Micro flip teaching – An innovative model to promote the active involvement of students

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The use of the flip teaching methodology, a new trend in educational innovation, has had a significant impact. It has led to the creation of spaces that provide online video for use in the classroom while also encouraging the active participation of students. However, the implementation of this methodology can be problematic in the classroom. A new micro flip teaching module has been designed and implemented to resolve these issues.

The main objectives of this research were to measure the impact of learning, to determine the degree to which students are involved in the process through the creation of learning resources and to measure how participating students view their experience of micro flip teaching. This model incorporates answers to issues that currently pose a barrier, such as link activity or the major effort that would be required to change an entire course design.

The results show that the micro flip teaching model has a direct impact on student learning. The study offers proof that the model is not in any way subject-dependent nor does it require a great effort for students to adapt. Student perception of the usefulness of the model is based more on the methodology itself than on either course content or the teachers participating in the experience.

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1. Introduction

To enable students to master subjects without using the classic memorising content process, based on passive attitudes where students are passive recipients of information, it is necessary to look for active and constructive strategies (Ritchhart, Church, & Morrison, 2011). The teacher must shift learning responsibility to the student, focusing it on him or her (Roehl, Reddy, & Shannon, 2013). Active learning can therefore be defined as any method or instructional pedagogy that engages students in the learning process (Prince, 2004). This method is facilitated by the use of technologies that allow greater interaction between students and the experience and knowledge of others (Lasnier, 2000). Active learning is focused on students and their commitment to the learning process (Prince, 2004).

In traditional training models (based on educational paradigms), learning occurs in two phases: transmission and assimilation (Gómez, 2002). In the transmission phase, teaching is carried out via lectures (knowledge transmission) and the provision of support resources (resources transmission) (Brahimi & Sarirete, 2015). In the assimilation phase, students apply the information acquired in the transmission phase to their tasks, laboratory practices or cooperative activities (Shryock, 2015). In some subjects, teachers are present at the assimilation stage (e.g., in laboratories), whereas for other subjects teachers are not usually present (e.g., completing tasks, homework or collaborative work). Face-to-face classroom teaching is based on master lectures in the classroom, where
students usually passively listen to a teacher’s explanations (Sein-Echaluce Lacleta, Fidalgo Blanco, & García-Peñalvo, 2015). Likewise, students are usually asked to carry out certain activities outside school. At the primary and secondary educational levels, these activities are often called homework and are done at home. At the higher education level, these out-of-classroom activities are often called tasks and students usually do them at home, in libraries or at other university facilities. Based on these characteristics, society has a vision of education that could be summarised as “lessons at classroom and homework at home”. Represented at every educational level, this model has been applied for decades. Known as the teaching-based model, it is often associated with passive student learning.

Flip teaching (FT) introduces a complete change of perspective by looking for the student’s active involvement in the learning process. It works by alternating the two main activities of the traditional model: lectures and homework. The key change is that lessons are conducted at home and homework in class (Lage, Platt, & Treglia, 2000).

In 2000, a number of authors raised this idea of swapping the location where the two main activities of the traditional model take place (lessons in the classroom and homework at home). Lage called it the inverted classroom (Lage et al., 2000), whereas Baker called it classroom flip (Baker, 2000). Since then this switch of activities has been called the flipped classroom, flipped learning or FT. This paper considers FT to be the most widespread and descriptive name for this new educational process. The common aspect for the process that all these names identify is that classes are replaced by videos, reading or any other activity that students can do independently outside of class time. The classroom becomes a meeting point where practical activities are performed cooperatively (Angelini & García-Carbonell, 2015; Fulton, 2014; Shryock, 2015).

Apart from these guidelines, there is no shared model for FT (CCL GUIDE, 2013; Bachnak & Maldonado, 2014; Galway, Corbett, Takaro, Tayloran, & Frank, 2014). Although there is general agreement in the research literature about the use of video to replace lectures, there is no uniformity in terms of duration or complementarity with other resources such as presentations, reading, book chapters, websites, etc.

There is also no agreement regarding the way in which the interaction happens in the classroom. The most common models include problem posing, cooperative solving and teacher-student interaction to answer questions. There is agreement regarding the effort required for the application of this method (Danker, 2015; EDUCAUSE, 2012; Herreid & Schiller, 2013; Simpson & Richards, 2015). In addition, most research on FT is based on measuring how useful the method is perceived to be both by teachers and students (Yoshida, 2016). There is, however, very little measurement of FT’s impact on learning.

This lack of specific guidelines and models is typical of innovations such as FT that are currently popular. It takes an estimated period of two years for a model to be consolidated and stable over time (University of Minnesota, 2016).

The next section, Foundations and Proposals, describes the general framework of FT and gives the aims and objectives of the paper. The following two sections describe the experimental design of the proposed model, analyse its new features in contrast to current models and explore model exportability guidelines. In the Results section, the outcomes of this work and the qualitative and quantitative analysis results are presented. Finally, the results are discussed and conclusions drawn.

2. Foundations and proposals

The FT model suggests that transmission activities can be carried out without the physical presence of teachers, whereas assimilation takes place in the presence of teachers. In this way, interaction is promoted between pairs (Brahimi & Sarirete, 2015); knowledge is applied through classroom activities in cooperation with students and teachers (de Oliveira Fassbinder, Fassbinder, & Barbosa, 2015). FT is based on a model where the basic principle is that there are activities outside the classroom where transmission is applied and classroom activities where assimilation is cooperatively applied. Except for these guidelines, there is no standardized application model, as discussed in the introduction, nor are there any specific activities outside or inside the classroom.

However, there is agreement on the important changes that are required for courses that use FT. The Flipped Learning Network (FLN) has defined the FLIP model as being based on the following four pillars (Hamdan, McKnight, McKnight, & Arfstrom, 2013): a flexible environment, a learning culture (changing role of teachers), intentional content (to encourage student participation) and a professional educator (professional trainer). Another example can be found in the proposal made by Bergmann and Sams (2012) who argue that to apply FT requires increased interaction between students, that students acquire responsibility for their own learning, that teachers act as guides in the classroom, and that virtual storage spaces, contents and classes are required where students can conduct learning activities.

Techniques based on learning analytics can be measured and collected. Current data relating to students and their environment (García-Peñalvo, Fidalgo-Blanco, Sein-Echaluce Lacleta & Conde-González, 2016) may affect decision-making processes related to improved learning (Conde-González & Hernández-García, 2015). As a result, work outside the classroom can be measured using electronic media. This generates new opportunities for observing the relationship between student participation and performance (Gómez-Aguilar, García-Peñalvo, & Therón, 2014, García-Peñalvo and Seoane-Pardo, 2015).

It is desirable to provide new knowledge on measuring results. This includes the impact of method on learning outcomes, as opposed to measuring how useful teachers and students perceive the method to be, which is the case in the vast majority of research studies (Yoshida, 2016).

This paper provides new knowledge to help strengthen the FT method. To achieve this aim, the impact of FT on learning and consolidation was analysed. A simple and improved state of the art model based was introduced. This model does not require a large investment of effort and can be adapted to any course. There is no need to adapt the classroom, as has been suggested by some authors (Bergmann & Sams, 2014; Ramirez-Montoya and Ramirez-Hernández, 2016). In addition, in FT, the learning process is enhanced with learning resources generated by the students.

The application model presented in this paper is called micro flip teaching (MFT) and was implemented for a traditional classroom course (García-Peñalvo et al., 2016). The model establishes a link between the activities outside and inside the classroom. For the small part of the subject matter covered by the course, the model promoted student participation through the methodologies of active learning (Freeman et al., 2014). The use of conventional lectures was reduced, without being entirely cancelled.

To analyse and interpret the interactions that occur between students, teachers and platforms where learning occurs through FT, it is necessary to measure, collect, analyse and present the data through learning analytics (García-Peñalvo & Sein-Echaluce Lacleta, 2015).

The main objective of this paper is to measure the impact of FT on learning. It also offers an easy-to-use solution that can be applied to any course, without great effort on the part of teaching staff. Other specific objectives of this paper are to:
• Measure the impact of MFT on learning and knowledge retention.
• Determine the level of involvement of students using this method through the creation of learning resources.
• Measure how participating students view their experience of the MFT method.

3. Experiment design

This study was based on part of the Programming Fundamentals course at the Technical University of Madrid, included within the Science, Technology, Engineering and Maths (STEM) disciplines. The course is part of the first year of the Biotechnology degree and has 131 students organised into two groups: 68 students take the course in the morning and 63 in the afternoon. The distribution of students is organised by the school secretary using alphabetical criteria. A random group of 68 students (the morning group) was chosen for the experiment. The afternoon group was chosen for contrast and as a control group.

The experiment was performed in a block of five sessions, with two hours per session. The first three sessions had a strong theoretical component with regard to the research in this paper. The first session was given to the two groups in a traditional way (by lecture). This enabled us to ask a question of common control that served to establish the equivalence of the two groups. The next two sessions were held using the MFT model for the experimental group and traditional methods for the control group.

The duration of sessions was identical for both groups. Each session for the experimental group lasted 100 min, taking into account both classroom and non-classroom locations. The same duration held for the control group, in this case fully face-to-face. It was important to match the total time spent to ensure that both groups had an identical workload. In many FT studies, time spent teaching outside the classroom is not counted. Although this is correct from the organizational point of view, the experimental group would have more work than the control group, if this time were excluded, and this would affect the validity of the results.

After the third session, an identical questionnaire was presented to each group, with no prior notice. The questionnaire consisted of five questions (Qn). Q1 referred to the first session, given 30 days before. This was a control question because both groups were taught using the same method (a conventional lecture) in the first session. The following two questions (Q2 and Q3) referred to the second session, given 15 days before (with the experimental group using the MFT model and the control group using the traditional method). It is worth noting that the third question, simple and with a low rate of discrimination, was useful for checking learning retention. The final two questions (Q4 and Q5) referred to the third session. Here, as well as looking to see whether there were significant differences between the two groups, the questions aimed to measure immediate learning with questions about the topics covered in this last session. The methods used in each session can be seen in Fig. 1.

The survey included questions about learning and enthusiasm from the Student Evaluation of Educational Quality (SEEQ) survey (Marsh, 1982). The goal was to verify that these two variables were equivalent in the experimental group, which might otherwise detract from validity in the test results. Students in the experimental group were then asked how they viewed the MFT method compared to traditional methods. This survey consisted of 16 closed questions based on the Likert scale and 3 open questions: “That’s what I liked about the method”, “That’s what I disliked about the method” and “Improving the method”.

The survey also took into account the work generated by the students at the link stage because this is an indicator of active student participation as a learning resource.

The following section analyses the quantitative results (examination and number of jobs generated individually), qualitative results (questions on learning and enthusiasm) and the questions that compare MFT with traditional methods.

4. The MFT model

In addition to the traditional set of activities (in class and outside class), this paper incorporates a third type of activity known as link activity, as shown in Fig. 2(a). The MFT model is so named because one of its features is that it can be applied to only part of a course. Another feature is its ease of application. This section analyses and justifies the model.

4.1. Out of classroom activity

The aim of this module (Fig. 2(b)) is usually to take the lecture outside the classroom. Our model takes into account the length of video and includes controls to ensure that participants have seen the video and to ensure that it provides the same functionality that students have in a lecture. This includes opportunities to ask the teacher questions, to have a dialogue between the audience and the teacher and for teachers to recommend additional material.

4.1.1. Video length

The idea here is not to include the entire lecture, but only the most significant parts of it and to start applying concepts. The video used in the model is about 10 min in duration because cognitive studies show that the novelty of any stimulus tends to disappear within 10 min. After that length of time, humans tend to look for new content (Medina, 2008). In our study, we made a single FT video session, enabling the student to focus on the most important part of the lecture. For these reasons, it is the teachers themselves who must record the video.

4.1.2. Verifying that participants have seen the video

Each video has an associated mandatory questionnaire that students must answer. In this way, it can be established that participants have seen the video and understood the most important parts.

4.1.3. Opportunities to make and answer questions, comments and reflections

In most research work, questions are resolved in the classroom session (Nwosisi, Ferreira, & Rosenberg Walsh, 2016; Strayer, 2012; Lage et al., 2000; Yoshida, 2016). We have chosen to add a doubts forum along with the video session because research indicates the need for assistance at home (Yoshida, 2016) as it is a time when students have less guidance (Strayer, 2012). Both teachers and students can participate in the forum. The forum has two objectives: (1) to respond in the shortest time possible to any questions that arise when viewing the video and to give instant feedback; and (2) to promote student-student interaction as it has been shown that such interaction improves learning (Fidalgo-Blanco, Sein-Echaluce, García-Peñalvo, & Conde, 2015).

4.1.4. Additional material

The student is provided with additional material that can extend, supplement or reflect on what is presented in the video. The teachers themselves may provide such material or it may be provided as an external resource.
4.2. Link activity

Link activity (Fig. 2(c)) is important as it allows the student to make a connection between the lesson at home and classroom activities (Strayer, 2012). A common mistake in FT models relates to the use of switch activities that occur in traditional methods. An example is when lectures are videoed verbatim for use outside the classroom. FT is more than this and requires the student to be an active subject in his or her learning (Galway et al., 2014), to have greater involvement in learning and to have an opportunity to apply what he or she has learned (Bachnak & Maldonado, 2014). This activity is a task that students must perform individually, applying concepts demonstrated in the video. Therefore, in this activity students generate learning resources, which have three objectives: (1) to check the degree of assimilation of the concepts in activities outside the classroom; (2) to generate educational resources for use in classroom activities; and (3) to get students to be active subjects and to be more involved in the learning process, including home activities, where students are usually more passive. In addition, this activity enhances the usability of the knowledge.
generated by students as a learning resource (Sein-Echaluce, Fidalgo-Blanco, & García-Penalvo, 2016).

Two modes are proposed when carrying out activities: (1) activities are visible to all students; and (2) activities can only be seen by teachers. In the first mode, a student can see the activity of their peers once uploaded (thereby avoiding possible copies). This mode seeks to build a debate between students and results can be compared between tasks. The second mode, in which only the teacher can see the work, seeks to take advantage of the surprise factor used as an educational aspect.

In both cases, the activity is sent through the Moodle platform, where the course is located. In the first mode, the activity is uploaded to a Questions and Answers (Q&A) forum where, once their task has been published, students can see the other results. In the second mode, the activity is sent to the teacher by uploading it as a task resource on the platform.

Link activity is carried out online, using a forum of doubts, reflections and comments available in the previous section of the course. In this way students can interact with other students and teachers.

4.3. Classroom activity

In classroom activity (Fig. 2(d)), students and teachers meet in person. The objective is that interaction, participation and cooperation occur among the people present. For this reason it is important to use the results of the work carried out by the students in the previous session. In our case, the students presented the results of their work. The teacher uses these results to trigger debate with other students (for example, a student with different results shares his/her opinion establishing a discussion to see which results are more valid). Again two modes are proposed: one in which teachers have previously chosen an activity to use in the classroom and another in which the student can choose to present their work voluntarily. This study used both systems at each session.

Once there has been debate, interaction and participation, pooling is carried out. The objective of this sharing is to link what has been discussed with the following topics. The usual format for this activity is a brief lecture.

After the lecture, cooperative work begins where learning resources from outside the classroom sessions and those in the classroom are put into practice, promoting active learning by students.

4.4. Structure of the proposed method

This method is applicable to any subject and each section is easy to implement. In this research, free video screencast programs were used (where only a laptop is necessary), whereas other activities used a free LCMS, Moodle, for example.

Lecture sessions in college are two hours in length (with a 20-min break). As a result, in the MFT model, we defined a time for each section as shown in Fig. 2(e), where t1 corresponds to the time out of classroom and t2 to classroom time. The complete duration was equivalent to a 2-h classroom session. In FT, this duration could vary depending on the length of face-to-face sessions.

The total length of each MFT session was approximately 100 min. Activity outside the classroom and link activity occur online. The duration of these activities is approximately 45 min. It is recommended that the total length of activities outside the classroom should be between 10 and 20 min. Depending on the length of the video, this time includes watching the video, performing the test, participating in the forum and browsing the supplementary material. Link activities (assimilation and execution) should not exceed 30 min. Classroom activity has a total duration of about 50 min: 15 for discussion, 10 for the mini lesson and 25 for cooperative work. This leaves a margin of more than 10 min based on the complexity of the subject matter or the cognitive activity to be boosted.

5. Results

5.1. Homogeneity of groups and scope of content

To identify the homogeneity between the control group and the experimental group, where the MFT model is applied, the performance and the factors associated with the format developed in both groups were analysed prior to the study. This first block was independent. The same teachers, documentation and format were used in both groups and no FT was applied. This block used cooperative methodology with three to five teams and a course forum on the Moodle platform for communication support.

This procedure is based on that of Mason, Shuman, and Cook (2013), where homogeneity was sought by comparing the group in similar subjects. In our case, we worked on the same subject in two different blocks.

In Fig. 3 we can compare the grade point average (GPA) obtained by each student group. In addition to the GPA, two other variables that characterise the activity and the results of students in this block are shown. The first variable utility is part of the final grade of the block and was calculated based on the implementation of a task to provide a solution to the topic (usually all tasks meet a specific need) and the knowledge provided by students against generic information that can be found on the Internet, according to criteria provided by the teacher. The second variable — messages in the forums — analyses the level of activity generated by the student groups. The third variable is the work assessment. The average scores of the results obtained in both the control and the experimental group show no significant differences in the U of Mann-Whitney test, with a p-value 0.814, taking a significance level of 95%.

A logistic regression (Agresti, 1996) was used to look for and establish whether there were connections between belonging to the control or experimental sample using the three variables that characterise the group work. The applied model is based on a function that has a dichotomous dependent variable (the group to which they belong) and three independent variables: one qualitative (utility) and two quantitative (the number of messages in forums and the marks).

There were no significant relationships between the study variables and the dependent variable Z, according to the p-value of the analysis of logistic regression variance, which scored a significance...
level of 95% (p < 0.05). The results are shown in Table 1. This result indicates that there are no significant statistical differences between the two groups and suggests that both groups were very similar, in terms of their previous knowledge, before starting the research block in which MFT was applied.

5.2. Student testing and performance

To assess the impact and effectiveness of the methodology outlined here, student performance was studied and compared using a final questionnaire that was presented at the end of the block of study in which MFT was applied, as described in the previous section.

Since the data do not meet the normality assumption, according to the Shapiro-Wilk and Kolmogorov-Smirnov test, the existence of significant difference is compared between analysis groups by the U Mann-Whitney test in two independent samples and the Z of Table 2.

In the three sessions used with the MFT model were compared, as described in the previous section.

Since the data do not meet the normality assumption, according to the Shapiro-Wilk and Kolmogorov-Smirnov test, the existence of significant difference is compared between analysis groups by the U Mann-Whitney test in two independent samples and the Z of Kolmogorov-Smirnov test. The mean score of questions from each of the three sessions used with the MFT model were compared, as shown in Table 2.

Table 2 shows that the average mark has no statistically significant differences (p-value > 0.05). The score obtained in Q1 (control question) by the experimental group is 3.79 points out of 10, slightly lower than the control group (at 4.28). The same happens with Q2, with a low rate of discrimination. On the other hand, questions Q3, Q4, and Q5 (associated with FT sessions) do show significant differences between the two groups, with average scores more than three points higher in the experimental group when compared to the control group.

5.3. Student perceptions of teaching and teachers

The results of the survey completed by students after the third session about their perception of learning for both groups were similar, yielding no significant differences in test Chi-square values (χ²), with p-value <0.5. As shown in Table 3, student perception of teachers is very similar in both groups when dealing with the level of enthusiasm of the teacher, whereas there seems to be a greater acceptance of classwork in the control group, with 3.63% versus 3.43% in the experimental group.

5.4. Student perception of MTF methodology

Student perception of the MFT methodology was studied using a perception survey with both closed and open questions. From this first assessment, it should be noted that over 80% of students agreed or strongly agreed that classes that incorporate this method into classroom activity were much more dynamic than face-to-face sessions. Among the activities outside the classroom, 83% of students believed that this method allowed them to better understand the topics covered in the classroom. Finally, over 95% students were in agreement or strongly agreed that this method allowed them to go to class with an existing and conceptual vision of the topics: 67% of students disagreed or were neutral regarding the fact that they asked more questions in class when applying this methodology. The full survey results are available in Appendix A.

Table 1
Logistic regression: p-value from analysis of variance of the variables.

<table>
<thead>
<tr>
<th></th>
<th>(Min-Max)</th>
<th>Mean (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messages</td>
<td>(152–478)</td>
<td>270.32 (110.571)</td>
<td>.779</td>
</tr>
<tr>
<td>Work assessment</td>
<td>(18–30)</td>
<td>24.31 (3.985)</td>
<td>.612</td>
</tr>
<tr>
<td>Utility</td>
<td>(1–3)</td>
<td>2.16 (3.834)</td>
<td>.864</td>
</tr>
<tr>
<td>N valid (as listed)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.4.1. Construct analysis of MFT method perception

It is necessary to analyse how students perceive the utility of working with this methodology in more depth. To do this, a model was defined based on the MFT method perception survey in order to identify the different constructs that define MFT and how they influence the perception of students in improving their attitudes towards learning.

This analysis seeks to prove the existence of causal relationships within the MFT model and aims to explore the existence of a correlation between the variables defined by the MFT model with regard to active learning and improving learning attitudes. To do this, we relied on the FLIP model (Hamdan et al., 2013) constructs by modifying two additional constructs within the MFT methodology perceptions questionnaire. All questions are shown in Appendix A. Table 4 shows the relationship between the construct developed and the survey.

To verify the reliability, convergent validity and discrimination validity of the 16 close-ended items in the survey, SmartPLS (Ringle, Wende, & Will, 2005) was used as the analytical tool and the verification of the measurement model was based on the following criteria (Chen, Wang, & Chen, 2014):

1. Reliability — composite reliability (CR) has to be higher than 0.7.
2. Convergent validity: (i) all indicators loading need to be larger than 0.7; (ii) and the average variance extracted (AVE) of construct needs to be larger than 0.5.
3. Discrimination validity: (i) cross loading in group loading should be higher than between groups; (ii) construct correlation in between should be lower than 0.85; and (iii) when placing the square root value of the AVE of a construct on the diagonal line and comparing it with the correlations of others, the value should be higher than any correlation to the other constructs.

Descriptive statistics of the MFT model constructs are shown in Table 5. Positive feedback is also illustrated. The results indicate that the measurement is reliable. The mean value for the construct “Improving Learning Attitudes” was 3.78 with 0.84 STD value, which indicates that the students felt improved attitudes to learning when using the MFT methodology.

The structure model was used to explore the possible causal relations between MFT model constructs. As shown in Fig. 4, all the paths reported here using SmartPLS were significant (p < 0.05, ** p < 0.01, *** p < 0.001). Construct analysis reveals that the flexible environment of this model has more influence on the perception of active learning than the intentional content and the professional educator (FLIP teacher) constructs. In addition, active learning contributes directly to the perception of improved attitudes towards learning. Given the small sample, the main objective of this model was finding out how the different constructs affect the perception of students in improving their attitudes towards learning. Active learning has a clear influence on this model.

5.4.2. Qualitative analysis of MFT method perception

The anonymous answers given by students to the open questions in the MFT method perception survey were analysed. The survey was completed by 43 of the 68 students. Table 6 shows the most significant responses and the coincidence rate between students with regard to the first two open questions.

For the third question (“Improving”), the responses were quite varied, emphasising ideas such as improving the immediacy of response, reducing the number of hours or adding more documentation on the Moodle platform. However, 22.2% (10) of students said they would not change anything and even that they would like this methodology to be applied to other subjects. Some interesting answers were received. One student suggested the idea of using
videoconferencing to replace all face-to-face classes, whereas another student stated that it would be interesting to allow video downloading so that the videos could be watched offline, for example, when on public transport. Two students agreed that it would be interesting to propose more classroom discussions involving all students as part of the method.

6. Discussion and conclusions

The main objectives of this research were to measure the impact of learning, to determine the degree to which students were involved through the creation of learning resources and to measure how experience of the MFT method was perceived by participating students. For this purpose, a new model was designed and implemented. This new model incorporates answers to issues that currently pose a barrier, such as link activity or the major effort that would be required to change the design of an entire course.

With regards to measuring the FT impact on learning, we first determined that the people who participated in the experimental and control groups were homogeneous, as well as looking at the academic context in which they participated.

The homogeneity of the groups was demonstrated as there are no significant differences between the mean scores of the groups in the control block. The homogeneity of the two groups was also demonstrated as there is no relationship between belonging to one group and the control variables defined in this block. The analysis of other factors external to the MFT model, such as the perception of the enthusiasm of teachers and the degree of learning, did not provide meaningful relationships between the two groups. This procedure shows that only the independent variable, the MFT method, has significant relationships with the results obtained in both groups. The marks show that the independent variable affects two situations: improvements in learning the contents that have just been presented in a training session and improvements in learning the contents of previous training sessions. The results obtained in the Q2, Q4 and Q5 questions confirm significant differences between the two groups, with an average increase in marks of 37% in the experimental group versus the control group.

### Table 2

Average and standard deviation of comparison of exam questions grouped by session.

<table>
<thead>
<tr>
<th>Question/session</th>
<th>Experimental group (EG)</th>
<th>Control group (CG)</th>
<th>U of Mann-Whitney test</th>
<th>Z of Kolmogorov-Smirnov test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>p-value</td>
<td>p-value</td>
</tr>
<tr>
<td>Q1/S1</td>
<td>3.79 (2.97)</td>
<td>4.28 (3.18)</td>
<td>0.278</td>
<td>0.711</td>
</tr>
<tr>
<td>Q2/S2</td>
<td>8.06 (1.9)</td>
<td>8.41 (2.83)</td>
<td>0.000&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>Q3/S2</td>
<td>9.81 (1.35)</td>
<td>9.3 (1.6)</td>
<td>0.499</td>
<td>1.000</td>
</tr>
<tr>
<td>Q4/S3</td>
<td>9.27 (1.67)</td>
<td>5.8 (3.89)</td>
<td>0.000&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>Q5/S2</td>
<td>9.81 (1.35)</td>
<td>5.45 (4.91)</td>
<td>0.000&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.000</td>
</tr>
</tbody>
</table>

<sup>*</sup> Statistically significant results p < 0.05 and p < 0.01.

### Table 3

Result of survey about perception of the class and statements to which responses were significantly different.

<table>
<thead>
<tr>
<th>Question</th>
<th>Experimental group</th>
<th>Control group</th>
<th>Chi-square value ($\chi^2$)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I thought it was pleasant and challenging</td>
<td>3.43 (0.796)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.63 (1.018)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>6.957</td>
<td>.138</td>
</tr>
<tr>
<td>I learned more things I consider interesting than I expected</td>
<td>3.43 (0.965)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.56 (0.975)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.368</td>
<td>.498</td>
</tr>
<tr>
<td>My interest in the subject of computers has increased</td>
<td>3.12 (0.959)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.07 (1.009)</td>
<td>1.380</td>
<td>.844</td>
</tr>
<tr>
<td>I think what I learn can be applied outside the subject</td>
<td>3.60 (0.892)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4 (1.024)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>7.437</td>
<td>.115</td>
</tr>
<tr>
<td>Teacher enthusiasm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has shown enthusiasm and given explanations</td>
<td>4.14 (0.683)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4.14 (0.792)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>2.004</td>
<td>.572</td>
</tr>
<tr>
<td>Has been dynamic and active</td>
<td>4.12 (0.815)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4.12 (0.953)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>1.893</td>
<td>.595</td>
</tr>
<tr>
<td>Enjoyable classes</td>
<td>3.75 (0.887)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.75 (1.043)</td>
<td>2.321</td>
<td>.577</td>
</tr>
<tr>
<td>Get hold of my attention during exposure</td>
<td>3.62 (0.981)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.56 (1.025)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>1.494</td>
<td>.828</td>
</tr>
<tr>
<td>Answered student questions</td>
<td>4.14 (0.798)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4.24 (0.833)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>7.106</td>
<td>.130</td>
</tr>
</tbody>
</table>

<sup+a</sup> Statistically significant results, p < 0.05.

<sup>+</sup> Likert scale 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

### Table 4

5 constructs and 16 indicators arranged for the survey.

<table>
<thead>
<tr>
<th>Flexible environment</th>
<th>Professional educator</th>
<th>Improving learning</th>
<th>Attitudes</th>
<th>Intentional content</th>
<th>Active learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q01 (1–2) (q1) (q2)</td>
<td>Q03 (1–3) (q5) (q6) (q8)</td>
<td>Q04 (1–2) (q9) (q10)</td>
<td>Q05 (1–3) (q11) (q12) (q13)</td>
<td>Q06 (1–3) (q14) (q15) (q16)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5

The descriptive statistics of the MFT model constructs.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cronbach’s alpha</th>
<th>Composite reliability</th>
<th>Mean</th>
<th>STD</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Learning</td>
<td>3</td>
<td>0.860</td>
<td>0.785</td>
<td>3.81</td>
<td>0.886</td>
</tr>
<tr>
<td>Flexible Environment</td>
<td>2</td>
<td>0.869</td>
<td>0.865</td>
<td>3.86</td>
<td>0.872</td>
</tr>
<tr>
<td>Improving Learning Attitudes</td>
<td>2</td>
<td>0.863</td>
<td>0.841</td>
<td>3.78</td>
<td>0.840</td>
</tr>
<tr>
<td>Intentional Content</td>
<td>3</td>
<td>0.865</td>
<td>0.808</td>
<td>4.07</td>
<td>0.759</td>
</tr>
<tr>
<td>Professional Educator</td>
<td>3</td>
<td>0.822</td>
<td>0.889</td>
<td>3.78</td>
<td>0.862</td>
</tr>
</tbody>
</table>
Although other studies have shown that the application of FT has positive results for learning (Collard, Girardot, & Deutsch, 2002; Day & Foley, 2006), the entire subject was taught using the FT model in these studies. This study demonstrates that it is not necessary to transform the whole subject for improvements to the implementation of FT. Other studies highlight the need to develop existing resources and/or develop new resources (Mason et al., 2013). This can generate high cost and time resources when the subject is designed with the FT format, assuming a barrier for teachers to incorporate this methodology in a complete course. In contrast, the generation of MFT blocks, as shown here, minimises this time and cost and decreases part of the barrier presented to certain teachers in the incorporation of these methodologies. The MTF model reduces the effort required by teachers as it does not propose moving away from the lecture format completely. It is only necessary to perform a 10 min video with the most relevant parts of the lecture.

This study provides more detail on the treatment of control variables in contrast to other studies. Consequently, the results have more relevance and validation. The lack of relationship with other external factors to the MFT model when looking for significant relationships between the two groups suggests that the model itself improves these results. These findings are in line with the results of other studies (Mayer & Moreno, 2003).

Regarding student perception of the FT method, it should be kept in mind that the results may be influenced by a refusal to accept new models due old habits of passive learning (Chen et al., 2014). However, there was, in general, a positive perception with regard to this method as more than 80% of students agreed that classes that incorporate this method into classroom activity are much more dynamic and also enable them to better understand the topics discussed in the classroom. In addition, 95% of students believe that this method improved their preparation before class attendance. These results are similar to other research applied to FT in higher education (Bachnak & Maldonado, 2014; Galway et al., 2014; Tanner & Scott, 2015). In this way, and considering that this is a preliminary course for students, this study supports the idea that the introduction of these methods can more easily involve students in active learning (Freeman et al., 2014; O’Flaherty & Phillips, 2015).

The analysis of relationships between variables of perception and the MFT model has shown that the flexible MFT environment has a greater influence on active learning, which, at the same time, benefits improvements in the perception of the participants regarding their attitudes towards learning. These causality relationships support the assumption that implementing the model is of greater importance than the contents of any particular course or the particular teachers who applied the model. This feature

Table 6
Open survey questions.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
<th>Match rate (N° students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>That’s what I liked about the method</td>
<td>Prior knowledge of matter is going to be seen in class</td>
<td>15 (34.8%)</td>
</tr>
<tr>
<td></td>
<td>Able to always have videos and repeat viewing</td>
<td>10 (22.2%)</td>
</tr>
<tr>
<td></td>
<td>To see the videos when desired</td>
<td>9 (20.9%)</td>
</tr>
<tr>
<td>That’s what I disliked about the method</td>
<td>It requires more time watching videos or work at home</td>
<td>9 (20.9%)</td>
</tr>
<tr>
<td></td>
<td>Lack of immediacy in resolving doubts</td>
<td>8 (18.6%)</td>
</tr>
<tr>
<td></td>
<td>Videos repeat the same seen in class</td>
<td>6 (13.9%)</td>
</tr>
<tr>
<td></td>
<td>Problems with technology (connection, platform, etc.)</td>
<td>5 (11.6%)</td>
</tr>
<tr>
<td></td>
<td>Very long videos</td>
<td>5 (11.6%)</td>
</tr>
</tbody>
</table>

Fig. 4. The structure model of the survey questionnaire.

<table>
<thead>
<tr>
<th>Q01_1</th>
<th>Q02_1</th>
<th>Q03_1</th>
<th>Q03_2</th>
<th>Q03_3</th>
<th>Q04_1</th>
<th>Q04_2</th>
<th>Q05_1</th>
<th>Q05_2</th>
<th>Q05_3</th>
<th>Q06_1</th>
<th>Q06_2</th>
<th>Q06_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.876</td>
<td>0.870</td>
<td>0.904</td>
<td>0.731</td>
<td>0.721</td>
<td>0.842</td>
<td>0.630</td>
<td>0.743</td>
<td>0.513</td>
<td>0.886</td>
<td>0.906</td>
<td>0.794</td>
<td>0.423</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Flexible Environment</td>
<td>Professional Educator</td>
<td>Active Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

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<td></td>
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<tr>
<td></td>
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</tr>
</tbody>
</table>
enhances the exportability of the model to any type of subject.

The model incorporates an important new feature compared to other models, that is, link activity. This activity involved students doing individual work after seeing the video at home. A total of 100 tasks were provided in two sessions of MFT, some which were used by teachers as a learning resource. This provides an indicator of student involvement in learning, based both on their ability to do a job after the 10 min video provided and on the usefulness of such work as a teaching resource for the course. These results are consistent with the ideas of Tucker (2012), who raised the need to redesign activities outside the classroom to be better integrated into classes, with active learning pedagogies to enable students to understand the model and to improve motivation to prepare for class. In general, these activities should be integrated into any FT model because this offers a solution to the problem suggested by O'Flaherty & Phillips (2015) who argue that students are less likely to engage in activities outside class if they lack interactivity or are not linked directly to class.

The qualitative study of open answers used the coincidence method to highlight two advantages and two disadvantages. Nearly 40% of open responses agree that knowing a subject prior to being taught in class is a great advantage. With the MFT method, students can learn the subject theoretically before class. The method focuses responsibility on the students and enables them to apply what they have learned through classroom activities and concepts, as emphasised by McLaughlin et al. (2014). Using the MFT method, topics are learned at home through the concepts presented in the video, in a real situation. As a result, in addition to knowing the subject, students can reflect on it and apply it to a real situation, which corresponds to cognitive development as reflected in Bloom's taxonomy (Bloom, Krathwohl, & Masia, 1956) and subsequent revisions (Anderson, Krathwohl, & Bloom, 2001).

Another highlight of the MFT model is the ability to access content when it is desired and as many times as necessary (23.2%). Highlighting this as an advantage is more surprising as it is usual for content to be accessible through LMS systems. It may be because the video (10 min) in this assessment consists of a summary and highlight of the topic to be discussed in class, as recommended by authors like Bachnak and Maldonado (2014). This will be studied in future research as it is possible that the methodological aspects of the content (duration, purpose of the video, format, link activity) are more valued than online access to the content itself.

In any case, responses to the open questions reaffirm the importance of the methodology to the students and teachers versus the content. This may also influence the methodology.

The least liked aspects of the method highlight the extra time that students have to spend on activities at home (20.9%). Here, the results contrast with other research where students do not have this perception (Roehl, Reddy, & Shannon, 2013). This is important because, as stated in the introduction, the MFT model should not make students spend more time on learning than students who are not using the FT method. The students participating in the experimental group knew that the time they spent in the experimental group (activities outside the classroom plus classroom activities) was the same as that spent by the control group. Therefore, this response reaffirms the time distribution of the model proposed and implemented in this study. This model takes into account classroom time in all those subjects where the model is applied. This approach may pose a problem in some cases because the administrative policies of the school or university may offer resistance to the idea of eliminating classroom hours and replacing these videos. It will require local authorities and schools to incorporate these innovations into their programmes and curricula (Brahimi & Sarrirete, 2015). Nevertheless, this result opens an important institutional debate about the need to rethink the regulations applicable to classroom training.

With regard to the speed of doubt resolution (18.6%), the results indicate that this is a disadvantage of the method. It certainly is a disadvantage with methods based on FT (O'Flaherty & Phillips, 2015; Lister, 2014) as the immediacy of providing solutions is a factor that enhances the learning process and encourages participation (Balaji & Chakraborti, 2010; Krause, Stark, & Mandl, 2009). For this reason, the model proposed in this paper provides a forum for questions associated with classroom activities, thus attempting to minimise the time needed to answer any questions. This fact should make authors of works on FT explore how questions relating to activities at home can be resolved during classroom activity. If failure to provide answers to questions means that the student cannot understand a concept video, the student will fail to complete learning, as is known from prior research.

To sum up, the MFT method is easily transferable because it minimises the effort required for implementation and because of its ease of implementation and the effectiveness of the results. These features make the MFT method particularly suitable for a first approach to FT in classroom training.

The results suggest interesting further research into testing the use of the material available online in LMS systems. Link activity also requires more study, primarily with regard to its relationship with the active participation of students and its effectiveness when compared with methods other than FT.

The main line of discussion opened by this study relates to the need for changes in the current legislation to allow a mixture of contact hours and hours online. Changing this policy is likely to influence the consolidation of FT methodologies.

Appendix A. Micro flip teaching (MFT) method perception survey

<table>
<thead>
<tr>
<th>Questions</th>
<th>N</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(q1) More participatory than the classroom sessions without this method</td>
<td>43</td>
<td>2 (4.7%)</td>
<td>17 (39.9%)</td>
<td>16 (37.2%)</td>
<td>8 (18.6%)</td>
<td></td>
</tr>
<tr>
<td>(q2) More dynamic than in face to face sessions without this method</td>
<td>43</td>
<td>1 (2.3%)</td>
<td>6 (14%)</td>
<td>27 (62.8%)</td>
<td>9 (20.9%)</td>
<td></td>
</tr>
<tr>
<td>(q3) Students asked more than in other classes without this methodology</td>
<td>43</td>
<td>1 (2.3%)</td>
<td>11 (25.6%)</td>
<td>17 (39.5%)</td>
<td>11 (25.6%)</td>
<td>6 (14%)</td>
</tr>
<tr>
<td>(q4) Students have reviewed more than other classes without this methodology</td>
<td>43</td>
<td>1 (2.3%)</td>
<td>5 (11.6%)</td>
<td>15 (34.9%)</td>
<td>16 (37.2%)</td>
<td></td>
</tr>
<tr>
<td>(q5) Instructor has asked more questions of students</td>
<td>43</td>
<td>5 (11.6%)</td>
<td></td>
<td></td>
<td>7 (16.3%)</td>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)
References
Brahimi, T., & Sarirete, A. (2015). Learning outside the classroom through MOOCs.


