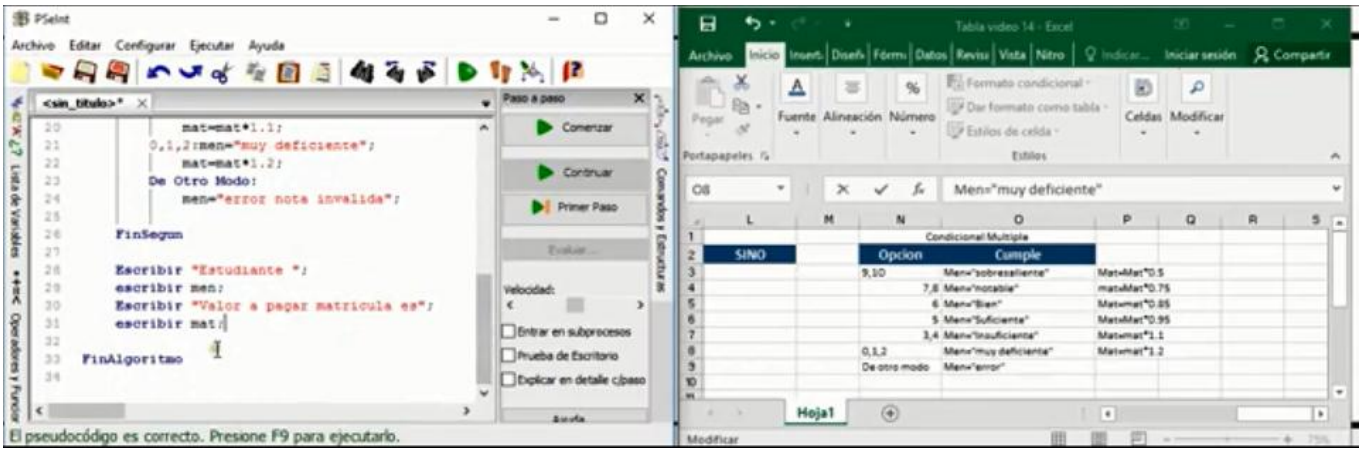

Fig. 6. Coding of the program.

4. CONCLUSION

The use of the flipped classroom is a necessary methodology to engage the student in learning and is essential at times when, due to Covid-19, classes must be conducted virtually. The design and use of the appropriate tools can help to make a successful class, taking into account the duration time of the videos, as well as the animation in each video explanation, which will allow implementing the classes in an inverted way, involving the student in his own teaching. The teacher can give feedback with his own explanations of the subject where he finds a greater deficiency of the group in each subject, and make more effective and shorter videos.

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