

THE CIVIL ENGINEERING OLYMPIAD: A PROGRAM TO OPEN STUDENT VOCATIONS

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Abstract.

Five years ago the US Bureau of Labor Statistics predicted a much higher than average growth in jobs over the next decade in Civil Engineering (CE) areas, approximately 19%. This supposes a clearly need for qualified civil engineers to fill these jobs, however during the last decades the number of students interested on CE university degrees has decreased. In Spain, the economic crisis has aggravated the problem, in consequence the Professional Association of Civil Engineers (Colegio de Ingenieros de Caminos, Canales y Puertos) and four Superior Technical Schools of the universities of Granada, Sevilla, Alicante and Polytecnic of Valencia have joined together to develop a program to open secondary students vocations. The program has been named The Olympiad in Civil Engineering; it is a competition between teams of five students to overcome, in the shortest time possible, six tests related to different areas of CE: Hydraulic Engineering, Mechanical and Structural

Engineering, Environmental Engineering and Construction Engineering. Winner team of each university will compete in a national final. In May 2018 one of the participant universities has developed a pilot experience to check the tests and solve possible organization problems to celebrate the First Edition of the Olympiad of Civil Engineering in 2019 with a higher number of Universities. This is one way to increase the pool of gifted students who could study Civil Engineering degrees in future, as similar competitions and programs successfully developed during year, for example Mathematical, Biological or Chemical Engineering Olympiads, among others.

1 INTRODUCTION

Technological and Engineering university degrees will be, during the next decades, the ones that have the best job insertion and an exponential demand. However, fewer and fewer young people decide to choose them. This situation, which is known as "talent deficit", is already a problem in the area of Engineering and it is causing an imbalance between the professional offer and the needs of the labor market. Universities, companies and human resources consultants, warn that without the appropriate professionals, the economic consolidation could be put at risk. Randstad, a leading company in human resources, declared that in 2020 Spain will need 1.9 million highly qualified workers [1].

There are several reasons to explain this vocations crisis. On the one hand, the applied methods in primary and secondary education to teach the basic materials for Engineering (mathematics and physics) are not motivating; on the other hand, the non-choice of engineering studies is linked to the fact that this sector has lost its recognized high quality of work; besides, the salaries do not respond to the demands and they are not proportional to the difficulty of this studies.

In the case of Civil Engineering, this situation has been aggravated by the crisis, which has reduced, in Spain, public investment to unsuspected limits a decade ago. However, the professional with advanced training in the framework of Civil Engineering, the called *Ingeniero de Caminos, Canales y Puertos* in our country, has been characterized by a recognized training that has enabled him to adapt to different labor markets, not only the construction sector.

Therefore it is necessary to encourage vocations in this sector at increasingly younger ages showing that civil engineering has a great future in the development of infrastructures in developing countries but also in developed ones. They will also be key professionals in the technification and digitalization of Europe, and in particular Spain, since the technological revolution is already present in the infrastructures: waste and drinking water autonomous plants, waste management self-winding plants, intelligent bins to collect municipal waste, intelligent transport, etc. Besides, five years ago the US Bureau of Labor Statistics predicted a much higher than average growth in jobs over the next decade in Civil Engineering (CE) areas, approximately 19%. This supposes a clearly need for qualified civil engineers to fill these jobs [2,3].

Following the example of successful cases of competitions in Mathematical, Biological or Chemical Engineering areas [4], among others, the Professional Association of Civil Engineers (*Colegio de Ingenieros de Caminos, Canales y Puertos*) and four Superior Technical Schools of the universities of Granada, Seville, Alicante and Polytechnic of Valencia have joined together to develop a program to open students' vocations. The program has been named The Olympiad in Civil Engineering (*Olimpiada de la Ingeniería de Caminos, Canales y Puertos*) and, after a pilot experience last May, the Professional Association expects to extend it throughout different Spanish universities to make visible the profession in secondary schools. This paper describes the initiative, as well as preliminary results of pilot experience.

2 DESCRIPTION OF THE OLYMPIAD IN CIVIL ENGINEERING

The Olympiad in Civil Engineering (Figure 1) has been designed as a team competition in which students from Secondary Schools compete in 6 events pertaining to various areas related to Civil Engineering activities (Figure 2): Hydraulic Engineering, Environmental Engineering, Structural Engineering, Civil Engineers and their constructions. These events should be properly developed in the shorter time as possible. Events will be developed as a gymkhana in teams of 5 students and supervised by a teacher who plays the role of referee.



Figure 1:Logo designed for the The Olympiad in Civil Engineering.

1. Build your future	2. Da Vinci Bridge	3. Build a dam
A half-arch structure must be built to resist without falling for at least 5 seconds	Da Vinci Bridge will be built and resist, without falling, to one of the member of the team during, at least, 5 seconds	A dam will be built and the time it takes to break once it is filled with water will be measured
4. Civil Engineers and their constructions	5. ReLATICicla	6. Playing to be Engineers
6 puzzles with pictures of engineering works should be assembled in the shortest possible time	A 2 m sculpture with recycled cans should be built	It will consist in making a challenge with a construction videogame

Figure 2:Characteristics of events forming The Olympiad in Civil Engineering.

The Olympiad has been planned for three levels of competition: local, regional and national, described bellow (Figure 3):

- **Local level.** This phase will run by Secondary Schools to invite teachers and students to improve skills related with this area thanks to the practice of the 6 events designed.
- **Regional level.** In this case the selected teams will have to compete in each Superior Technical Schools that participate in The Olympiad. Teams that excel at regional competitions advance to the national level. During the participation, general and cultural activities will be also developed in the University Centre.
- **National level or Great Final.** Each year, one of the participant Universities will be chosen as headquarters to the final competition. Participant teams of different places of Spain will travel to the national headquarter to develop the same 6 event. Three final levels of winner will be chosen after the competition: Olympic Gold, Silver and Bronze Medals in Civil Engineering. During the participation, general and cultural activities will be also developed in the University Centre and in the city.

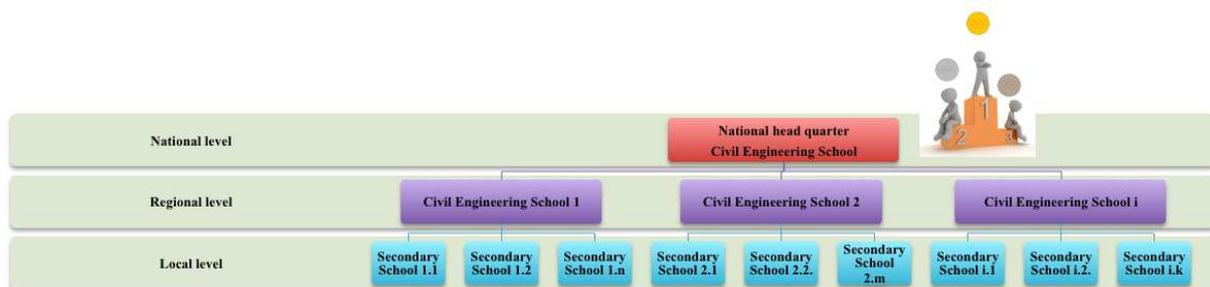


Figure 3:The Olympiad in Civil Engineering competition levels

3 DEVELOPMENT OF THE PILOT EXPERIENCE

In order to verify the six events designed by teachers from different universities, as well as the organization of the competition, a pilot phase was carried out in May 2018; during this phase students of 2° ESO from the Secondary School Cristo de la Yedra, in Granada, was invited to participate. Some organizers of the Olympiad visited the School to explain to teachers the objective of the competition, the development of the events and to give them some materials necessary to train.

After a month of training with the teachers of the school, 25 students were selected (16 girls and 9 boys) organized in 5 teams. These teams visited the High Technical School of Civil Engineering of the University of Granada, where they competed along one morning with another team integrated by university teachers. Six teachers of the High Technical School acted as referees for each of the events. Figure 4 shows some pictures of the competition during the development of the events.



Figure 4: Pilot experience of The Olympiad in Civil Engineering in High Technical School of Civil Engineering at the University of Granada.

The score of the different events was given in time. Table 1 summarized the name of each of the participating teams, as well as the scores obtained in the different events in minutes. The winning team was Cheese Team, the team that developed all the events in the lower time. The winner of each event and the final winner have been identified in this Table.

Table 1: Final scores for each team, in minutes

Events	Teams					
	Efestivw onder	Picapiedra	TeamC heese	TeamD ream	Roquefort	Teacherst eam
1. Buildyourfuture	0.68	1.68	0.67	1.58	1.05	1.8
2. Da Vinci Bridge	7.25	2.2	2.88	3.06	3.63	3.75
3. Build a dam	3.87	3.27	1.46	2.2	1.63	2.4
4. Civil Engineers and their constructions	10	12	11	11	10	10
5. ReLATIcicla	15	15	15	13.26	15	15
6. Playing to be Engineers	11	11	8	9	9	7
Final score	47.8	45.15	39.01	40.1	40.31	39.95

Final position	6°	5°	1°	3°	4°	2°
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In order to know the influence of the Olympiad on the participating students, a brief survey was prepared and implemented before and after the event. It was designed to ask about the working area of Civil Engineers or the possible election of students to study to develop this profession, among others. Figure 5 shows that before the competition, be Civil Engineer was among the five first positions only in the case of three students (12 %); however, at the end of it the number was increased to 7 (28%), that is, it was increased by 16%. On the contrary, the election 6th or higher positions were reduced by 16%, passing from 15 to 11 students. Therefore, it could be concluded that the competition opened up vocations among potential students to be Civil Engineers. It is important to note that, both before and after the competition, there were not girl who chose the profession of Civil Engineer among the top five positions. This result highlights the importance to encourage girls to study Engineering degrees in general, and Civil Engineering particularly.

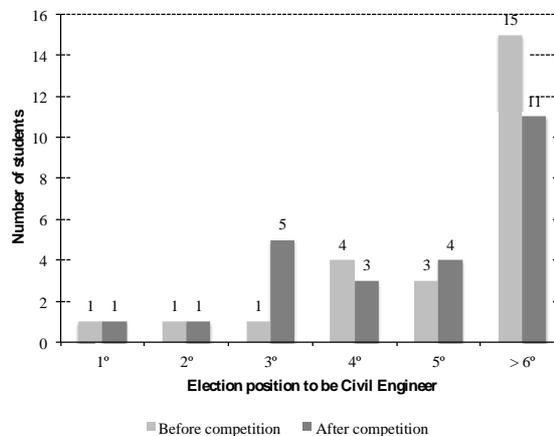


Figure 5:Pilot

experience of The Olympiad

in Civil Engineering in High Technical School of Civil Engineering at the University of Granada.

Regarding the knowledge that students have about the working area of Civil Engineers, Figure 6 summarizes results before and after the competition. Results have showed that, although there are some working areas of Civil Engineers are clearly known, for example the construction of roads, bridges, railway lines or ports, this profession is not always very well known by young people who, before the competition, thought they also built cars or airplanes. There were others working activities that are not so well known, such as the construction of large structures (football stadiums) or facilities for water treatment; however, after the competition, these working areas were selected by the students. It is possible to conclude that the Olympiad has been useful to improve the knowledge of Civil Engineers working area.

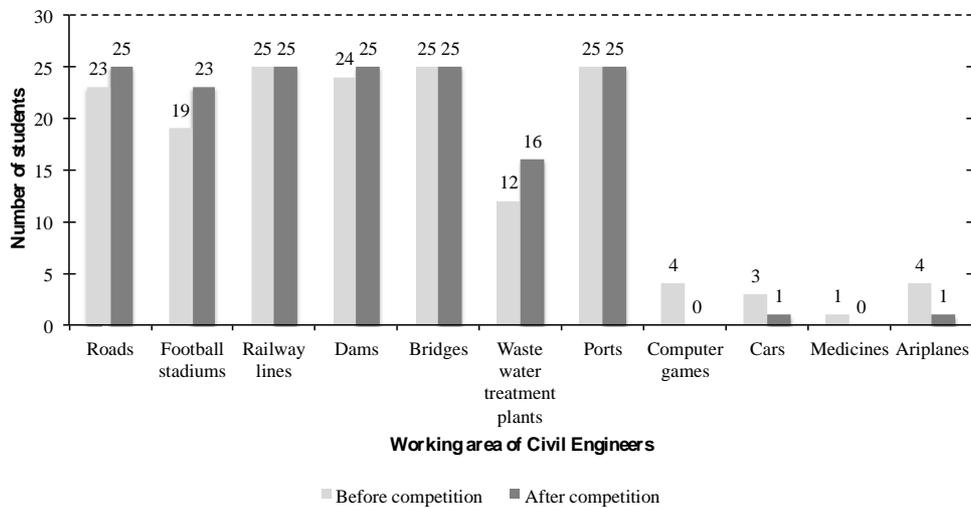


Figure 6: Knowledge about working area of Civil Engineers before and after the competition.

The experience observed has allowed for improving some organizational aspects of the events, the organization and determine the cost of the experience. The final proposal has been sent by the College of roads to all Spanish schools with the aim of promoting an edition for the 2018/2019 academic year including local, regional and national levels. The estimated cost, with 5 teams participating in each regional headquarters has been estimated in 2,000 €/headquarter. The final cost of the Olympiad will be linked to the number of regional venues that finally decide to participate; it depends on number of students that finally will travel to the national headquarters. In the case that participate 6 universities, the total cost has been estimated in 22,000 €, including regional and national level organization. Most of the material needed for testing will be re-used in the following editions. Therefore, the total cost of successive editions will be reduced to approximately 12,000 €/year.

4 CONCLUSIONS

- The developed of The Olympiad in Civil Engineering is an opportunity to spread and

- clarify the role of Civil Engineers of Secondary Schools students and teachers.
- This program will encourage teachers of Secondary Schools to improve applied teaching of basic materials of Engineering (Mathematics, Physics).
 - The Olympiad in Civil Engineering develops soft skills in Secondary Schools students: group work, deduction capacity, basic knowledge application, and creativity, among others.
 - Local and national competition will be an incentive for students to participate and, in consequence, strengthen the objective achievement of this initiative.

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