

WORKSHOPS IN “CONSTRUCTION OF STRUCTURES I”: A NEW TEACHING METHODOLOGY IN THE BUILDING ENGINEERING DEGREE

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Abstract

Both the current economic situation in the construction sector and the continuous normative changes in the building area imply the use of new methodologies to enhance students' competences in the degree of Building Engineer.

The aim of this paper is to present, analyse and discuss the development of constructive workshops as a new teaching methodology used in the subject of Construction of Structures I at the University of Alicante to complement the constructive and technical knowledge acquired by our students and to enhance their communicative and representation skills essential for their professional practice in the future.

The used methodology is based on the development of three-dimensional construction details (in groups of 3 or 4 students) to be shown in two A1-panels exposed in the corridors of the Polytechnic School. Thus, students' work approaches constructive problems in a global way by discussing simultaneously with teachers and other groups about the most suitable solution on each case. This contribution has multiperspective results and improves criticism of students in different areas, encouraging new learning strategies and active participation.

What is more, on-line information and web applications have been used to prepare and organize this kind of workshops, allowing students to use new technologies as a complementary learning methodology.

In conclusion, the use of these new workshops in the Degree of Building Engineer stimulates an interactive class versus a traditional lecture where the participative groups' attitude and the development of oral presentations dissolve the traditional boundaries regarding public communication skills of the students in the Degree.

Keywords: construction, workshop, building engineering, innovative methodology.

1 INTRODUCTION

On the one hand, the implantation of new university degrees within the European Higher Education Area (EEES) implies the need of innovative methodologies in all kind of subjects, especially those regarding practical knowledge demanded by society.

On the other hand, both the current economic situation in the construction sector and the continuous normative changes in the building area [1,2,3] imply the use of new teaching methodologies to enhance students' competences, specialization and team work in the degree of Building Engineer.

The main aspects that will characterize this professional practice in the coming years (and university education should give a response about them) are based in a better understanding of technical solutions, 3D design and participation in multidisciplinary teams during the teaching-learning process [4,5]. Because of that, it is necessary to enhance students' ability not only in solving construction problems in architectural projects but also to present their decisions in public, to other professionals or non-experienced audience, in order to explain the potential of their specific proposal.

So for us, it seems especially important for our students to acquire the ability to expose and reason technical solutions to other agents involved in the construction industry; and therefore, the training process should emphasize these kind of skills: transmission of ideas, reasoning ability and self-criticism of the students.

Because of that, the aim of this paper is to present, analyse and discuss the development of constructive workshops as a new teaching methodology used in the subject of Construction of Structures I (Fig.1) for the Building Engineering Degree at the University of Alicante to complement the constructive and technical knowledge acquired by our students and to enhance their communicative and representation skills (essential for their professional practice in the future).



Fig 1. Logo of the subject "Construction of Structures I".

2 MATERIALS AND METHODS

In Construction of Structures I we propose both interactive classes and practical exercises supervised by teachers, combining individual work, group work and workshops. This methodology enhances the ability for understanding new concepts, the students' capacity for working in groups, and their ability for conveying their ideas and solutions in public exhibitions. Considering all these aspects, pupils defend and present their proposed technical solutions, what shows their capacity for expressing their ideas and criticise different resolutions of technical problems.

The used methodology is based on the development of three-dimensional construction details (in groups of 3 or 4 students) to be clearly defined in two A1-panels exposed in the corridors of the Polytechnic School. Thus, students' work approaches constructive problems in a global way by discussing simultaneously with teachers and other groups about the most suitable solution for each case. This contribution has multiperspective results and improves criticism of students in different areas, encouraging new learning strategies and active participation in the workshops' sessions [6, 7].

The main topics studied in this subject are divided into five different blocks: the first is dedicated to generalities of reinforced concrete and armours; shallow foundations are studied in the second block; aspects of deep foundations are explained in the third block; the fourth is devoted to the various types of existing walls; and finally, the fifth block is reserved for slabs. These 5 general blocks gradually cover different stages of real professional work of the Building Engineer, having an important constructive dimension and a real professional application [8].

These lectures are complemented by an interesting practical work that students undertake voluntarily to secure the contents studied through the different blocks, allowing them the achievement of new skills through the practical application of knowledge in constructive real examples.

2.1 Statement of coursework

Regarding this, the coursework consists on the implementation (in 2D and 3D) of one on the details studied and corrected during the practical classes. Students have previously worked in class with those details, drawing different solutions. Therefore during the development of the workshop, students assure new knowledge defining that particular solution in drawing programs (.cad) to deepen about the construction process (step by step) necessary for actual construction work.

Given this methodology, each of the 5 theoretical groups in the subject is divided into working groups of 3 or 4 students, depending on their personal preferences. Once students have organized each group, the teacher provides a detailed list with an individual assignment to each working group (Fig.2).

ASIGNACIÓN TRABAJO CEI		
GRUPO	PRÁCTICA	DETALLE
Grupo 1.1	Práctica 8	A
Grupo 1.2	Práctica 6	A
Grupo 1.3	Práctica 7	C
Grupo 1.4	Práctica 5	A
Grupo 1.5	Práctica 3	B
Grupo 1.6	Práctica 8	B
Grupo 1.7	Práctica 4	Secc. A
Grupo 1.8	Práctica 7	A
Grupo 1.9	Práctica 9	Planta Unidireccional
Grupo 1.10	Práctica 4	Planta
Grupo 2.1	Práctica 6	C
Grupo 2.2	Práctica 5	B
Grupo 2.3	Práctica 7	B
Grupo 2.4	Práctica 4	Secc. B
Grupo 2.5	Práctica 8	C
Grupo 2.6	Práctica 9	Planta Reticular
Grupo 2.7	Práctica 1	Ejercicio 1

Grupo 3.1	Práctica 9	Secc. A
Grupo 3.2	Práctica 8	D
Grupo 3.3	Práctica 7	D
Grupo 3.4	Práctica 4	Secc. C
Grupo 3.5	Práctica 10	Secc. Unidireccional
Grupo 3.6	Práctica 8	H
Grupo 3.7	Práctica 5	C
Grupo 3.8	Práctica 10	Secc. Reticular
Grupo 3.9	Práctica 8	E
Grupo 3.10	Práctica 5	D
Grupo 3.11	Práctica 10	Ejercicio 2
Grupo 4.1	Práctica 7	F
Grupo 4.2	Práctica 3	A
Grupo 4.3	Práctica 8	F
Grupo 4.4	Práctica 10	Planta Unidireccional
Grupo 5.1	Práctica 8	G
Grupo 5.2	Práctica 7	E
Grupo 5.3	Práctica 6	B
Grupo 5.4	Práctica 10	Planta Reticular

Fig 2. List with individual assignment to each working group.

In addition to that details' assignment, the teachers prepared a detailed description of the instructions for the completion of course work: delivery will consist in making two A1 panels for each group of students. Each detail will fully explain (with texts and drawings) the construction process. Regarding the texts, it is considered that there should be a detailed description of the construction process, as well as a legend in every detail. Referring to the drawings, we consider relevant both 2D drawings (plans, sections, details, etc.) and 3D drawings (general views, details, assembly process, etc.).

Furthermore, the statement indicates that both A1 panels + CD (with texts and drawings describing the constructive procedure of the detail assigned to each group) will be delivered in the first class (according to the group for each student) in the last week of the semester. That day, all required documentation will be delivered and the panels will be hung in the walls outside the classroom.

To assure that all aspects of the delivery were sufficiently clear, the teachers provided three different examples of possible designs for the A1 panels (Fig.3), given that they had to combine all kinds of information (plans, sections, 2D details, 3D details, images, photographs, etc.) for a better understanding of the constructive element in each studied case.

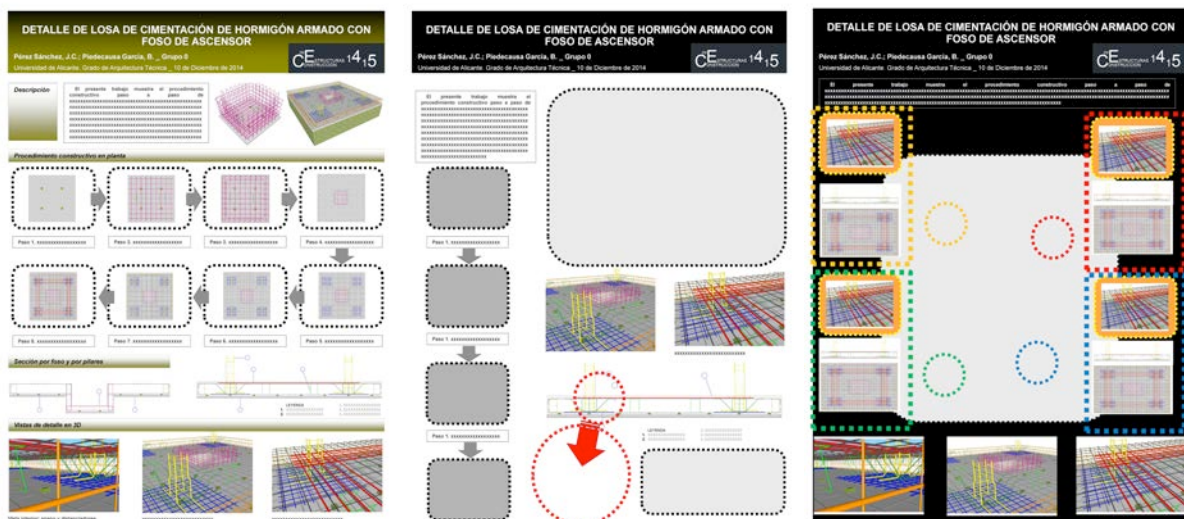


Fig 3. Examples of possible designs for posters in A1 format.

2.2 Requirements of delivery

Moreover, in order to clearly establish the documentation required for delivery, the statement of the course work also includes a list of the minimum deliverables:

- 2 panels A1 with a montage of texts and drawings (Following the examples of Fig. 3).
- 1 CD or DVD with the following contents:
 - **.dwg files**, with the 2D drawings in Autocad (sections and plants). Following the distribution of layers and 2D drafting standards established in the designs provided by the teachers. (Fig. 4).
 - **.skp files**, drawings made in 3D Sketchup (perspective). Following the distribution of layers and 3D drawing standards established in the designs provided by the teachers. (Fig. 5).
 - **.pdf files / .ppt**, with panels A1.
 - **.jpg files** with the images used.
 - **.ppt file** with the oral presentation for the second day.

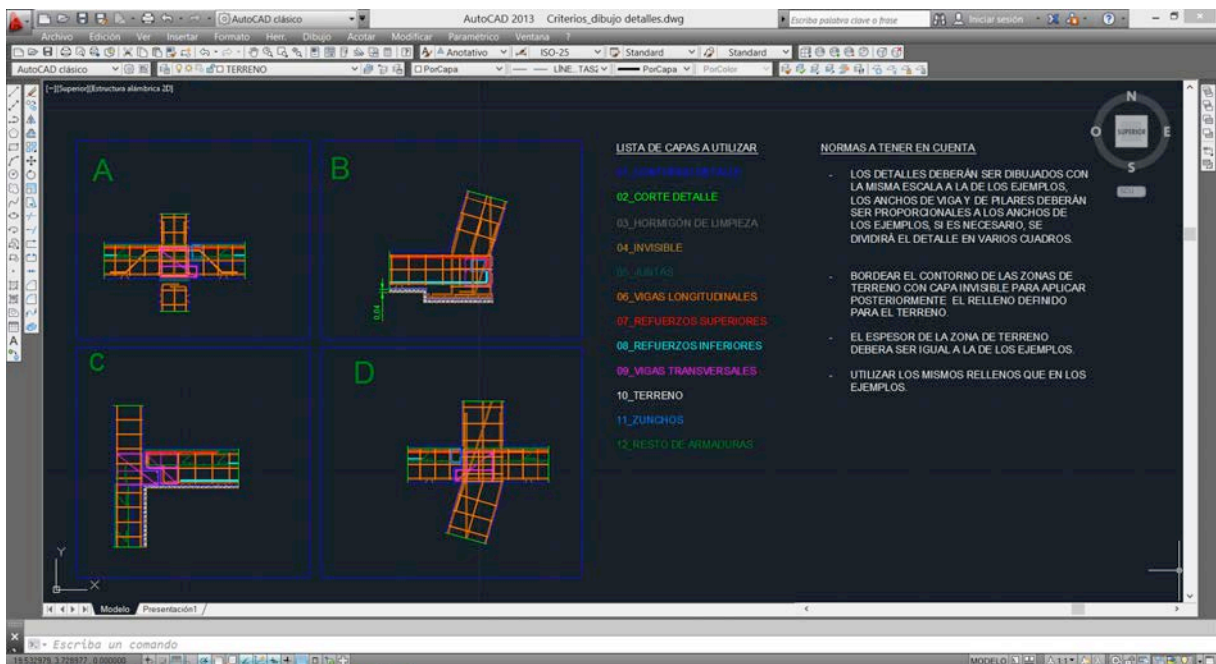


Fig 4. Drawing standards in 2D provided by the teachers.

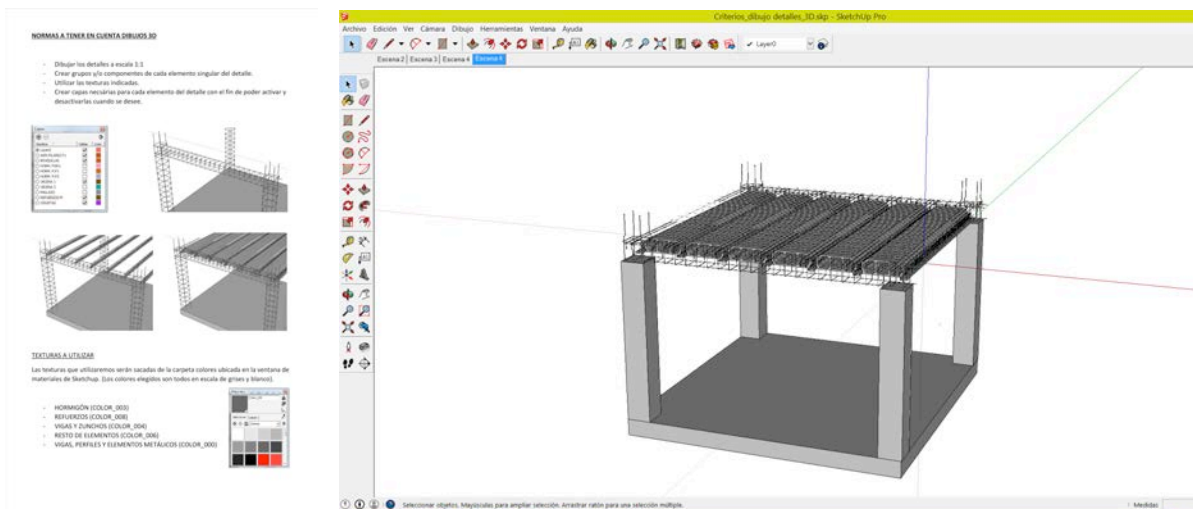


Fig 5. Drawing standards in 3D provided by the teachers.

On the other hand, besides the delivery of the two panels required with graphic information, it is proposed that, in the last class of the semester, every students' group exposed orally their work in the classroom (with constructive solutions), preparing a PowerPoint presentation with images and texts of the assigned detail (Fig.6).



Fig 6. Oral presentation of each working group to other teammates.

In order to increase the resources available for students during the completion of course work, they are also provided the opportunity to correct the graphical part of their work with an expert in design. The schedule of these corrections was available online (with dates and hours) (Fig. 7), so that each group of students could book their preferred time for each correction.

Corrección parte gráfica trabajo de curso CE1

Cada grupo deberá reservar sólo una franja horaria de 15 minutos, por lo que las dudas deben referirse al contenido gráfico y ser concretas.

Online Application
Youcanbookme

MORNING: 6 DISPONIBLE	AFTERNOON: 9 DISPONIBLE
jue 11/12/14	vie 12/12/14
9:30	9:30
9:45	9:45
10:00	10:00
10:15	10:15
10:30	10:30
10:45	10:45
11:00	11:00
11:15	11:15
11:30	11:30
11:45	11:45

Fig 7. Online application where students could choose day and time for graphical correction of their work.

3 RESULTS AND EVALUATION

The workshop and the public exhibitions proposed reveal the importance of these exercises to provide adequate training for future professionals. With these types of practices, leadership skills and group work can be evaluated. The work in multidisciplinary teams answer the current need of a greater specialization and sharing knowledge among students of different backgrounds through interaction; public/private discussions give unexpected and interesting results through their final work (Fig.8).

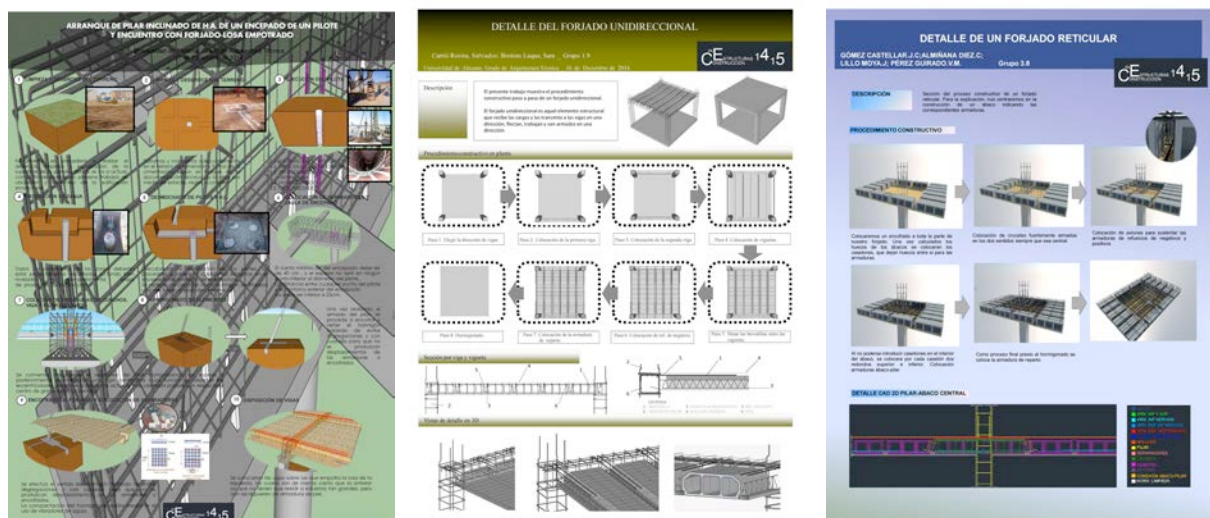


Fig 8. Coursework 2014-15.

Evaluation criteria is based on the assessment of both knowledge and skills displayed by the students in posters and oral presentations, showing the best way to explain and transmit different constructive

solutions. Therefore, taking into account the correct constructive information required for technical architectural projects, as well as the proper expression of their content, criteria and technical arguments about the relationship between architectural idea and its construction are also evaluated.

Moreover, in order for students to become actively involved in the evaluation of their work, a form has been proposed to vote for the best poster and best oral presentation. Thus, all teams should cast their vote for the best poster (among all groups of the subject) and the best oral presentation (for each group) via the following web form:

<https://docs.google.com/forms/d/1EtI8qJRiLuXjcmJeC5JIBmNNh1Lmb-4xRBEX62RYLeM/viewform>

In this form, apart from indicating the group number chosen, students have to indicate two reasons motivating their choice. No group can vote for himself and in case of tie, the teachers' opinion shall prevail.



Fig 9. Control of deliveries: posters, oral presentations and documentation on CD + online form for choosing the best course work.

4 CONCLUSIONS

The development of public workshops and exhibitions in the course of Construction of Structures I in the Building Engineering Degree has revealed the interest of students in learning through this kind of practical work. Regarding this, the participatory attitude of each member of the group is valued in the final work, considering their knowledge and domain of all the solutions developed by the team (Fig.10).



Fig 10. Public exhibition of the panels outdoors 2014-15.

The public exhibitions stimulate the enforceability of each individual student while develops the ability to work in multidisciplinary teams and distribution of tasks. The review and valuation of work between different partners (Peer Reviewing) (Fig.11) stimulates the ability regarding self-evaluation of personal work.

Thus, each team has chosen the best oral presentation and best poster from his teammates. The result of this vote will be reflected in an academic recognition of effort and quality for the teams with the best selected works.

Número del Grupo que emite el voto (Ej. 1.1, 2.3, etc.)	Mejor póster	2 razones de la elección como Mejor Póster	Mejor Presentación Oral	2 razones de la elección como Mejor Presentación Oral
1.2	2.1	Porque está bien organizado, las vistas de 3D son claras	1.3	Por que está bien explicado el proceso de erosión y bien explicado
1.1	2.1	Es el que más nos gusta	1.3	Nos ha gustado bastante, ha estado bastante elaborado
3.8	4.2	Por su aparente gran elaboración y nos gusta mucho el formato elegido.	3.4	Ha sido lo que mejor han explicado en detalle, que nos ha servido para aprender respecto al examen de Eneer ya que han puesto un vídeo explicativo muy útil para la asignatura.
2.4	2.3	Me ha parecido sencillo y muy explicativo.	2.1	Es muy explicativa y el dibujo en 3D ha permitido verlo todo muy bien.
2.3	2.4	Se aprecia muy bien todo el desarrollo y proceso constructivo	2.4	El vídeo ha facilitado la comprensión.
1.8	2.4	El 3D estaba muy bien hecho y la vista en planta	2.4	Buena presentación y proceso constructivo muy fácil de entender
		Buena presentación y dibujos muy trabajados.	2.4	Muy completa y fácil de entender
		Las razones de nuestro voto son: - El trabajo no presentaba ningún fallo constructivo. - Se presentaban dos carpetas en A1. Estaba compuesto, cada uno, de detalles únicamente en 2D y, aunque eso no era realmente lo que se pedía, al ser el detalle complejo era la mejor manera de entender y poder apreciar todas las armaduras, direcciones, encuentros, etc. - Además, están los motivos también mencionados en la parte de la mejor presentación oral.		La presentación nos gustó mucho por varios motivos: - Aunque este grupo no hizo una presentación tal y como se pedía, el vídeo, el cual, tanto el profesor como a todos los alumnos, nos gustó mucho. Se entendía perfectamente el proceso constructivo paso por paso y se notaba que sabía muy bien de lo que hablaba y muy claro, cualquier persona podía entenderlo. - También quiero destacar que el grupo estaba compuesto por tres alumnos, de los cuales solo uno fue a exponer. Se notaba, y luego lo explicó, que el trabajo lo había hecho casi todo él y eso creo que se tiene que valorar también, que solo una persona tenga que hacer todo un trabajo así por problemas.
3.4	3.3	Por la buena explicación del detalle. Colocación de imágenes en 2D, 3D y de obra.	3.3	Por la buena explicación del detalle a estudiar
4.2	3.9	Por la buena explicación del detalle. Colocación de imágenes en 2D, 3D y de obra.	3.4	Por el formato de la presentación y explicación del detalle
3.7	1.7	Considero que este grupo es uno de los que mejor a cumplido los objetivos pedidos en el trabajo y muestra perfectamente el proceso constructivo del detalle.	3.4	El power point es el que mejor a sintetizado la información contenida en el trabajo y asimismo tenía muy buena presentación visual.
1.7	1.2	Sencillez visual y facilidad para entender los conceptos	1.2	Transmisión sencilla y rápida de los conceptos
1.4	4.2	1. Buena distribución del trabajo. 2. Buenos dibujos en sketchbook.	4.2	1.- buen trabajo en general. 2.- buena explicación oral.
1.9	2.1	Esta muy bien contruido.	1.2	Sugieren explicar muy bien su trabajo.
4.1	4.2	Detalles 3D muy trabajados. Explicaciones claras. Montaje del póster ingenioso.	4.1	Exposición clara y concisa. No se han pasado y expuso el detalle de manera muy coherente.
4.3	3.9	Por la buena presentación y forma de explicar el detalle a estudiar mediante 2D, 3D y imágenes	4.1	Por lo bien que explicó su detalle
		Además tenemos (pero sabemos su número de grupo) - Es un trabajo que se ha realizado en su totalidad a diferencia del resto, todo el contenido es sencillo y se entiende con solo darle un vistazo a su póster.	4.1	Una exposición muy bien explicada y fácil de entender.
2.8	4.2	Es claro, sencillo y bien estructurado	3.2	Powerpoint bien realizado.
3.3	3.6	Buena presentación estética y clara sucesión de los pasos. Buenas perspectivas explicativas en 2d.	2.3	Clara y buena exposición y muy bien definidos los pasos en la construcción del detalle.
1.8	3.3	Bien secuenciado y bien detallado el proceso constructivo.	3.3	Tiene un vídeo del proceso constructivo lo se apreciaba muy bien y se transmitía claramente la idea
2.2	2.3	Nos gusta su presentación en los dos A1, muy completa y bien detallada.	2.3	Las chicas presentaron de forma clara su trabajo y además estaba muy completo.

Fig 11. Conclusions of the Peer reviewing: best poster and best oral presentation.

In short, the use of this new methodology in the subject and the novelty of this type of work "outside the classroom" for students of this degree, enhance the acquisition of necessary communication and graphic skills for the professional practice of the future Building Engineer. What is more, these workshops complement and better synthesize the diversity of knowledge acquired during the theoretical issues through a reasoned and coherent constructive process, which is shown in a panel exhibition in the corridors of the school.

We believe that the use of these new workshops in the Degree of Building Engineer stimulates an interactive class versus a traditional lecture where the participative groups' attitude (Fig.12) and the development of oral presentations dissolve the traditional boundaries regarding public communication skills of the students in the Degree.



Fig 12. Different groups of students participating in the workshops.

In conclusion, this teaching methodology experienced in the course of Construction of Structures I is equally applicable to other subjects of the degree with different content, not only in terms of knowledge but also regarding the skills developed, since the proposed methods and results are directly linked to practical aspects of the professional work for Building Engineers.

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