Engineering and technological learning in educational and professional contexts

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ABSTRACT
This paper reflects the result of a drawn challenge of enhancing the discussion related to the problematic of how to ease the transition of young engineers from academia to professional life. How can students be better prepared to face the actual demands? Can we identify some particular issues that need more attention? How can the linkage between academia and companies be strengthened? Several works were presented, reflecting concerns and sharing experiences: four papers focus on Internship projects; one papers emphasis the development of more conscientious professionals regarding laboratory safety; other called attention regarding modern market demands (necessity for professionals to integrate fields like computer science, information systems and computer engineering); and two papers centered on the importance of motivating young students to science, technology, engineering, and mathematics.

Categories and Subject Descriptors
Education [Interactive learning environments; Collaborative learning; Learning management systems]; Professional topics [Project and people management; Computing education; Computing and business]

Keywords
Engineering education; engineering Internships; professional contexts; soft skills; young professionals.

1. CONTEXTUALIZATION
This track aimed enhancing the discussion around Engineering Education especially concerned with young professionals. Different perspectives were welcomed, namely from the point of view of young engineers and/or senior students, educators, tutors and senior engineers.

1.1 Problematic
The sharing of successful practices between communities is essential to gradually improve the success of young engineers. It was intended to address problematic like:

- How may teachers improve the development of key competences in engineering students?

- How can the impact between academic and professional worlds be minimized?

- Which contributions can professional institutions provide for a better linkage with the academic structures to smooth transitions?

- How can technology improve this interrelation?

- Are these concerns multicultural?

On the other hand, with Bologna declaration implementation, several countries undertook serious modifications in their course curricula.

- How did these modifications contribute to the rapprochement of these two worlds?

1.2 Topics
Some of the main topics regarding this track could be related to:

- Project work in engineering education

- First contacts with engineering profession

- Improving engineering competences during education

- Engineering graduate students competences versus companies professional needs

- Long-term vision about engineering education

- Comparative studies in Engineering Courses following Bologna guidelines

The editorial is organized in three main parts: after its contextualization, it is first followed by an introduction where the authors' foresight this problematic, share and supported their concerns. After giving an overview of all accepted papers in section 3, a summary of the main ideas is made in the last section.

2. INTRODUCTION
The gap between the academic and the professional world is more or less common and certainly will always exist. However, regarding the recent Bologna implementation, and the (theoretical) increase on students' learning responsibility due to lessen lecture hours on the majority of engineering curricula

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courses, can we say this problem is diminishing? What can be done in order to facilitate this transition, providing students with enough background, which can help them led with different situations? Several studies can be found reflecting this problematic [1][2][3][4] but clearly much more still needs to be discussed. This problematic was the main challenge for this track session.

As well put by Swart [4]: if we think the basic theory acquisition (developed in Academia) is more related with knowledge and comprehension [5], with cognitive strategies [6] or abstract conceptualization [7], and the advance practice, which will provide a smooth adaptation to students' professional initiation is more related with synthesis and evaluation [5], intellectual skills [6] or active experimentation [7], shouldn't academia and professional contexts pay more attention on how to potentiate this link?

When thinking of paying more attention to practice, there is a risk of students skipping some theoretical aspects that are crucial in order for their engagement in deeper approaches learning. But, on the other hand, are academia not risking students developing more surface learning if no advance practice is required? The balance of what is fundamental in a 3 years course, allowing students to be in their best when they graduate is a challenge.

Young engineers should be able to relate concepts and ideas and think about solutions and new meanings for new problems. For this, they should have theoretical and technical expertizes that will allow them to design and develop solutions. This is what characterizes deep learning [8] and this is what's expected from an engineer. So, how can the process be improved in order to facilitate young engineers to achieve excellence?

Several experiences have been developed and reported in literature in the last decades and many with very successful results (for instance the use of PBL [3][9][10] or CDIO [11]). Some of them require a complete modification of course curriculum organization and also a mentality adjustment from both teachers and students. Others require specific resources, not easy to deliver in low budget scenarios. The objective of this paper is not restricted to those main experiences, but also in identifying and giving an opportunity for other *human investments* that can perhaps be more easily reproduced but which can still lead to the improvement of this problematic. Without a delivery of a formula for success, it is imperative that this kind of discussing and sharing of successful practices reach more college professors and Deans, professionals and companies CEO's, students and recent graduate students.

3. CONTRIBUTIONS

The contributions to these thematic were more centered in the telling of academic experiences. Some papers addressed the assessment of the courses, regarding the transition between the academic world and the professional demanding, others addressed main topics that are becoming essential in the market and the necessary measures of adjustment academia is developing. There are also reports on major reforms made in some courses. By order of appearance, in the next subsections all accepted papers are presented, highlighting their major ideas and contributions

3.1 Introducing Big Data topics: a multicourse experience report from Norway

Beathe Due, Monica Kristiansen and Ricardo Colomo-Palacios from Østfold Univ. College, Norway; Dang Ha The Hien from eSmart Systems, Norway.

This paper deals with the lack of Big Data related subjects in College Education facing the increasing demands for instance of Information Technology Project Managers with Big Data expertise.

The authors present initiatives that are taking place at the Faculty of Computer Sciences, Østfold University College, Norway to integrate Big Data as a topic in three different scenarios: at bachelor level, at master level and in continuous education courses.

The authors summarize the main proposed modifications in teaching approach and assessment in order to fulfill what they identify as essential: that *universities and scholars integrate fields like computer science, information systems and computer engineering to develop students in the three essential stages of Big Data: Data Collection, Data Analysis and Data Visualization*.

This has been applied in 2014/15 in a Master degree and the others will be implemented in the next scholar year. The initial results in terms of course assessments and students´ acceptation unveil promising perspectives for the initiative.

3.2 Enhancing STEM courses through A Robotic Innovative project

Sérgio Silva from UTAD, Portugal; Salviano Soares from UTAD and IEETA-UA, Portugal; António Valente from UTAD and INESC-TEC, Portugal; Rolando Barradas from University of Minho, Portugal and Paulo Bartolomeu from Globaltronic – Electronics and Telecommunications - Águeda, Portugal.

As the authors claim, the project described in this paper addresses the urgent need to enhance student interest and performance in science, technology, engineering, and mathematics (STEM) courses. This interest must be natured in young students in order to fight the absence of students in these areas.

Based on a problem based learning strategy, young student are entangled in developing creative ideas and while involved in a contest they may learn with lesser effort. For instance, a graphical programming language, with higher levels of abstraction, can be used as a way of reaching younger public, with no previous programming experience and provides a strong foundation in their minds for later study and training in IT and IT-related subjects.

3.3 New technologies applied to the development of risk prevention competency in engineering students

Laura Lavandera Mayo, Ana María Vivar Quintana and Ana Belén González Rogado from University of Salamanca, Spain.

This paper brings us an important issue in engineering education: the laboratory safety. The development and usage of security measures should be methodically and systematically part of teachers' and lab technicians' procedures. This can help not only secure students safety but will also have a didactical purpose of teaching them the importance of these security measures anywhere they work in the future.

In this study, the authors address the incorporation of technology in a practical guide using Quick Response – QR – Codes, markers and safety elements map. Practical sessions were developed with Food Engineering Laboratories students, in University of Salamanca. The aim was to develop students' skills in risk prevention, guaranteeing their safety during the practical teaching. This is an on-going work and the authors do not present definitive results. However the initial results on a questionnaire made to students, point to the success of this implementation.

3.4 Higher Education Competences versus Companies Professional Needs in Engineering

Natércia Lima, Joaquim Alves and Gustavo Alves from the Polytechnic of Porto – School of Engineering, Portugal.

This work addresses the current gap between higher education and the demands of professional world.

It starts by making a review on international institutions internships on industrial companies in means of comparing with the efforts developed in the Instrumentation and Metrology Master degree in a Portuguese Engineering Institution.

It calls attention to the importance of generic skills development. Familiarizing students with programs such as Work Integrated Learning (WIL) allows them to increase their adaptability to the next stage in their life – their professional career. The authors consider the personal approach used, with regular visits to each company, to understand their needs and establishing the work plan along with the continuous supervision, is the key to the WIL Program success.

The analysis was performed over the last 2 academic years, within several companies and 30 students enrolled in Dissertation / Project / Professional Training.

This paper highlights the importance this cooperation between academic and professional world can have as well as the benefits for everyone: schools, companies and students as young professionals.

3.5 Mathematics and technological integration in the Brazilian basic education as motivation to STEM

Priscila Cadorin Nicolete, Marta Adriana da Silva Cristiano, Juarez Bento da Silva, Simone Meister Sommer Bilessimo, José Pedro Schardosim Simão and João Bosco da Mota Alves from RExLab/PPGTIC/Federal University of Santa Catarina, Brazil; Kryscia Daviana Ramírez Benavides from CITIC/ University of Costa Rica.

This work brings us an approach of how the integration of technological resources in basic education (teaching science, technology, engineering, and mathematics - STEM subjects) was developed in Brazil.

As the authors state, nowadays students' motivation is a major problem in Brazilian public schools, which results on poor performance and fragile knowledge construction. This can lead to the weakness of students' confidence and ability to successfully perform their tasks. This problem may undermine a later choice for an engineering career.

The exploration of playful digital resources and the easy access to mobile devices such as smartphones and tablets can actually represents a unique opportunity for educational development promoting Information and Communication Technologies (ICT).

This papers report how can ICT be turned into a mathematical laboratory to experience, develop intuition, conjecture, verify, demonstrate and see the mathematical situations in a practical way. The results, based upon questionnaires on teachers and students perceptions, shows recognition on the improvements achieved.

3.6 A Market Approach for Curricular Capstone-Internships

António Costa from the Polytechnic of Porto – School of Engineering, Portugal.

This paper brings us an example on how the gap between academia and the professional world can mitigate. This implementation occurred in 2006-2007 major curriculum revision (Bologna Process implementation in Portugal) of Informatics Engineering Bologna 1st cycle at ISEP.

In the last 9 years, hundreds of students have been exposed to the CDIO Initiative™ (Conceive – Design – Implement – Operate) practices and 955 students have graduated. The CDIO Initiative defines twelve standards of good engineering practice and serves as guidelines for educational program reform and evaluation.

The author defends that "it complements the current cumulative grade system with a set of three descriptors that individually describe proficiency in program *Knowledge*, *Capability* and *Competence*, to improve professional/social recognition of graduates and to facilitate the profiling of those graduates by employers".

Another key factor in the success of this high level course is the management of capstone-internship projects with interesting external organizations, mostly in Porto metropolitan area, but in other cities of Portugal as well foreign countries. Since 2007 more than 500 organizations have been registered.

Time management and meeting deadlines are currently the two "soft skills" with worse results. A soft skills module (16 hours) was recently introduced in the 1st curricular year and preliminary results indicate improvement.

3.7 Internship Assessment from Company Supervisor's viewpoints: a five-year experience

Isabel M. Brás Pereira, Paulo Silva, M. Teresa Sena Esteves, Margarida M. Ribeiro and Anabela Guedes from CIETI/ISEP, Portugal; Celina P. Leão and Filomena Soares from ALGORITMI/University of Minho, Portugal.

This work reports an assessment of curricular internships performed by the chemical engineering students from Instituto Superior de Engenharia do Porto (ISEP). It meant to validate if students have the required skills and how well they integrate in the real working world. This analysis was performed over the last 5 academic years, considering the company supervisor point of view. A total of 39 companies have participated.

Each student has a tutor in the company and an accompanying teacher in ISEP, with whom he should meet regularly. In the middle of the internship students have to prepare a progress report and make a public presentation.

With the objective of identifying the main difficulties and the importance of the internship for both student and employer, this work showed that the assessment of students' performance is globally very positive. The items showing better results refer to punctuality, attendance, learning skills during the internship and students' relationship with peers. The one with poor results where sense of initiative, autonomy or scientific knowledge in specific areas. They show almost no statistical differences along the five years of the study. Another important and positive result is the growing availability company's show to undertake more internship students. The study also shows that about 14% of the students were invited to stay in the company after the internship.

3.8 Academic internships: the experience of the Civil Engineering Department of ISEP

Diogo Ribeiro, Tiago Abreu, Rui Camposinhos, Carlos Félix, Rui Gomes dos Santos, Maria de Fátima Portela and Sílvia Azevedo from the Polytechnic of Porto – School of Engineering (ISEP), Portugal.

This paper describes and evaluates the experience of the Civil Engineering Department of ISEP to promote academic internships in the Civil Engineering Master course. The adopted strategy involved the constitution of a list of companies with who it is formalized a partnership agreement. These internships began in 2012 and in the academic year of 2014-15 extended to a total 44 companies.

Three questionnaires were conducted to each of the identified interest group: companies, students and ISEP's supervisors. These three different perspectives were analyzed separately in order to achieve performance indicators. The overall results are very encouraging. Another important and positive result is that approximately 43% of the students are now working in the companies where the internship occurred.

4. FINAL REMARKS

Four papers focus on Internship projects as a significant curricular advantage to smooth students' transition from the academia to the reality of daily engineer challenges. All of these papers brought authentic perspectives from each actor in the process and the benefits seem to be common.

The presented results in the four works seem to be in accordance with other studies, which suggest that students' soft skills such as initiative, writing skills, and oral communication need more attention. However all of them showed a high level of satisfaction and a good percentage of students' employability in internship' company.

The other four papers also present relevant themes to young professional engineers: the development of more conscientious professionals (laboratory safety) or more in accordance with modern market demands professionals (integrate fields like computer science, information systems and computer engineering); and, the importance of motivating young students to science, technology, engineering, and mathematics (STEM) using robot project or mobile applets.

5. ACKNOWLEDGMENTS

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