

## ACTIVE LEARNING FOR PROJECT MANAGEMENT IN CIVIL ENGINEERING

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**Abstract.** Higher Educations studies in Spain were very much impacted by the Bologna Declaration. This was also so for the Civil Engineering curricula (Ingeniero de Caminos, Canales y Puertos). When the European Higher Education Area (EHEA) was launched to promote homogeneous Civil Engineering programs in all European countries, structure of the studies changed from a five-year program to a four-year bachelor program followed by a two-year master. Not only duration, but also pedagogical methods were drastically transformed. The passive-learning professor-centred methods turn into active-learning student-centred ones.

In this paper, the example of an elective subject for Project Management of Civil Infrastructure will be presented. In this subject, Project Based Learning is the basic learning method. Students, by groups, have to work on a real project of a big civil engineering infrastructure (airport terminal, railway line, highway line). To do so, all the documents from a real project under construction are provided. Students, by groups, have to follow all the steps leading to a successful completion of the works, from proposing an offer for the bid, to the health and safety, quality and environmental management; from the technical and economic planning of the site, to the management of the relation with the press.

The presentation will address topics as various as the group motivation, the acquisition of soft skills, the learning methodology, the virtual visits to site, the interaction with BIM or the impact of the group size.

### 1 INTRODUCTION

Higher Educations studies in Spain were very much impacted by the Bologna Declaration. This was also so for the Civil Engineering curricula (Ingeniero de Caminos, Canales y Puertos).

When the European Higher Education Area (EHEA) was launched to promote homogeneous Civil Engineering programs in all European countries, structure of the studies changed from a five-year program to a four-year bachelor program followed by a two-year master [1]. Not only duration, but also pedagogical methods were drastically transformed. The passive-learning professor-centred methods turn into active-learning student-centred ones[2].

In this paper, the example of an elective subject for Project Management of Civil Infrastructure will be presented. In this subject, Project Based Learning is the basic learning method. Students, by groups, have to work on a real project of a big civil engineering infrastructure (airport terminal, railway line, highway line). To do so, all the documents from a real project under construction are provided. Students, by groups, have to follow all the steps leading to a successful completion of the works, from proposing an offer for the bid, to the health and safety, quality and environmental management; from the technical and economic planning of the site, to the management of the relation with the press.

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## **2 LEARNING METHODOLOGY AND CONTENTS**

The students are provided with the design project of a big civil engineering infrastructure and they will have to work for the full term on it. A single project is proposed to the whole group for a given academic year. These infrastructures are normally in construction or already in service. Therefore, the students can see real pictures of different phases of the project and even visit the site.

The students form work groups of 3 to 4 individuals. In order to know the project in general, they analyse the available documents linked with the contract that includes: the contract draft, its annexes, tender specifications, the design project (construction plans, technical specifications, unit prices, bill of quantities, cost estimate or health and safety studies) and the work planning. All things considered, they propose an offer for the bid. This offer might include a reduction of the original construction estimation cost, incurring in an offer risk. To conclude, a real tender is proposed among the work groups to choose the best offer.

Secondly, each group are assigned a section of the project. This section is constituted of an independent construction unit (e.g. a diaphragm wall or an underpass). They will have to study deeply their section. Especially, they examine the plans and the technical specifications to design the construction strategy. They define the necessary resources (labor, equipment, materials) to build their own section. They have to produce a complete work plan of their section, which must fit in the global plan of the infrastructure schedule. They can use a Gantt Chart organization method or similar. For this reason, it is necessary to coordinate the tasks, the predecessors, the floats, the dependencies, the critical path and the dates.

Thirdly the work group resolves specific exercises about quality and environmental management. They prepare check point tables, in which they include the main quality and security controls they consider necessary to implement in their construction method.

An important part of the subject deals with Health and Safety. The construction hazard rate is higher than in others productive sectors. The students learn to identify the workers risks

during the operations and to establish appropriate preventive measures. They choose a particular activity of their section and develop the correct prevention protocols. They present these measures in plans and diagrams to explain to the worker teams.

The students acquire transversal skills such as BIM (Building Information Modelling), which is a new technical collaborative strategy. In particular, they learn to work with BIM programmes like Revit. That way they are able to make a three-dimensional drawing of a building construction and produce several documents: plans, bill of quantities, working plan, among others.

Finally, another transversal discipline in the subject is the relation with the press. The students can know the most important advantages of answering questions correctly in a press conference.

The evaluation criterion takes 60% of the mark from the assignments and 40% from an individual exam. To foster collaboration between the groups and an effective exchange of information and actual co-working, extra points are provided if all individuals of the group get a minimum score. To motivate cultural and gender diversity extra points are also given to groups composed by students coming from different countries or with gender diversity.

Every year the students fill in a survey to detect possible improvements to include in next academic years. They agree with the general dynamic of the subject and the evaluation system. They value the acquired knowledge, because they think it is very useful for their career. Results will be shown in the oral presentation.

### **3 TECHNICAL VISITS**

The students have the possibility to be involved in technical visits from three perspectives.

In the first place, students can go to the construction site linked with their project. In these visits, the technical team explain to them the project, the work plan and the main key points of the project in the site office. Then, students are provided with the personal protective equipment and visit the site.

This is very motivating for the students. However, present regulations of Health and Safety make very difficult such visits, as companies do not provide very willingly such chances. Moreover, such visits only provide a still photograph of the site, so different construction steps are missed.

Hence, virtual visits are also planned during the course. Technical personnel from construction site come to the University and explain the main characteristics of their project. In their presentation, they show execution pictures and the main problems faced on site. These presentations are very interactive and students can ask them any doubt about it.

Moreover, students visit the headquarters of a construction company. In this visit they can see the real dynamic in this kind of companies: how they propose a bid, how they manage human resources or how the technical department works.

### **4 SOFT SKILLS: COMMUNICATION**

Soft skills are also taught in the subject plan. In the first place, press professionals teach students to face crisis situations, teaching them how to give a press conference and how to deal with the media. Students learn techniques to express correctly the facts in a press conference

and to answer questions. As an example they have to develop the communication strategy for different hot topic crisis experienced lately in Spain, the “no vull pagar” affair, where some citizens complaining about the highway tolls decided not to pay and the huge traffic jam experienced in a Spanish highway in 2017 due to the heavy snow.

Furthermore, students have to work with basic negotiation strategies, which are necessary to lead teams and to discuss with clients or suppliers.

Student’s surveys confirm that these soft skills are considered important for their education. Moreover, they have not received this kind of training during their academic studies.

## 5 CONCLUSIONS

In conclusion, Project Basic Learning allows students to complete their academic education with skills focused on their future career.

Students have at their disposal the design project of a big civil engineering infrastructure; on which they will have to do several assignments during the course. The exercises were about: bid proposal, cost estimate, Health and Safety, environmental measures, constructive methods or scheduling.

The evaluation criteria take 60% of the mark from the assignments and 40% from an individual exam. To foster collaboration between groups and an effective exchange of information and actual co-working, extra points are provided if all individuals of the group get a minimum score. To motivate cultural and gender diversity extra points are also given to groups composed by students coming from different countries or with gender diversity.

The students have the possibility to be involved in technical visits from three perspectives: to visit construction sites, virtual visits and to visit the headquarters of a construction company.

Soft skills are included in the subject plan in different times. The student’s surveys show the importance of these skills in their academic formation.

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