# Influence of class size and methodology on learning experience

## Influencia del tamaño de clase y de la metodología en el aprendizaje

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Recibido: 15/07/2018 | Aceptado: 13/10/2018 | Fecha de publicación: 31/12/2018
DOI:10.20868/abe.2018.3.3835

## HIGHLIGHTS

- Evaluation of different methodologies in relation with the size of the class.
- Student 'satisfaction perception with innovation learning methodologies.
- Professors 'satisfaction perception with innovation learning methodologies.

## TITULARES

- Evaluación de diferentes metodologías en relación con el tamaño de la clase.
- Percepción del grado de satisfacción del alumno con las nuevas técnicas docentes empleadas.
- Percepción del grado de satisfacción del profesor con las técnicas de innovación empleadas.

## ABSTRACT

The aim of this paper is to present different implemented innovations in education focused on the specific course "Industrial Constructions" at Escuela Técnica Superior de Ingenieros Industriales (ETSII) Universidad Politécnica de Madrid (UPM), that for more than ten years have been adopted, in order to propose a more adequate framework for learning and evaluation. This paper reports on the outcomes of a research study to clarify the role of class size and identify other constraints to the success of innovative actions.

The research covers several years and it includes different number of students´ groups through that period. The course has been included in diverse educative programs over time, but also varied innovative actions have been implemented as well, including experiential learning with practical perspective and magisterial lessons approach, and experiential learning combined with flipped classroom and gamification, etc. The linear perspective of the research allows to compare different instances as well as the conclusions and feelings from teachers´ perspective in accordance. It is not claimed a fully rigorous statistical robustness in the comparison because there are many uncontrolled variables, therefore, it is highlighted that the comparison is a qualitative one, with high added value from the teacher's perspective.

The analysis shows some expected results regarding the size of the groups but also other interesting results regarding motivation and students´ skills that can contribute to enhance teachers´ perspective in their selection of the best methodology.

**Keywords:** *Engineering education, Experiential learning, Flipped classroom, Gamification.*

## RESUMEN

El objetivo de este artículo es presentar diferentes metodologías innovadoras en educación realizadas en el curso de "Construcciones Industriales" durante más de diez años en la Escuela Técnica Superior de Ingenieros Industriales (ETSII) de la Universidad Politécnica de Madrid, para proponer una estructura de aprendizaje y evaluación. Este estudio presenta los resultados de la investigación sobre la influencia del tamaño de clase e identificar otras limitaciones con el éxito de las acciones de innovación educativa.

En los diez años en los que se ha realizado esta investigación participan grupos de clase con diferentes números de estudiantes. Esta asignatura se ha impartido en diversos programas docentes y con diferentes metodologías, como son clase magistral y aprendizaje práctico de trabajo de grupo, y aprendizaje práctico con clase invertida y gamificación. La visión de la investigación permite comparar distintos casos así como las conclusiones conforme a las opiniones y puntos de vista de los profesores. No se trata de un estudio comparativo con un alto rigor estadístico debido al número de variables adicionales, por lo que se subraya que las conclusiones del estudio son cualitativas con un alto valor del enfoque del profesor.

El análisis muestra algunos resultados esperados respecto el tamaño de la clase, pero también otros resultados interesantes en cuanto a la motivación y competencias de los alumnos que pueden contribuir a mejorar el enfoque de los profesores en la selección de la mejor metodología.

**Palabras clave:** *Educación en ingeniería, aprendizaje práctico, aula invertida, gamificación.*

## 1. INTRODUCTION

University teachers often face an interesting and stimulating challenge, such as the introduction of educational innovations that allow improving the educational quality of their teaching and the acquisition of skills and abilities of their students that will help them to develop a successful career.

The characteristics of the socio technological environment nowadays have configured a new scene, that can be considered disruptive in many ways from the social and educative setting of decades before. The digitalization and permanent connection of society to the Internet almost everywhere, has changed the way students access information, acquire digital skills, interact and so, modify their learning process from early stages of their education [1].

In this current academic environment there are new powerful drivers based on the availability of plenty of resources and ICT tools and SW, that combined with new pedagogical approaches, as we will discuss in the article, can enhance academic results and success of our students.

For university teachers, the design and practical introduction of educational innovations, on the other hand, is not often free of difficulties and restrictions of diverse sorts. It is for all this, that in such a dynamic environment where there are numerous resources and possibilities for educational innovation, the need to find the most appropriate and adaptive ones, that offer results in the shortest possible time, has configured as a strategic element and differentiator for the personal and professional growth of our students.

The evaluation of the quality of educational innovations is a complex issue [2; 3]. In this article we analyze the success of educational innovations in groups of engineering students who have taken the same course over a twelve-year period, and in which different educational innovations have been introduced during that period every year.

The indicators of the degree of success or failure of the innovation introduced are evaluated taking into account the qualifications of the students. This way we can objectively analyze the degree of improvement through the qualifications achieved. It is necessary to understand that we start from a point of reference, and over time both society and the environment, and students are changing. In addition, due to the digital transformation of the environment and social reshaping we observe these variations happen more frequently and more quickly.

Among the multiple variables that can affect the results of students under analysis, most of them cannot be considered under control. Our objective, however, has been to understand if and how, among those restrictions, the size of the group of students can be an important element that constrains the degree of success of the educational innovation introduced.

The first objective of the research has been to contrast with the available data the working hypothesis, that the size of the group limits the results obtained through the educational innovation introduced. This factor, as the results obtained have shown, can determine the greater or lesser success of the educational innovations introduced.

The second objective of our investigation was to determine, once the initial hypothesis was confirmed, to find a relationship between the type of educational innovation and the results obtained based on the class size.

The pursuit of continuous improvement and adaptation of the teaching methodology incorporating new innovations has introduced in many cases, among the university professors, a desire for novelty and immediacy of successful expected results, that has not been supported by the actual facts. One of the keys, as our outcomes reflect, is to introduce those innovations best adapted to the group size and profile of the new students.

The rhythm of introduction of the innovations sometimes is a challenge for the University teachers. The risk of not choosing the right innovation for the course and group of students and so achieve the expected results is a reality that many professionals experienced in their day to day. This research gives some clues on how new innovations in education could achieve better results considering the size of the group and choosing those sort of innovations that better fit with the size of the students group under consideration.

The structure of the article is as follows; first a bibliographical review of the issue has been made. Next, we introduced the methodology followed in the article and the analysis of the data, the observed results of the study for the academic results obtained by different groups of engineering students attending the course "Industrial Constructions", at the Escuela Técnica Superior de Ingenieros Industriales (ETSII) at Universidad Politécnica de Madrid (UPM), for a twelve-year period. After the evaluation and discussion of the results obtained, the article ends highlighting the main conclusions of the study.

## 2. LITERATURE REVIEW

Today's society is developing remarkable innovation capabilities based on the use of technology as a facilitator for social transformations, it is the so called Knowledge Society. Therefore, to foster such revolution the new graduates need to acquire critical and proactive ways to develop their own strategies. This approach requires that the university education fosters the development of collaborative work skills, the interest for the technological solutions implemented, but also of critical analysis capabilities of the same.

During last decades significant efforts have been devoted to foster the knowledge about learning science and technology topics and many effective pedagogies and interventions, according to [4]. However, it became clear that the level of implementation and adoption of research based instructional strategies was not coherent with the research efforts [5; 6]. Indeed, it is realized that engineering educators and engineering education researchers have limited experience with education and social science theories.

From the literature review, [7] described the Four Categories of Change Strategies that allows for categorization of change strategies. Such structure became further developed in [8] and under such structure, the proposal of this paper fits into the Diffusion and Implementation block, related to individuals as a prescribed intended outcome, looking to develop new practices and to encourage their use. When considering the philosophical models for reforming education [9], the presented approach fits into the Conceive-Design-Implement-Operate (CDIO). This is because it provides an articulated ecosystem where each course can contribute to the general model in accordance to its particular conception. The courses referred in this paper attends to the Conceive-Design phases.

Among all the techniques and tools available, this paper focuses its attention both, on innovative approach in learning about theory, but also in learning from the practical activities. In regard to the methodologies used in theory, different alternatives have been used depending on factors like the class size [10], ranging from the classical magisterial class up to flipped classroom [11].

The need to implement realistic practical activities as part of the educative actions has been highlighted by different authors [12]. In this case, and in accordance to the characteristics of the involved courses, group-based visits to construction sites and technical analysis of the implemented solutions are the goals. Site visits create an interactive learning environment for students and provide exposure to a real-world spatiotemporal experience of a construction project [13].

As a relevant part of the process, the assessment procedure took into account different existing proposals [14; 15] in order to establish a well understood, fully traceable system, making it possible to discuss found differences.

## 3. METHODOLOGY

This study examined the results of different teaching strategies to teach the same contents during different academic years where size of the groups varies. Figure 1 describes the segmentation according to class size and methodologies. To stablish a comparison, it is necessary to use the results of the previous year to compare the traditional working methodology versus the new flipped classroom.

Due to the practical concepts of the courses, in all cases students do a practical assignment, including visits to a construction sites or industrial facilities, in order to obtain the data needed to work with, discussing results and making a correlation over theoretic information obtained in class and practical information, so they could propose a suitable modification. Since the aim of this task and this working methodology have not changed, they are used as "vertical" reference to compare the influence of methodology. Results obtained from different courses allow us to understand the influence of class size and the teaching strategy.

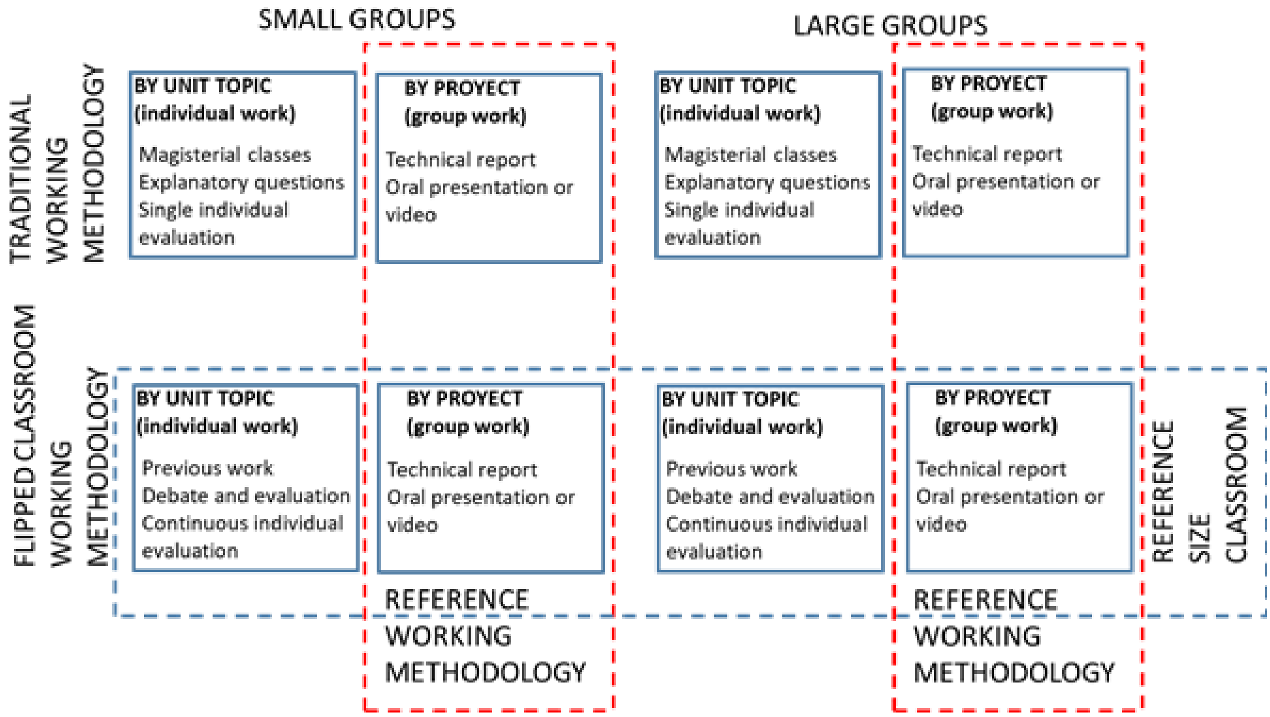



*__Fig. 1.__ Methodology structure.*

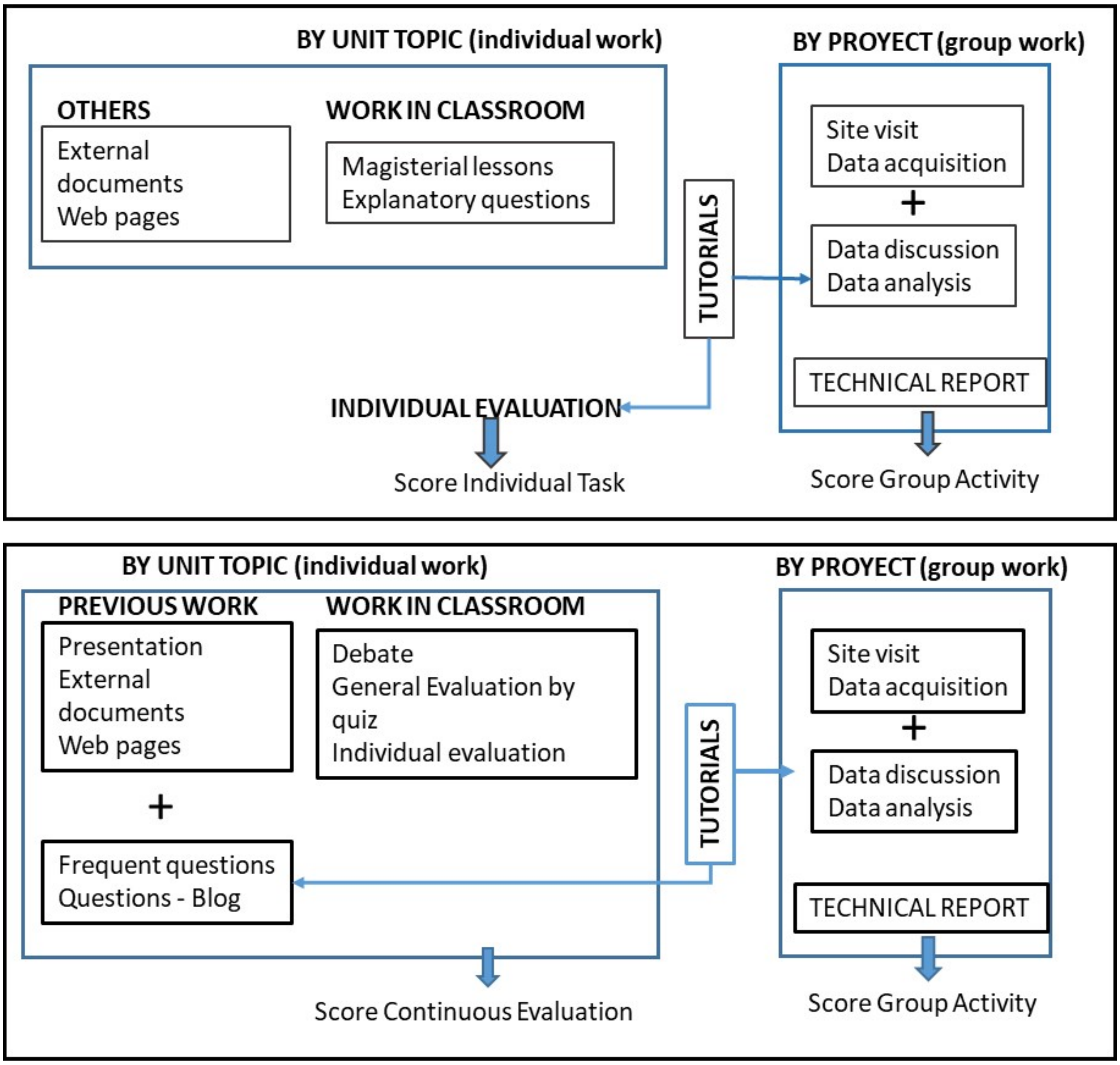



***Fig. 2.*** *Scheme differences in working methodology.*

## 3.1 Changes in educational methodology

For the last twelve years, professors and students had made a strong effort to close the existing gaps between the competences market demand for new industrial engineers and the ones they acquire at the University. In 2014 a new Master Program was implemented at ETSII-UPM, thus giving the opportunity to define new methodologies for a better configuration and results. However, it was important to keep the good results that had already been achieved in the implementation of the "old model", with classroom activities and focused on the acquisition of certain competences, that were accomplished under the so called "more traditional methodology".

This study investigates the different effects that new changes in the teaching methodology, a sort of "blended learning experience" in some cases, had on engineer students' achievements, and also the impact due to other characteristics, particularly the size of the groups, on those outcomes. Size is a relevant parameter that for one reason, large-scale classes, or other, few students, has not been so well analyzed at the same time a new teaching methodology is introduced.

The aim is to better adapt the new technologies and students' competences to market demand. For this reasons the learning strategy for the course "Industrial Constructions" has had always two different sort of activities: There are individual tasks, but also a group activity, a project group, students have to do in collaboration with their peers to stimulate cooperative learning, as they will do in a real professional environment (Figure 2).

We understand by traditional methodology (upper graph in Figure 2), when the professor uses mainly the time in classroom, face-to-face, to give magisterial classes and answer the questions students raise. Students rarely prepare topics in advance, even though they have documentation available at the internet educational platform (Aulaweb or Moodle) for the course, however, normally there are not many questions. At the end of the semester students must do a test on the contents of the course; a single score from this test is obtained. They use tutorials (face to face) rarely previous to the test date; they use extensively tutorials for the practical work.

The lower graph in Figure 2 shows how flipped classroom was implemented. Main difference with previous methodology was that students had the option to receive tutorial support per unit topic through the educational platform (web based), and they get at the end of the semester their final score, obtained after doing all the required tests for follow up.

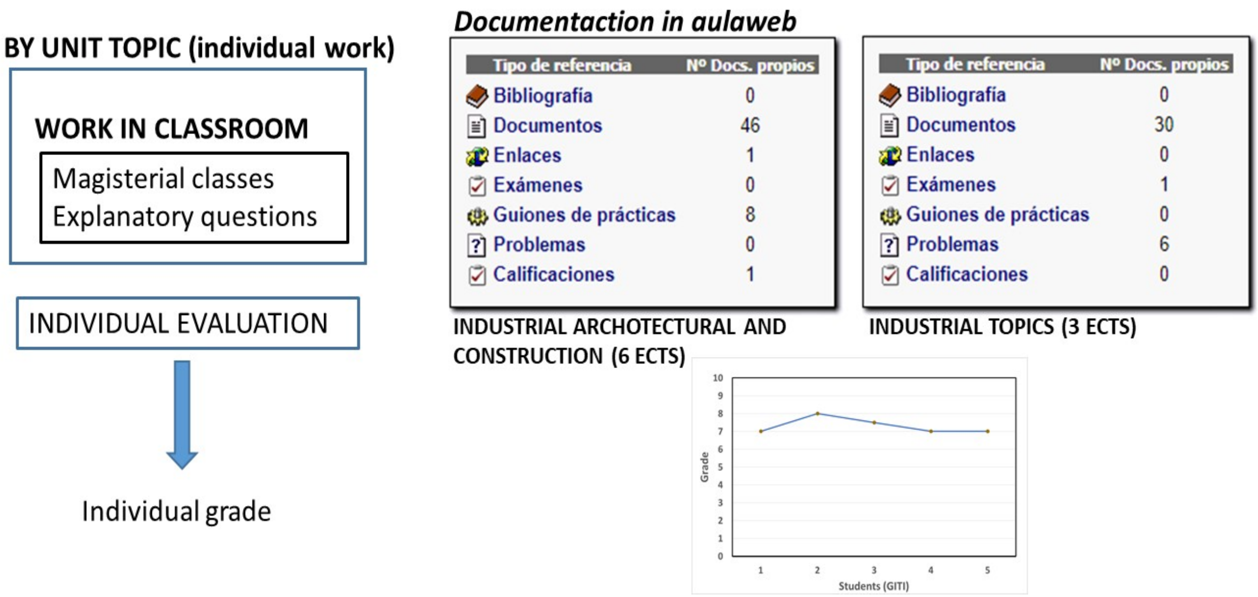



***Fig. 3.*** *Scheme for traditional class methodology*

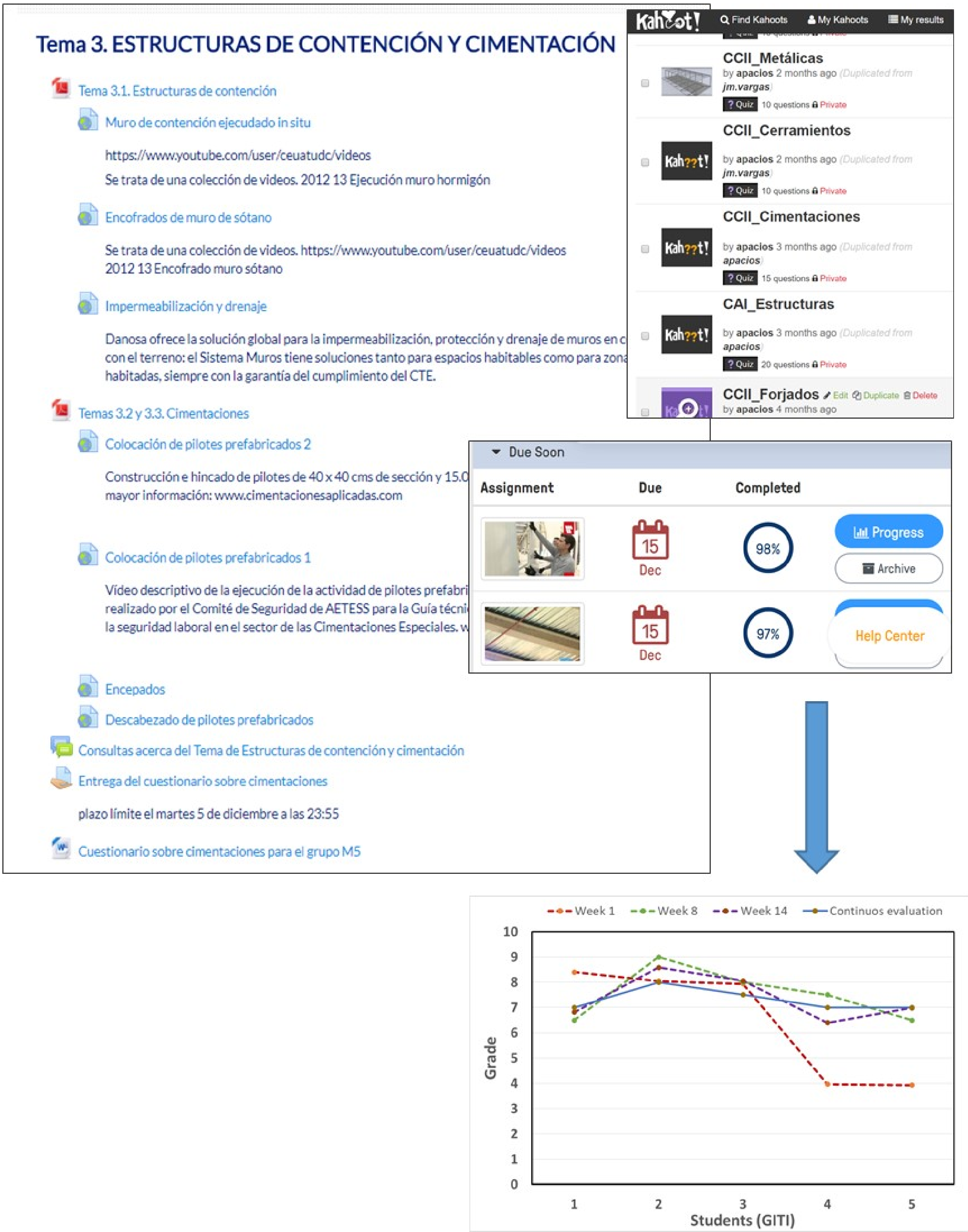



*Fig. 4. Scheme for clipped classroom methodology*

## 3.2 Changes in educational methodology

Figure 3 shows how the traditional methodology in class was carried out. Students had access to the working platform (web-based). There, they could download the documentation for the different lessons and topics, e.g. that included presentations to be used in face-to-face classes, reference documents, as well as practical examples. After following the different topics in face-to face classes and tutorials with the professors, they must pass a final test, a single individual one.

On the other hand, the scheme followed with an innovative teaching strategy (Figure 4), followed a different implementation. Using a web-based platform, with detailed documentation and e-learning modules the students could learn by themselves with greater flexibility due to the flipped learning methodology. The introduction of new tools, e.g. Kahoot or EDpuzzel, to evaluate allowed to get personal scores for every student in a gamification environment, for the different lessons when face-to-face classed took place. Each student had a minimum of 14 single scores (corresponding with at least 14 tests plus oral questions answered at classes) in a seven-week period of time.

## 4. RESULTS AND DISCUSSION

To investigate the positive effects achieved in the different groups, we have considered three different periods in terms of educational methodology applied.

The first one, corresponds to a long period of time, nine years, academic courses 2003 to 2012, (Table 1). The data available for this research include students´ scores, size of the groups and teaching methods for the Course “Industrial Architecture and Construction II”. This is a core subject for students following the Engineering Majoring “Construction” at ETSII-UPM. These courses were included in a program of 10 semesters, and the course was done the 8th semester, what means the complexity of the course is in accordance with the program.

The methodology used during this nine-year period involved two parts: Magisterial, face-to-face, Classes (MC) and the evaluation was done with 5 to 10 open questions this was 70% of the final score for the student. The second part was the Experiential Learning with a Practical perspective (ELP), a team work (3 to 4 people) and the evaluation of this part was done by a written report and oral presentation, that accounted for 30% of the final score for the student.

The number of students attending these courses varies among the time period but ranges from 13 to 51 students; an average of 25 is quite representative.

| | MC | ELP | Final score |
|---|---|---|---|
| Semester 8 (8 of 10)<br>Industrial Architecture and Construction II (4.5ECTS) | 6 ±0.50 | 7.9 ±0.84 | 6.4 ±0.54 |

***Table 1.** Average achievement scores obtained with Methodology I, (2003-2012): MC and ELP.*

The second period goes from 2015 to 2017, the new Master and the new Industrial Engineering Degree at ETSII-UPM was introduced and the course "Industrial Architecture and Construction II" was modified in order to accomplish the requirements of the new Educational Programs. The course changed its name to "Industrial Complex" for Master students but there was another new course for undergraduate students "Industrial Architecture and Construction".

The course "Industrial Complex" is included in a Master Program of 4 semesters, and the course is delivered the 1st semester. This is a core subject; the complexity of the course is in accordance with the new program. There are six groups simultaneously each of an average of 60-65 students.

The course "Industrial Architecture and Construction" is included in a program of 8 semesters, and the course takes place the 7th semester; this is not a core subject except for those students that have chosen the specialization on Construction. The complexity of the course was in accordance with the new program. There is only one group with around 6 students.

For both courses the evaluation is slightly different to the first period methodology.

For "Industrial Complex" (Table 2), the evaluation consists of Magisterial, face-to-face, Classes (MC) and the evaluation is done with a test (50 to 60 questions) this accounts for 35% of the final score. The second part was the Experiential Learning with a Practical perspective (ELP), a team work (10 people) and for the evaluation of this part a written report and a video presentation is required, this is65% of the student´s score.

| | **MC** | **ELP** | **Final score** |
|---|---|---|---|
| Semester 1, Master<br>Industrial Complex (1.5 ECTS) | 7.90 ± 1.80 | 7.50 ± 0.50 | 7.5 ± 1.61 |
| Semester 7, E. Degree<br>Industrial Architecture and Construction (4.5 ECTS) | 6.2 ± 0.87 | 8.0 ± 3.6 | 7.5 ± 0.57 |

***Table 2.*** *Average notes obtained with Methodology I, from 2015-2017: MC and ELP.*

| | **FC** | **ELP** | **Final score** |
|---|---|---|---|
| Semester 1, Master<br>Industrial Complex | 7.11 ± 1.00 | 7.280 ± 1.58 | 7.20 ± 0.89 |
| Semester 7, E. Degree<br>Industrial Architectural and Construction | 7.30 ± 0.45 | 7.50 ± 0.61 | 7.43 ± 0.54 |

***Table 3.*** *Average achievement score obtained with methodology II, (2017-2018): MC, FC and ELP.*

For "Industrial Architecture and Construction" (Table 2), the evaluation consists of Magisterial Classes (MC) and the evaluation is done with 5 to 10 open questions. This accounts for 35% of the final score. The second part was the ELP, a team work (3 students) and for the evaluation of this part a written report and oral presentation (face-to-face) is required, this is the 65% of the student´s score.

After two years following the traditional methodology, (Methodology I) the level of satisfaction both from students and professors was low. Main changes were addressed to better fit working activities in the classroom with the evaluation system. Flipped classroom (FC) was adopted, and continuous evaluation by oral and quiz tests (Table 3).

The ETSII-UPM is a well-recognized Engineering University for students. This situation has been the same for the past 20 years. The admission qualification for a student to follow studies at ETSII-UPM is similar for all the period cover in this research. It can be assumed that the students´ level and motivation, year by year is equivalent, and so the scores from different academic years for the students can be used either as reference or to estimate the tendencies.

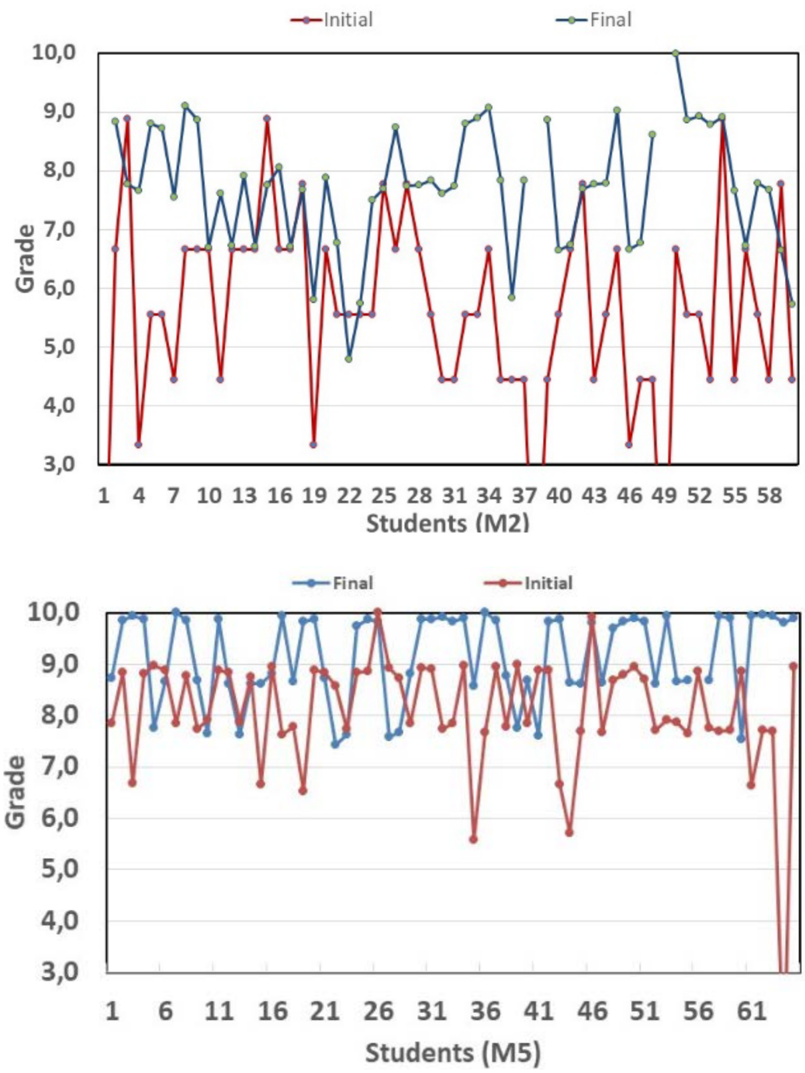



***Fig. 5a y 5b.*** *Comparison of same test performance after discussion in classroom.*

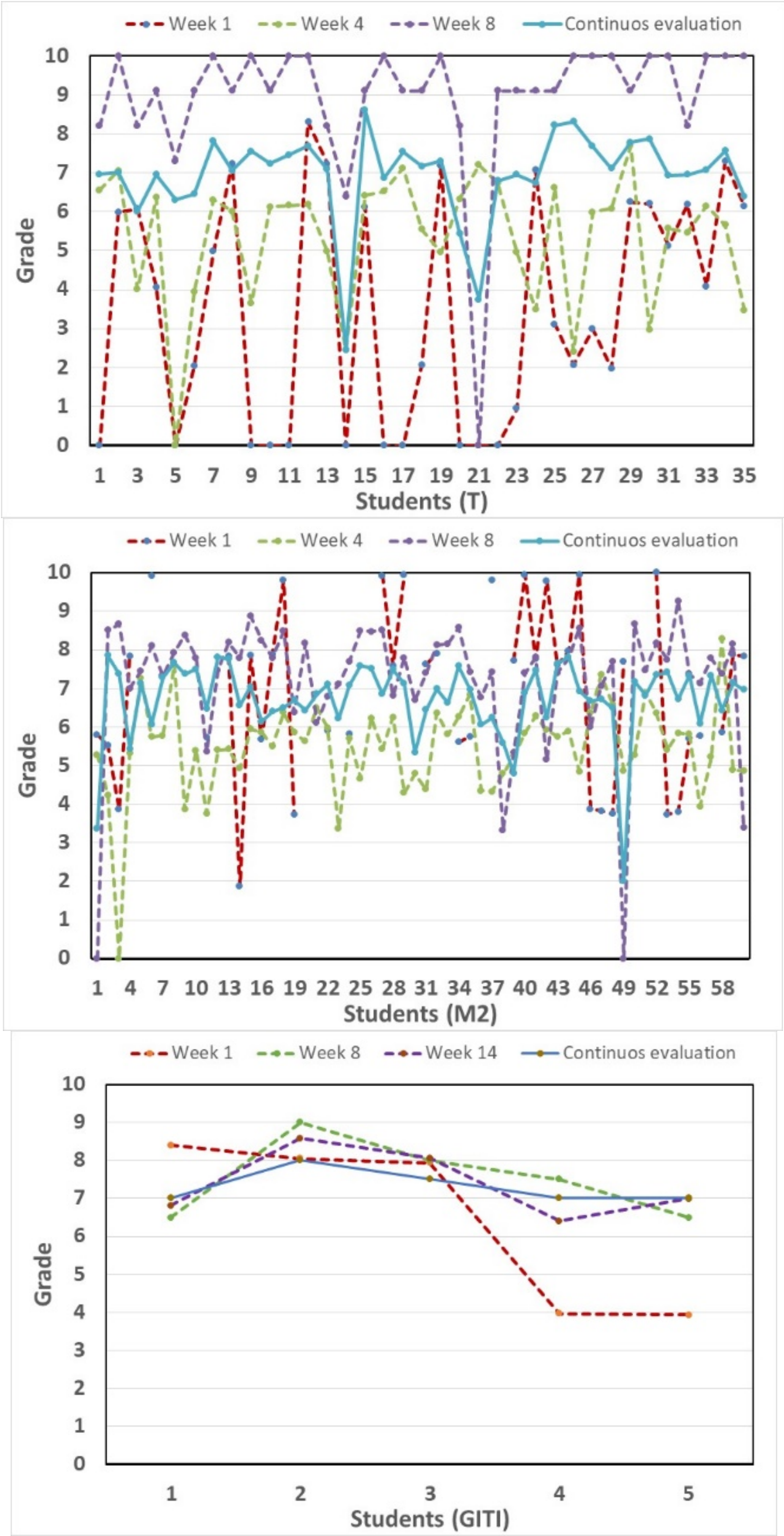



***Fig. 6a, 6b y 6c.** Registers of the on-going evaluation for student of Industrial Complex, (T, M2, M5), and Industrial Architectural and Construction (GITI).*

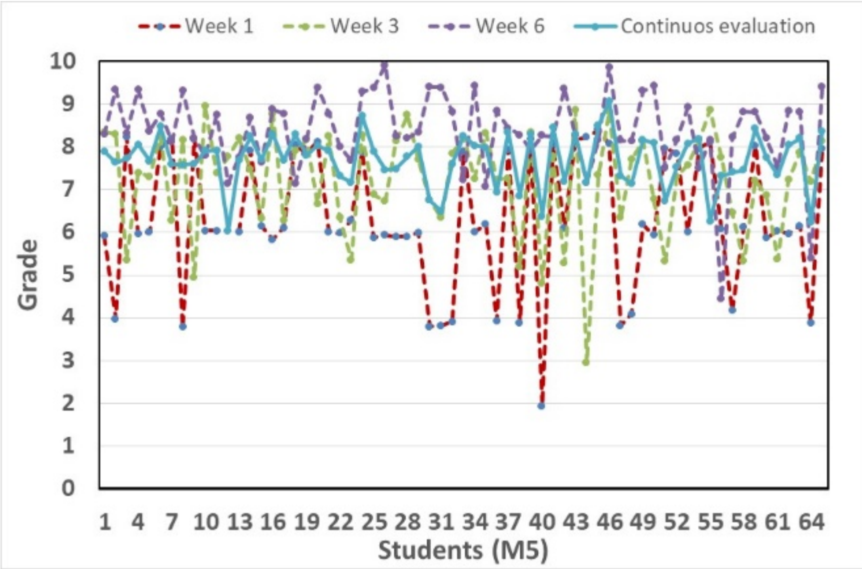



***Fig. 6d.*** *Registers of the on-going evaluation for student of Industrial Complex, (T, M2, M5), and Industrial Architectural and Construction (GITI).*

## 4.1 Changes in educational methodology

In order to evaluate students´ learning process and achievements, a blind test is done to check the previous work done by students attending flipped classrooms, this blind test is done in the classroom. After working on topics associated with the lessons, the same test is repeated at the end of the class. In all cases, after discussions and oral questions on topics related to the test, students obtained better scores, as it was expected. Students from the group M2 (Figure 5), first bimester, obtained worst grades in the beginning, so the opportunity to improve their scores was higher; poor results are related to no previous work before class. Students from group M5 (Figure 5), second bimester, were aware of the importance in the evaluation of doing the previous work, so closer results were obtained. Some evidence of students using similar test to prepare their next test, were also found, so that could be another explanation for better results achieved in group M5.

## 4.2 Effect of student effort by on-going evaluation

The plots in Figure 6 represent registers of individual students evaluation per week; the doted lines, on-going evaluation at the beginning of the period, mid and last weeks of the semester, against the final score obtained in the on-going evaluation obtained in class (continuos lines). Groups T, M2 and M5 correspond to the course Industrial Complex, (Master), and group GITI corresponds to the course Industrial Architectural al Construction, (E. Degree).

Students attending group T have a different background than students in groups M2 and M5. These ones most of the times have a different Degree not obtained at ETSII. Student registers (per week) from group M2 shows how the scores achieved at classes were closer to the ones done in the last week, and averages 6.7 points. This is consistent in all groups even though the average value changes.

The average grade for group M5 is 7.7 points; since this group attended classes the second bimester, an influence on the acceptance and commitment with the new methodology implemented can be appreciated.

The average grade for group M5 is 7.7 points; since this group attended classes the second bimester, an influence on the acceptance and commitment with the new methodology implemented can be appreciated.

## 4.3 Students perception of methodology

To collect this data, data from the quality survey done by the ETSII educational services has been used. Only the most relevant questions are listed in Tables 4 and 5. Scores ranges from 0 to 5, (0) totally disagree, (5) completely agree.

The relevance of the course for the students is the same in both cases, however, the degree of satisfaction is higher when they follow Methodology I (Table 4, 3.1 v. 2.5, Table 5).

The time devoted is a key factor for students' satisfaction as question number 3, shows (Table 4, 3.1 v. Table 5, 2.3).

Regarding documentation there is a different perception between the groups as question 4 shows (Table 4, 3.1 v. Table 5, 2.5).

| | **ELECTIVE SUBJECT** Industrial Architectural and Construction **(6 answers)** | **CORE SUBJECTS** Industrial Complex **(86 answers)** |
|---|---|---|
| 1.-My level has improved in comparison with competences in the program | 4.8 | 3.2 |
| 2.-The practical work helps to better understand the topics | 5.0 | 3.4 |
| 3.-The dedication to this course is in agreement with the number of ECTS | 4.0 | 3.1 |
| 4.-The documentation is adequate to follow the course | 4.2 | 3.1 |
| 5.-I consider the course important to my professional activity | 4.7 | 3.1 |
| 6.-Generally speaking I am satisfied with the course | 4.3 | 3.0 |

***Table 4.*** *Results from students' questionnaire when implemented Methodology I.*

| | **ELECTIVE SUBJECT** Industrial Architectural and Construction **(5 answers)** | **CORE SUBJECTS** Industrial Complex **(256 answers)** |
|---|---|---|
| 1.-My level has improved in comparison with competences in the program | 4.8 | 2.7 |
| 2.-The practical work helps to better understand the topics | 4.5 | 2.8 |
| 3.-The dedication to this course is in agreement with the number of ECTS | 4.3 | 2.3 |
| 4.-The documentation is adequate to follow the course | 4.2 | 2.5 |
| 5.-I consider the course important to my professional activity | 4.8 | 3.0 |
| 6.-Generally speaking I am satisfied with the course | 4.5 | 2.0 |

***Table 5.*** *Results from student survey when implemented flipped classroom. Methodology II.*

## 4.4 Professors' perception on methodology

In order to get information on the level of satisfaction among professors using flipped classroom a survey was prepared. Due to the lack of courses at ETSII related to construction sector, professors of similar courses, using blended learning and flipped classroom, were invited to fill the questionnaire; though the available data was low it was enough to find some interesting results.

The questions were grouped in five main sections related to students' opinion, perception of quality, methodology performance, motivation, students' performance, as well as overall professor level of satisfaction.

Most relevant questions are collected in Table 6 in which shows that professors are aware of the high level of their students (7.33), however they cannot fully understand the perception students´s have regarding the added value of flipped classroom (2.08). The students suggest they are very stressed and missed magisterial lessons. On the other hand, professors suggest that tutoring support have been underused.

## 4.5 Intercomparison of results and size effects

A résumé of some average scores are listed in Table 7.

Figure 7 allows the comparison between traditional methodology (Methodology I) and flipped classroom taking into account de size of the group, for different assignments. As it can be seen from plots in the first row of Figure 7, for all cases, students' performance is over the stablished reference (in blue color) obtained from a nine-year period. For small groups there are not relevant differences regarding the methodology followed.

| | ELECTIVE SUBJECT | CORE SUBJECT | ALL SUBJECTS |
|---|---|---|---|
| **NUMBER OF STUDENTS** | 6 | 65 | |
| **STUDENTS OPINION** (several marks) | | | |
| It makes me think | 33 % | 50 % | 75 % |
| I have to struggle with | | 75 % | 75 % |
| It is difficult but is worth it | 33 % | 25 % | 50 % |
| They are interesting for my professional future | 33 % | | -- |
| Not of my interest; I just have to pass the test | | | |
| **PERCEPTION OF QUALITY** | | | |
| Engage students in interactive discussion | 7.00 | 6.33 ± 1.53 | 6.50 ± 1.12 |
| Enhances self-understanding | 7.00 | 5.00 ± 1.00 | 5.67 ± 1.25 |
| Enhances critical thinking | 8.00 | 7.00 ± 1.73 | 7.25 ± 1.30 |
| Train to speak effectively | 4.00 | 7.00 ± 1.73 | 6.25 ± 1.79 |
| **PERCEPTION OF PERFORMANCE** | | | |
| It takes professor extra effort to accomplish the work | | | |
| It improves attitude of students toward learning | 8.00 | 8.60 ± 0.57 | 8.50 ± 0.50 |
| The use of documents and tools given to the students is adequate | 8.00 | 7.00 ± 1.00 | 7.25 ± 0.83 |
| It requires higher student work load | 5.00 | 5.00 ± 1,00 | 5.00 ± 0.71 |
| It facilitates to adapt to student educational needs | 7.00 | 8.33 ± 0,58 | 8.00 ± 0.71 |
| The number of students in class allows me to provide adequate attention to them | 9.00 | 8.33 ± 1,15 | 8.50 ± 0.87 |
| | 10.00 | 5,33 ± 3,21 | 6,5 ± 3,04 |
| **PERCEPTION OF STUDENTS PERFORMANCE** | | | |
| Students of very high quality | 9.00 | 7.33 ± 2.08 | 7.75 ± 1.64 |
| Students understand the value of the class | 8.00 | 2.08 ± 1.52 | 6.00 ± 1.58 |
| Students enthusiasm for the field of study is high | 9.00 | 4.60 ± 0.58 | 5.75 ± 1.92 |
| Students commitment to do continuous work is high | 7.00 | 5.33 ± 1.53 | 5.75 ± 1.30 |
| **LEVEL OF SATISFACTION** | | | |
| Very high | 100% | | 25 % |
| Average | | 33 % | 25 % |
| Low | | 66 % | 50 % |

***Table 6.*** *Results from professors' survey.*

| | AVERAGE SCORE (TEST) | AVERAGE SCORE (WORK) | FINAL AVERAGE SCORE |
|---|---|---|---|
| **Target** | 6.0 ± 0.5 | 7.9 ±0.8 | 6.4 ±0.5 |
| **MC small groups (ref)** | 6.2 ± 0.9 | 8.0± 3.6 | 7.5 ± 0.6 |
| **FC small groups** | 7.3 ± 0.5 | 7.5 ± 0.5 | 7.4 ± 0.5 |
| **MC large groups (ref)** | 7.9 ± 1.8 | 7.5 ± 0.5 | 7.5 ± 1.6 |
| **FC large groups** | 7.1 ± 1.0 | 7.3 ± 1.6 | 7.2 ± 0.9 |

***Table 7.*** *Average scores.*

Results show that following an on-going evaluation (e.g, flipped classroom) do not allow students to achieve the best scores. This can be explained taking into account that data is available only for the first year this new methodology has been introduced, and there is an effect not well measured, related with the innovation. The student faces for the first time at the Master Program with a new, more demanding methodology that requires him a more active role and responsibility of his learning process. This is not the only factor that can influence the answer: students in large groups perceive the course as less relevant to their professional activity. There is a common result in all the surveys that show a lower satisfaction with the new methodology implemented (Table 5). However, it is important to notice that the number of students that pass the course is larger, 98% versus 92%.

The second row in Figure 7 shows the influence of the methodology and group size on the assignments. The most relevant aspects are the homogeneity of the scores obtained in the different tasks. When using flipped classroom the assignments are much more balanced and less dependent on a single task (group or individual tasks) as happened in the previous years under Methodology I.

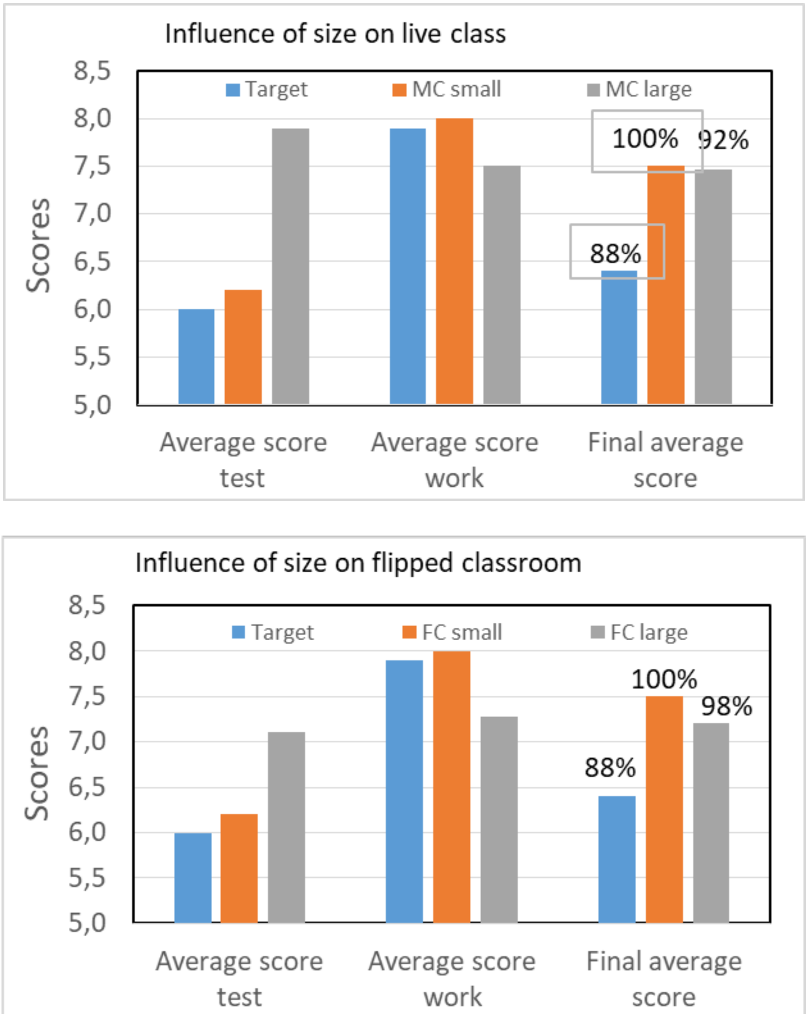
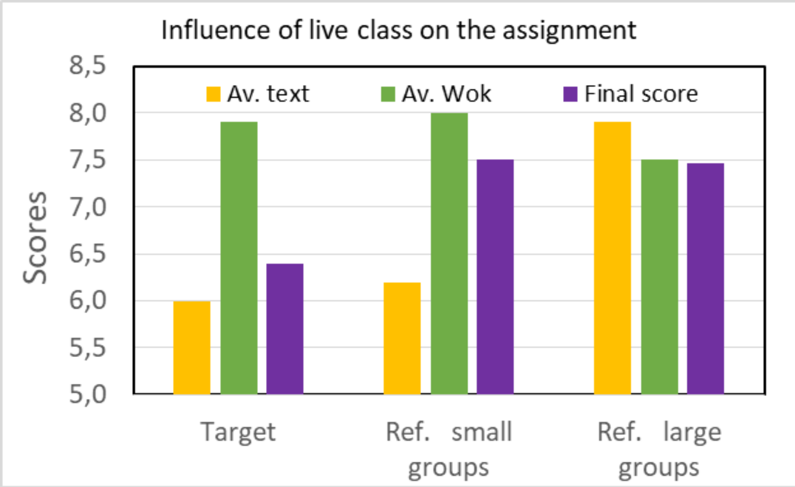



***Fig. 7a y 7b.** Accomplished score for small and large groups..*



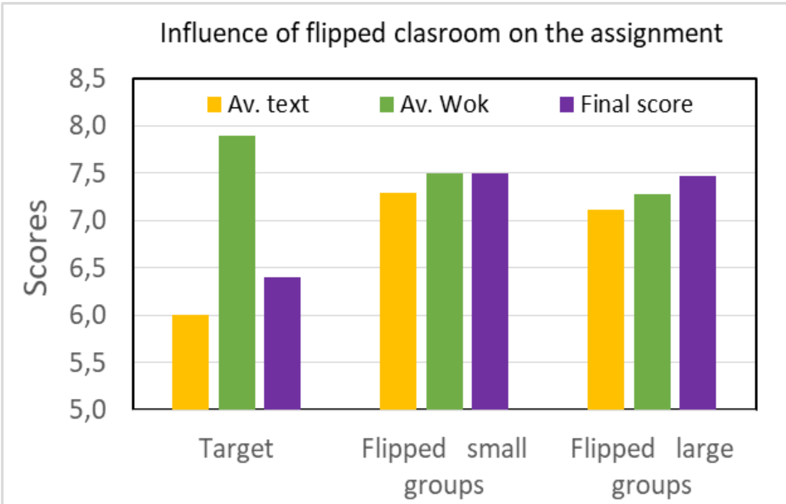




***Fig. 7c y 7d.*** *Accomplished score for small and large groups..*

## 5. CONCLUSIONS

The analysis shows some expected results regarding the size of the groups but also other interesting results regarding motivation and students´ skills that can contribute to enhance teachers´ perspective in their selection of the best methodology; after working in classroom on topics associated with the lessons, students obtained better scores than from previous test.

For groups of 60-65 students, students' perception regarding the added value of flipped classroom is low (3/5). In large groups the students' level of satisfaction when they follow Methodology I (3/5) is higher than when following Methodology II (2/5) due to the time devoted to go over all the topics and the claim of needing a better documentation. They do not acknowledge that practical work helps to better understand the topics. However, it is important to notice that with that educational approach the number of students that pass the course is lower.

This is the opposite for groups from 5 - 20 students, where they very much appreciate the opportunity of using the class time working as in professional assignments; in concordance the level of satisfaction was very high (4.5/5). No significant changes regarding the methodology followed were appreciated from small groups: in both cases the level of satisfaction was high.

Professors' perception is that takes an extra effort to give the flipped class and also that students underuse web-based tutoring support provided. In large groups there is not the time needed to give face to face tutoring support to all students, so a better interaction is needed. Professors and students' level of satisfaction regarding the class size is in agreement.

Following an on-going evaluation do not always allows students to achieve the best scores, even though they are more homogenous between the different tasks. This can be explained taking into account that students face for the first time at the Master Program with a new, more demanding methodology that requires him a more active role and responsibility of his learning process. This is not the only factor that can influence the answer: students in large groups perceive the course as less relevant to their professional activity. While for students in the small group the course is relevant in their specialization.

It can be conclude from the qualitative analysis presented that combining experiential work, flipped classroom and gamification, is a methodology suggested for small groups.

There are more constraints and challenges for the academic community taking into account the constant evolution and rapid changes of the so called "Digital Society" that have a deep impact on the success of the innovations introduced in the classrooms, some of them have being approached in this article and could be analyzed in future research.

## ACKNOWLEDGEMENT

The authors want to recognize the support obtained from the Universidad Politécnica de Madrid through its "Innovación Educativa" grants for the 2018 year.

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