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21st Century Challenges in Engineering and Technological learning

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ABSTRACT

The success of 21st century engineers[1] depends on demanding challenges, involving a large scope of scientific and social competences. College education must help students to develop those competences in collaborative environments and better address these needs. Developing students' knowledge and skills in contextualized engineering environments, practicing teamwork, leadership, decision-making, experimental work and critical thinking are some of the important aspects addressed in this track.

CCS Concepts

• **Applied computing→ Physical sciences and engineering→ education**

Keywords

Contextualization; Learning and Teaching Strategies; Competence Development; Engineering Education.

1. INTRODUCTION

When embracing their profession young engineers face the demanding new challenges of the 21st century. As Johansen [1] stated young engineers must realize that their expertizes should not only focus on scientific and technological aspects, but also on their social skills and characteristics like teamwork, creativity or leadership. So, engineering education must also stress the importance of these competences. Therefore, academic and professional worlds need to align in these new guidelines [2, 3].

Students must realize the importance of deep and meaningful learning, to mobilize it to solve the necessary problems [4, 5]. This represents very demanding skills, especially because it involves a high level of maturity [1]. Teachers can help them address these needs providing students with opportunities to develop scientific and social competences while working on the course contents, allowing them to work collaboratively and cooperatively with their peers [6].

Project work usually helps students to collaboratively develop personal effectiveness and workplace competences which will aid them embrace new challenges on a regular basis [7, 8, 9, 10].

On the other hand, 21st century students must master ICT tools and languages, without which they cannot cope with today challenges. So, their education must also facilitate its usage and provide opportunities of improving their expertizes in several applications. Also, engineering crucial experimental competences can be developed with the help of remote labs and simulations. However, teachers need to be aware of how to use these resources in the curriculum and how to make the best of them [10].

This year's track session addresses some topics of these up-to-date problematics. Providing forums where these considerations can be presented and discussed between academics, students and professional engineers will always bring some new insights and perspectives, teachers might use to reflect on their professional development.

2. ENGINEERING 21st CHALLENGES

How can a young engineer make a difference in the actual demanding professional world? And how can their academic background aid students to stand out? What do senior engineers seek and most value in a young professional?

Nowadays it is as important to address scientific expertizes as it is to address students' social and professional competences. How can teachers help their students in this hard-working task? Which characteristics should students have or develop to enhance their learning in active environments?

This track aims at encouraging discussion around Engineering Education especially concerned with young professionals in this new challenging professional world. Engineering Education organizations have been addressing these new professional challenges guided by general concerns such as: teamwork abilities, persuasion in multiple social contexts, creativity, handle complexity, leadership or strong work ethics. This stress the importance of these competences being worked through college along with communication, scientific and technological expertizes, problem-solving or analytical and quantitative skills.

However, the perspective from academic and professional worlds can be quite different. So, both point of views should be acknowledged and more documented. The sharing of successful practices among and between these communities is essential to gradually improve the success of young engineers.

Some of the main topics regarding this track can be related to the following aspects:

- Project work in engineering education
- First contacts with engineering profession
- Improving engineering professional, social and/or scientific competences
- Engineering graduate students' competences versus companies' professional needs
- Long term vision about engineering education
- Capstone projects versus professional internships
- Successful merged practices from Academia and Industries
- Multicultural aspects of engineering education

3. CONTRIBUTIONS

The first two contributions are examples of how *Multiculturality* can indeed provide profitable partnerships, helping engineer students to develop not only their technical expertizes but also their sense of leadership, enterprise and cooperation. Developed under the European Project Semester - EPS (which involves 18 European schools of engineering), these papers reveal not only the advantages of adopting a project based learning methodology (PBL), but also concrete examples of how they were implemented in practice.

Another aspect of *Multiculturality* is addressed in the third contribution which discusses a universal language lectured in all engineering courses and the importance of the use of IT tools in class teaching.

Finally, the last two contributions represent two points of view of the same problem, the difficulty of visualizing remote labs as being different from simulations. Addressed according to the scope of less experience students who are taking their first contact with this thematic (fourth contribution) and then addressing senior students where these differences can be presented more technically in order to get the most these didactical resources.

3.1 Self-Oriented Solar Mirror – An EPS@ISEP 2017 Project

This paper reports the development and outcome of an interesting project involving students from five countries with diversified experience and backgrounds. While presenting clearly how these students were presented with the challenging problem, how they organized themselves and finally their solution is presented.

3.2 Balcony Greenhouse – An EPS@ISEP 2017 Project

This paper addresses the point of view of students when dealing with first contacts with engineering profession through a project work while developing social and scientific competences.

The paper is focused on the solution this multicultural group of students developed to solve the proposed problem, which required different technical and transversal competences.

3.3 A Study of the IT Competence training in Technical Drawing in Higher Education

This study calls the attention of the usage of IT techniques in teaching a specific topic – technical design – in engineering and architecture degrees. This topic plays a crucial role in these future professionals since it represents a specific universal language.

The authors conducted a survey in the University of Santiago to evaluate these usage of IT tools in this context. This represents a diagnosis of the present state of this issue and improves the understanding in teachers realize its importance.

3.4 Do Students Really Understand the Difference Between Simulation and Remote Labs?

Developing critical thinking while working with virtual resources is critical and students should understand which kind of results they compile with each feature. Using a survey and a short interview, the authors compared students' understanding differences between remote labs and computer simulations in a sample of two countries, two universities, three courses. The common ground of these students was the fact that not only remote labs as the topic (electric circuits) was being taught for the first time.

The results showed that despite teachers' efforts explaining those differences and even showing students the physical location of the remote lab, there is a significant number of students who, at the end of the course, still had not entirely understand their nature. This indicates a need of future attention to this problem and practice activities where students may reach those conclusions by themselves.

3.5 Differentiating simulations and real (remote) experiments

This final contribution, even though it addresses the same problematic – differentiating remote labs from simulations - focus on a different scope: not the ability to do it, but how you can do it. It approaches the problem by presenting two didactical experiments of classroom electric engineering practice where the characteristics of both resources can be compared and students may better understand the limitations of the resources. This presents an example of how teachers may address the problem tackled in the former contribution, even though it would only be appropriated to more advanced students.

4. FINAL REMARKS

The academic years of the future engineers must help them develop a high sense of leadership, cooperation, creativity and problem solving, along with their scientific and technological knowledge. The 21st century brought demanding professional challenges students will only cope using their communication, collaborative, and envision skills, together with quantitative and analytical skills. The presented contributions shared invaluable experiences in engineering practice classes: project based learning developed in multicultural teams with different backgrounds students; the importance of using ICT tools developing engineering universal languages in class; the importance of teachers addressing natural doubts and confusions while using online resources to complement students' experimental expertizes to make the most of these assets.

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