APFT: Active Peer-Based Flip Teaching

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ABSTRACT

The Flip Teaching model[1] (the lesson at home, the homework in class) has been used to actively engage students in their learning process during the lectures. In this method, passive learning (the lesson) is transferred to homework and the activity (exercises, debates, collaborative learning, etc.) to the class. More advanced Flip Teaching models carry out an intermediate phase in which the students can actively participate "at home", such as Micro Flip Teaching model. This model proposes an on-line activity composed by the learning of the lesson and the realization of an individual micro-activity on the same and then, in class, work on the obtained results in the micro-activity. In this work, the Micro Flip Teaching model has been adapted to carry out the online activity in a collaborative way in work teams. The main novelty of this proposal is that the active participation of the students generates resources that can be used as didactic material in future editions of the subject. To evaluate the impact of this proposal, an experimental group has been established that used resources generated by students from previous subject editions, while the control group used only resources generated by the teacher. The research shows that the resources generated by students are equally effective than those generated by teachers.

CCS CONCEPTS

• CCS → Applied computing → Education → Collaborative learning

KEYWORDS

Flip teaching, Active learning, Cooperative Learning, Peer to peer learning.

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1 INTRODUCTION

The Flip Teaching (FT) model began with the exchange of the place where two of the main educational activities are usually performed: "lesson and homework". In this model, the lesson is done at home and homework in class. Lage, Platt and Treglia [1] named this model Inverted Classroom and on the same dates an identical model was called by Baker [2] as Classroom Flip. Later Bergmann called it Flipped Clasroom [3], finally the name of Flip Teaching was consolidated to define the model mentioned [4].

Regardless of the given name, the FT model is based on a basic approach for knowledge management [5, 6]: the physical or temporal coincidence of people generates knowledge if there is interaction and active participation rather than passive [7]. It is a matter of taking advantage of the spatial and temporal coincidence among students and teachers to perform cognitive activities that are of a higher order than the mere activity of "listening" [8].

On the other hand, following this approach, if the students are passive during a lesson, the place where it is carried out is indifferent. Thus, the "home lesson" of FT is usually formed by a video recorded by the teachers, although there are authors who indicate that the activity at home should simulate a classroom class [9]. That is the reason why forums for questions, questionnaires to verify that the students have "learned the lesson" and complementary material are added. Likewise, videos must meet a set of requirements to increase their effectiveness, such as the duration of less than 10 minutes [10].

FT's "homework in the classroom" is often based on active and cooperative methodologies such as problem-based learning, case-based learning, or teamwork.
Broadly speaking, FT model moves students' inactivity in the classroom (usually limited to listening to the master lesson) to their home, since listening and watching the teacher's video is an activity that is equal or more inactive.

However, one of the problems of the FT model is the possible disconnection and independence of the "homework" with "homework in the classroom" [11]. The responsibility to learn the lesson is attributed to the students, but in the classroom the teachers strive to apply active methodologies. Therefore, if there is a disconnection (for example, if the student has not learned the lesson) the model fails completely.

In the last few years, different models have emerged trying to connect the activity at home with the activity in class and it is usually added to the model an intermediate activity that improves the activity at home. This is the case of the MicroFlipTeaching model (MFT) [9, 12]. In this model, students also perform a micro work after viewing the video and the teacher uses the results of that work as a didactic resource in the classroom. This model has been tested and validated both to apply it in theoretical classes [4] and to the acquisition of generic competences, such as teamwork [9, 12].

This intermediate activity ensures that students, individually or in groups, acquire knowledge through practice; Knowledge that may be correct, erroneous or incomplete. The variety of the acquired knowledge enables students to perform peer-to-peer learning during classroom sessions, following the theory of Interactive Teaching by Eric Mazur [13]. Such peer learning is guided, coordinated and managed by teachers. The MFT model is therefore based on peer-to-peer learning during the classroom session.

A common feature to all FT models is that they are designed to be applied in a particular subject whose implementation has a beginning and an end. But why not use the students' accumulated knowledge in order to improve the subject? [14].

The dialogue among people with different knowledge, interaction and communication are the pillars of peer to peer learning, but if the time dimension is added, they are also the pillars of the creation of collective intelligence. Peer learning fosters a deeper understanding of the concept of interconnection [13], which provides support for building a collective intelligence. This is usually dynamic and permanent; that is, it does not have a beginning and a limited end, since people learn and unlearn continuously.

The contribution of this work is based on generating, managing and building collective intelligence using the MFT model. In order to do this, the students' experience at the highest point of learning (using the MFT model) has been captured during a subject and subsequently this experience is used in another different subject.

In the presented experience, we have defined a control group (CG), which uses the MFT methodology with videos generated by the teachers in the activity at home. Likewise, an experimental group (EG) has been defined, which uses videos in the activity at home that have been generated by other students who have already acquired the knowledge in previous academic courses.

The goal of this paper is to verify that the learning results are at least equal between the CG and the EG. It will also be analyzed if the conditions for collective intelligence are given.

In the next section the theoretical model of the work is presented; the description of the context will be the following topic; after that the results will be presented; and finally, the conclusions close the paper.

2 THEORETICAL MODEL

Through the literature, FT models can be classified into two modalities: models that simply transfer students' passivity from inside to outside the classroom and models that increase activity both outside and within the classroom.

The initial model, generally called FT, is based on transferring the passive activity of students from the classroom to home "the lesson at home, homework in class". Fig. 1-a represents this model. The activity at home is usually a video, but also it is possible to use readings, articles, etc. Classroom activity is often varied and includes classic methods of active and cooperative participation such as case-based learning, problem-based learning, teamwork, etc.

The activity at home is based on the students doing homework, but before the session in the classroom, not later as is done in the classic homework. In this case, the homework consists in "bringing the lesson learned". Watching a video, just like attending a master lesson does not guarantee learning the lesson, there is even a strong inertia of the students to suffer delays and not having "the duties" updated. Thus, the problem with the FT model is that students are often not able to perform tasks in the classroom because they do not bring the lesson learned.

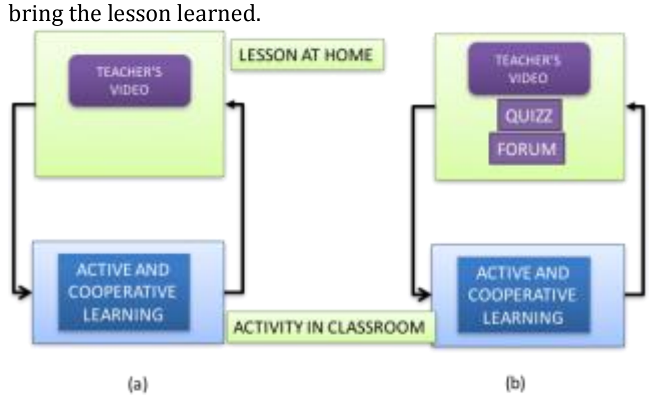

Figure 1: Initial FT models

In the first Flip Teaching models, the students do the activity at home without any help and therefore is the place where more guidance is needed [11] and for this reason help tools should be incorporated [15]. For example, the MFT model incorporates as help tools forums for debate and resolution of doubts and questionnaires to check the degree of acquisition of the video content by the students [4, 9], as shown in Fig. 1-b.

Other FT models attempt to reduce student passivity during classroom activity. An example of this model is the MFT model [4] that proposes an intermediate activity in which each student does an individual work that requires the application of what is explained in the video. The result of the work can be used in the classroom as a didactic resource for learning, for example analyzing correct and incorrect jobs. Fig. 2 represents this model.

In this paper, the MFT model is deepened and modified, specifically the intermediate activity is done in a collaborative way where students are organized into work teams. In this way, the students' passivity disappears due to it is necessary to carry out a group activity.

The activity in the classroom is based on organizing a peer to peer learning taking into account: the experience acquired by the students during the intermediate activity and the result of the activity itself. Teachers participate in peer-to-peer learning by managing interventions, defining times and carrying out reinforcement activities when the situation requires them.

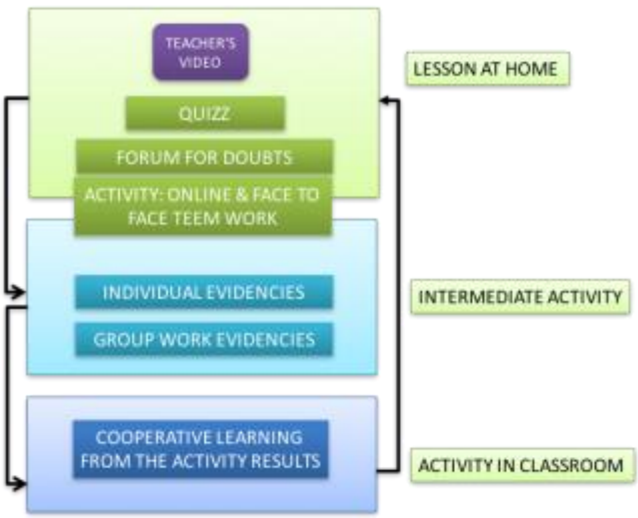

Figure 2: MFT active model

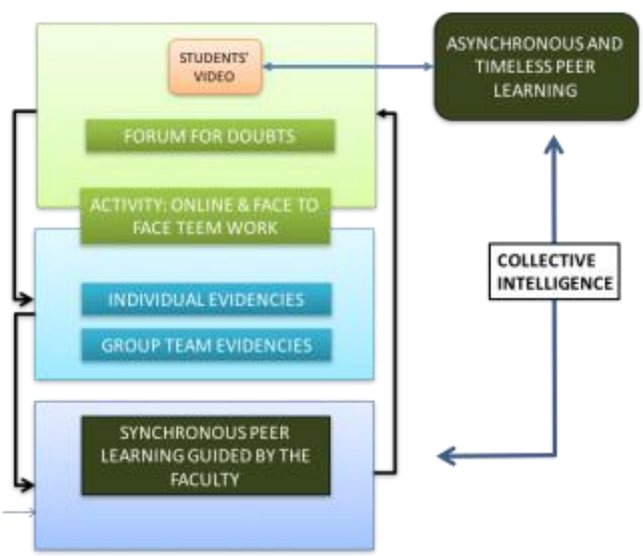

Figure 3: APFT model

Also, this work gives an important novelty both in the FT model and in the peer to peer learning activity, which is based on using such learning to produce and use collective intelligence. The FT model and peer to peer learning are applied during a given training process and synchronously, so it begins and ends during the training process itself. The higher level of learning occurs at the end of the activity, so it is proposed to encapsulate the knowledge for later use in a new peer to peer activity.

Thus, in a learning activity, it is proposed to use the students' knowledge from other subjects, degrees, universities and even other academic courses. In this way, collective intelligence is built during the FT model's home activity. Instead of providing the video of the teaching staff, a video is included where the students show their acquired knowledge in the realization of the intermediate activity in another learning process. They explain what they have done and how they have done. This model has been called Active Peer-Based Flip Teaching (APFT) and is represented in Fig. 3.

3 CONTEXT

The presented experience was realized between February and June of 2017 in the subject "Computing and Programming" of the first course of the Degree of Energy of the Polytechnic University of Madrid.

A total of 22 teams have participated, with an average of 6 members per team. To study the incidence of the model, the teams were divided into two groups: EG and CG with 11 teams each. 132 students have had the experience of a total of 180 students of the above-mentioned subject. The students who did not participate in the experience did not fulfil the same initial conditions as the rest of the students and could alter the results. Students who had already worked as a team in a previous edition of the subject, atypical groups (for example, 3 students) and students who started the subject with a significant delay compared to the rest of the students were excluded.

The activity at home consisted of examining a set of videos explaining "what to do" and in the intermediate activity the students, organized in work teams, had to generate a set of resources. In the classroom, students worked on the results of the intermediate activity, and each team debated, contributed, corrected and improved the result of the work. Some teams came to the classroom activity with poorly performed or incomplete work and other teams arrived with the activity performed correctly.

Five classroom sessions were held and in each session the teamwork phases (I-forming, II-storming, III-norming and IV-performing) defined by Tuckman [16] were developed for small teams and built-in and extended (adding "results") in accreditation standards such as the IPMA model [17]. The work has been done under the CTMTC model [18-21] that allows continuous monitoring of both the individual and the outcome of each phase.

To use the timeless peer to peer model with the experimental group and to develop collective intelligence, we used the knowledge acquired and explained by other students when performing the same phases of teamwork. Students of the subject "Fundamentals of Programming" of first year of the Degree of Biotechnology of the Polytechnic University of Madrid followed the same method of teamwork during the first semester of the course 2016-17 and at the end of each phase they explained the knowledge through a short video (less than 10 minutes) where they explained what they did in each phase and how they did it.

These videos were used in the experience presented in this work, instead of the videos of the teachers.

The first session was common for teams of both groups EG and CG. For this first phase, both teacher's and students' videos were used; that is, all the students participating in the experience had access to the same videos.

From the second session until the fifth last session, the CG group only acceded to the teacher's videos and the group EG to those of the students instead of the videos of the teaching staff. In the next section, the results of the experience are presented.

4 RESULTS

The results are grouped into three categories: data in which the two groups (CG and EG) are homogeneous; individual and group follow-up data; final academic performance scores and students' opinion regarding the authorship of the videos (both teachers' or students' videos).

4.1 Homogeneity of CG and EG groups

Input indicators are used to demonstrate that the two groups have homogeneous input profiles. For this purpose, entrance qualifications are used in the university as they are first-year university students (see Table 1).

The data were obtained by means of a survey made to the students voluntarily. 132 students participated in the experience, of which 88 have done the survey up to the date of writing this work (38 CG students and 50 EG students).

Table 1: University entry notes

	EG	CG
Mean	10.13	10.40
Deviation	1.17	1.04

4.2 Follow-up results

The day before each classroom session (corresponding to each phase of the team work), an evaluation was made about the degree of achievement of the expected results in each phase. This way, the members of each team with a low workload (possible "nervy" people) were detected.

Table 2: Follow-up table for session #4 in EG

	INDIVIDUAL	PHASE I	PHASE II	PHASE III	PHASE IV
EG1	YI	GG	GG	GG	RG
EG2	GI	GG	GG	GG	GG
EG3	YI	GG	YG	GG	RG
EG4	GI	GG	GG	GG	GG
EG5	YI	GG	GG	GG	GG
EG6	OI	GG	GG	GG	GG
EG7	YI	GG	GG	GG	GG
EG9	OI	RG	RG	RG	RG
EG10	OI	GG	GG	YG	RG
EG11	GI	GG	GG	GG	GG
EG12	OI	GG	GG	GG	RG

In each face-to-face session, progress was shown both individually (individual workload within each team to date) and group progress (degree of achievement of results in each phase of teamwork). Likewise, in each session the degree of achievement of the corresponding phase was presented, as well as of the previous phases.

For example, Table 2 includes information on the face-to-face session #4 (referring to phase IV) for the teams in the EG group. The following explains the combination of colors used by faculty and the codes used to explain in this work the situations that can be given, individually or in a group.

The Table 2 second column indicates the distribution of the workload of the different team members, examined by the faculty through a system of Learning Analytics [22]. The rest of the columns are the different group phases that must be performed. The colors for individual loading (Column 2, Table 2) mean:

- Green Individual (GI). Distribution of homogeneous work among the team members.
- Yellow Individual (YI). Homogeneous distribution with members located in the upper range of workload and others in the lower range, within homogeneity.
- Orange Individual (OI). There are members who work poorly and others work harder.
- Red Individual (RI). There are "nervy" people, members who are not working on the team.

Regarding the group phases (Columns 3, 4, 5 and 6 of Table 2) the colors indicate:

- Green Group (GG): Correct development grade.
- Yellow Group (YG). Correct development grade, but they have to make some minor modification.
- Orange Group (OG). The development has started, but there is some serious misconduct.
- Red Group (RG). The work has not been started or is incorrect.

Table 2 shows the number of equipment (Column 1), the individual load within each equipment, described below (Column 2) and the degree of achievement of each phase

(Columns 3 to 6). In this table, it is shown that in the EG2 team, its components had worked homogeneously (GI) and until the date in which the face-to-face session number 4 was performed, they had correct results in all phases. The EG6 team members did not have a similar workload (there are significant differences) and all phases had been performed correctly.

Table 3: Distribution of workload during the teamwork development

	EG	CG
GI	16	14
YI	13	10
OI	7	8
RI	8	12

Table 3 shows the results for the homogeneous distribution of the individual workload of the team members during the teamwork development. It means that during the 5 face-to-face sessions, the EG had, on 16 occasions, a fair burden of work sharing (GI). Nevertheless, the CG had it in 14 occasions (GI). On the other hand, for the EG, on 8 occasions, "nervy" people (RI) were detected, whereas in the CG group there were 12 occasions (corresponding to the RI row).

Table 4: Progress of the achievement of the phases throughout the development of the subject

Scenario	Number of times it is met	
	EG	CG
Green	68	52
Yellow	10	24
Orange	4	8
Red	22	20

Regarding the phases, the degree of their overall achievement is expressed in Table 4. In each face-to-face session, the corresponding phase is presented together with the previous ones. For example, in Table 2, the corresponding phase is phase IV and, nevertheless, the evolution of the previous phases is also presented. Taking into account this monitoring system, Table 4 shows the achievement of results in the different phases of the teams. For example, row 2 indicates that during the face-to-face sessions, 68 times the EG group correctly performed the phase while the CG group did 52 times.

4.3 Learning outcomes

Learning outcomes are based on the final obtained grade by the different work teams at the end of the subject edition. Table 5 shows the number of teams (EG and CG) that have obtained a final grade within the corresponding range.

Table 5: Work teams' final grades

	EG	CG
Range 1 and 2.9	2	2
Range 3 and 4.9	5	6
Range 5 and 6	4	3
Average grade	4.5	4.2
Deviation	1.09	1.4

4.4 Preferences about video type

The data were obtained from a survey made to the students, which participated voluntarily, at the end of the subject and before obtaining the final grade. Regarding the preferences of the type of video (both teachers' or students' videos), we can see in Table 6 the opinion of the 88 students, who in the first session accessed the both kind of videos.

Table 6: Preferences about video type

	1	2	3	4	5
I prefer videos made by faculty	5 (6%)	14 (16%)	**35** (40%)	23 (26%)	11 (13%)
I prefer videos made by students	6 (7%)	17 (19%)	**36** (41%)	23 (26%)	6 (7%)
I prefer both types of videos, from faculty and students	0	0	11 (13%)	18 (20%)	**59** (67%)

5 CONCLUSIONS

Table 1 data show that the students' entry grades in the university are similar in both considered groups for the investigation (CG and EG).

One of the conditions for learning between peers is that they have different levels of knowledge. It is shown that these conditions have been presented due to it can be observed that both individual and group level are shown to have very different knowledge. The 4 levels (green-correct, yellow-small errors, orange-errors and red-totally incorrect) are given in a varied and shared way over time. So, each student and each team has different knowledge and levels of experience, which encourages learning. Likewise, there are no great differences between this variety of individual and group knowledge between the CG and EG groups. Therefore, in both cases it can be said that peer to peer learning in the classroom can be done.

Regarding the construction of collective intelligence, it can be analyzed through the learning outcomes expressed through the obtained grades. The EG group, which used the encapsulated knowledge of other partners, has somewhat better success rates than the CG group. It is therefore demonstrated that the encapsulated content is at least as valid as the knowledge provided by the faculty.

In the first session, both the knowledge generated by the teacher and the knowledge generated by the students were supplied to the two groups. The students do not show a significant difference because of the knowledge of the faculty or the students, but if there is a very significant difference because they prefer the two kind of videos. This preference is characteristic of collective intelligence due to, on the one hand, it is said that it is necessary the knowledge of the students but also of the faculty.

Thus, it is shown that in this experience:

- Students' learning can be encapsulated and used under the APFT in later subject editions, even starting from different subjects and degrees.
- It is possible to propose a training process, under the conditions of the APFT model, as a process of building collective intelligence based on the different knowledges of students, teachers and alumni.

In this work, we have used encapsulated knowledge of a subject from the previous semester, taking into account that both subject and degree were different. But, it is possible to consider whether the encapsulated knowledge of the students who have made the experience improves against the encapsulation of the former students, as well as measure the improvement of the students' experiential knowledge. On the other hand, the management of collective intelligence increases with time and already in each use of the model increases in a linear way the number of people involved, so will knowledge grow in a linear way?, will the management of the increase of knowledge resources be complicated? Regarding the management and organization of collective intelligence to use outside the subject and in non-teaching periods, could it be exported and used in other educational levels?, could society be incorporated into that collective intelligence and improve it? All these approaches will guide new lines of future work.

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