

TEACHING OCCUPATIONAL RISK PREVENTION FOR UNDERGRADUATE COURSES IN CIVIL ENGINEERING

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Abstract

Due to the high accident ratio in the construction industry, teaching occupational risk prevention is a key issue in any university degree focused on building and civil engineering works. The School of Civil Engineering (Universitat Politècnica de València) teaches the Bachelor Degree in Public Works Engineering. In this program, there is a specific course entitled Occupational Risk Prevention in Construction in the second academic year (spring semester). At that time (second academic year), students are not mature enough to approach this subject in a traditional way; furthermore, they still lack some basic concepts on construction technology and methods. Therefore, the main goal of the teachers is to motivate the students, so prevention is ranked in their minds at the same level as production, management or quality. Other learning objectives of this course are to get familiar with the legal regulations and the specific terminology of occupational risk prevention. In order to meet these objectives, the students are encouraged to do different practical works. One of them is the identification of occupational risks at the construction site; every team has to choose a different one according to a set of predetermined requirements, analyze the site and provide justified recommendations for improvement. Another exercise deals with the selection of a real event, revealed in the public media; the students have to investigate the incident, analyze it, and propose the measures that could have avoided it. Thus, through the study and analysis of real-life examples, students gain a greater awareness of the importance of risk prevention in the Spanish construction industry.

Keywords: Construction, Motivation, Occupational Risk Prevention, Teaching.

1 INTRODUCTION

It is well known the current high accident ratio in the construction sector [1, 2]. According to the European Agency for Safety and Health at Work, each year more than 1,300 people die because of occupational accidents. Also, worldwide, workers in the construction sector are three times more likely to die and twice to get injured than workers in other sectors. Given the size of the companies and because small and medium enterprises (SMEs) account for over 99% of European construction companies, these businesses are the most affected by the accidents.

In Spain, this problem is worse, because the accident ratio is higher than in Europe [3]. The number of accidents has kept increasing since 1997 [2]. From the educational point of view, since 2010, there were not engineering degrees specialized in occupational health and safety. Engineers acquired professional competences just because of getting an engineering degree. With the Bologna Process, new programs and syllabus were created by the universities with the support of the Spanish Ministry of Education [4].

As a result of this process, the School of Civil Engineering at the Universitat Politècnica de València offers two mandatory courses related to occupational health and safety applied to the construction industry. There are two different undergraduate degrees offered by the School: Public Works Engineer and Civil Engineer. For the first degree, there is a mandatory course in the second academic year that deals with occupational health and safety in construction exclusively and it comprises 4.5 ECTS. For the second degree (Civil Engineer), there is a mandatory course in the third academic year that deals not only with occupational health and safety, but also with practical aspects of cost engineering; the occupational health and safety comprises 3.0 ECTS approximately out of the 4.5 ECTS of the course.

Both courses have the following goals:

1. Introduce the student to the occupational health and safety so they can learn not only technical aspects but also managerial ones.
2. Provide the vocabulary and terms to the students that are usual in occupational health and safety in construction.

3. Facilitate the regulations and standards related to occupational health and safety.

1.1 Educational Objectives

The main goals of these courses related to occupational health and safety are:

1. Build a positive attitude towards occupational health and safety.
2. Motivate the student so he/she perceives the occupational health and safety as something needed, locating it at the same level as production or quality.
3. Acknowledge the most important risks in construction, as well as the techniques and prevention measures in order to eliminate or decrease the risk.

1.2 Contents

The topics of the courses are grouped as follows:

<ol style="list-style-type: none">1. UNIT I: GENERAL ASPECTS<ol style="list-style-type: none">1. Introduction. Basic concepts on health and safety.2. Regulations on health and safety.3. Risk assessment.4. Standards on the construction industry.2. UNIT II: HEALTH AND SAFETY MANAGEMENT<ol style="list-style-type: none">1. Health and safety management applied to the construction industry2. Planning and monitoring applied to prevention of construction works.3. UNIT III: SAFETY ON CONSTRUCTION WORKS<ol style="list-style-type: none">1. Demolitions.2. Earthmoving. Site organization. Machinery.3. Concrete structures. Collective protective equipment.4. Industrial building and steel structures. Elevation machinery.5. Building. Walls. Finishes. Roofs. Auxiliary measures. Scaffolding.6. Highways and tunnels. Provisional signaling at the site.4. UNIT IV: SAFETY OF THE WORK TEAMS AND COMPLEMENTARY PROTECTIVE MEASURES<ol style="list-style-type: none">1. Electrical facilities. Electric risk.2. Individual protective equipment.3. Safety signaling.
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Fig 1. Contents by unit.

1.3 Organization

The teaching and learning methods are distributed in the following way:

1. Lectures, where the topics are explained by the teacher and questions are proposed to the students.
2. Practical activities, where the teacher proposes practical examples to solve as a team.
3. Visit to construction sites, included as a part of the teamwork for the course.

1.4 Evaluation

In order to evaluate the acquisition of the objectives, exams (from one to three) are done, as well as exercises that are explained in the following sections.

2 METHOD

In both courses students have to develop a team work whose objective is the critical analysis of a construction Project. Furthermore, in the course belonging to the degree in Public Works Engineering the students have to develop news related to the occupational health and safety published in Spain. This way, through the study and analysis of real cases, students get a better conscience on the importance of occupational health and safety in the Spanish construction industry.

2.1 Teamwork

The method is explained as follows:

- 1) Finding a construction project. Students have to form groups of 3-4 people. They have to choose a construction project in order to develop the homework. Before a deadline, one of the students in the group, chosen as a representative, has to deliver a pdf file with the following information on the project:

Title of the project.
Location, shown in a map.
Brief description of the project, providing pictures on the current state.
Components of the group, indicating the student that will represent the group for the matter of deliveries and notifications.

- 2) Once the project is accepted by the teacher, the students will visit three times the construction project in its different construction phases; they have to watch and analyze the occupational risks as well as the preventive measures adopted and the possible improvements. Using pictures and gathered information, they produce a power point presentation before a deadline. This course project is presented in class and it is evaluated by the teacher according to the criteria explained in section 3. The students analyze the risks and preventive measures adopted as well as the improvement proposals; the students have also to include an assessment of three risks, identified in an activity, a workplace, and teamwork developed through the general method of risk assessment.

2.2 Individual work

In this case, the students develop an individual work according to the following criteria:

- 1) Finding a piece of news related to the occupational risk prevention. The criteria to accept the news by the teacher are the following:
 - 1.1. The news has to be published in Spain.
 - 1.2. The publication period is established from May to February.
 - 1.3. The news has to be related with the occupational risk prevention in the construction industry.
 - 1.4. The students cannot choose the same news already chosen by other student.
- 2) Once the news is chosen, the students have to deliver, before a certain date, a pdf file with the following data:

Title of the chosen news.
Published news.
Source and date.
Name of the student.

- 3) The teacher has to approve the news presented by the students. In case of repeated news, the teacher accepts that one that has been delivered first. The student, whose news has not been accepted, has to look for another one that complies with the required criteria.
- 4) Once the news is accepted, the student has to prepare a power point including the following items: the chosen news, an abstract of the news highlighting the most important aspects, the development of the subject related to the news and the occupational health and safety, and

conclusions about what the student has learnt with the development of the work. It has to be delivered according to a deadline. As with the teamwork, the individual work is presented by the students in class, and it is evaluated by the teacher according to the criteria explained in the following section.

3 EVALUATION

The evaluation of both works, individual and team, is done according to the rubrics produced by the teachers of the course.

3.1 Teamwork

The evaluation of the teamwork is done using a rubric that contains the criteria related to with the educational objectives of the course. Moreover, these criteria group several items or facets that the work produced by the students has to comply with.

Fig. 2. Rubric for the evaluation of the teamwork.

SESSION #		EVALUATED BY :
Date		
Criterion	Score	
Delivery	0,5	Delivery of the file has been carried out in the appropriate format (power point)
		The file is named correctly
Structure	1,5	Title page: Information that appears in it allows to know the object and the authors of the work
		The work contains a paginated index that allows to know the work done
		The work highlights the important points
		The extension of the work is correct (30-40 slides)
		Parts of the exposition are well balanced and they are adjusted to the time set
Slides	2,0	The slides are numbered correctly . The slide number with respect to the total number of slides is included
		Each slide contains information of the work that is being described (titles, subtitles, etc..)
		No misspellings in the text
		Each slide contains few letters, short sentences, and they are well visible
		Colorful slides is pleasing to the eye , and the text contrasts well with the background of the slides
Public Presentation	2,5	The student has a clear pronunciation and he/she has used appropriate words
		The volume and rate of speech have been adequate
		Body gestures have been moderate
		The student has generally looked to the audience , trying to involve all the public in his/her presentation
		The presentation has been prepared in advance
Content	3,5	The content allows to know the work developed by the group
		The content of the work is related to the topics of the course
		The work contains conclusions that help to assimilate the work done by the students
		The work includes new contributions to the topics covered in the course
		The student / group have adequately answered all questions
TOTAL	10,0	

As it can be shown in the rubric (Fig. 2), five criteria are established, each of them divided in several items; all of them are required to evaluate the team work. The higher percentage is assigned to the content of the work (35%); this criteria values, among other facets, that student produce new contributions to the occupational health and safety field and that the work has sound conclusions that allow assimilating the analysis of the construction project for each group. Then, with a 35% percentage, the public presentation is evaluated, taking into consideration facets such as vocalization, voice volume or speaking speed, as well as the preparation of the presentation by each student. These criteria will difference the score of the students belonging to the same group, because the other criteria assess the team, not the individual. The other criteria is called "slides" (20% of the score), which considers facets such as orthography mistakes, numbering of the slides, titles and sub-titles, the easiness to capture the message by the rest of the class, or the quantity of text included in each slide. The structure of the work assess (15%) that the work has a cover with the required information to

identify the object and authors of the report, a table of contents (numbered) that allows knowing the contents, highlighting the important point, having a right extension and balanced parts. Finally, the format and name account for the last 5%.

3.2 Individual work

The rubric used for evaluating the individual works is very similar to the one applied for the team work, because the same criteria are evaluated: delivery, structure, slides, oral presentations and contents. In this case, however, the teachers have into consideration that the report contains all the required parts: news, abstract, development of the topic, and conclusions and personal opinions regarding lessons learnt. Furthermore, this work values if the student includes a set of correct bibliographic references.

4 RESULTS

Taking as an example one of the groups in the degree of Public Works Engineering (academic year 2012-2013), comprised by 54 students, the following results were obtained for each type of work.

4.1 Teamwork

The scores obtained in this work are depicted in the following figure.

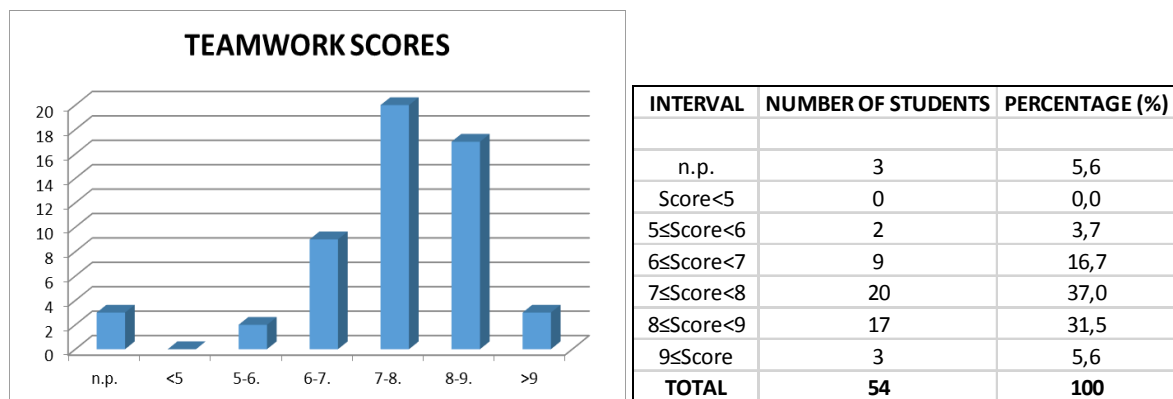


Fig. 3. Evaluation of the team work.

As it can be notice from Fig. 3, 74% of the students got a score higher than 7 (out of 10), having into consideration that almost 6% of the students did not delivered the work.

4.2 Individual work

In the individual work, the results were the ones shown in Fig. 4.

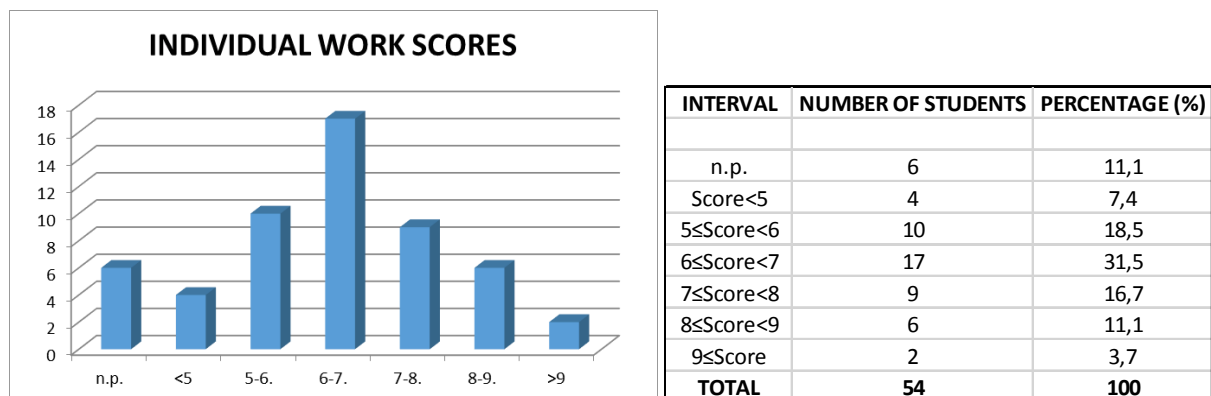


Fig. 4. Evaluation of the individual work.

In this case, the scores were more balanced among the different intervals, being the one between 6 and 7 the one with the most number of students (32%). That same percentage represented the student with score higher than 7.

5 CONCLUSIONS

The main conclusions of this experience are the following:

- Using rubrics in order to evaluate individual and team work, and considering the good scores obtained, it can be used to verify that the educational outcomes have been achieved. Specifically, through the evaluation of the contents of both works, it can be checked that the students have learnt the vocabulary and usual terms regarding the subject of occupational health and safety as well as the current regulations. Furthermore, evaluating the contents of the teamwork enable to verify that the students are able to identify risks, assess them and determine the preventive measures that are more adequate for their elimination or decreasing, as well as the comprehension of new construction methods. It is worth mentioning in this regard that the knowledge acquired by the students can be checked through the exams that are performed in both courses too.
- Moreover, the educational objectives of creating a positive attitude as well as a motivation towards the occupational health and safety are directed related with the good scores obtained in the works, because the interest and effort made by the students can be perceived, not only in the delivery and content, but also in the public expositions.
- The fact that the students have to visit construction projects and develop knowledge from current news facilitates that the students acknowledge the importance of the occupational health and safety for their future professional work, being as important as production for them.
- Finally, the development of the works is favored by the acquisition of transversal competences by the students, such as teamwork and public communication.

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