

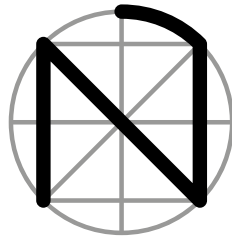


**Changing Higher Education One Teacher at a Time**  
**Book of Abstracts of the Third International Conference of the**  
**Portuguese Society for Engineering Education**

**Aveiro, June 27-29, 2018**



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T H E

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## Preface - CISPEE 2018 Book of Abstracts

Welcome to the **International Conference of the Portuguese Society for Engineering Education, CISPEE 2018!**

This conference is the third CISPEE event, following the editions in Porto (2013) and Vila Real (2016), and now in the city of Aveiro. Being a joint effort between the University of Aveiro and the Portuguese Society for Engineering Education (SPEE), CISPEE 2018 will emphasize the relevance of Engineering Education with (and for) Society. The organizers of CISPEE 2018 are aware of the current challenges (and responsibility) of Higher Education Institutions in preparing the near future professionals to address the needs of the society and market, at all levels.

This mission is extremely demanding, with a clear notion that all stakeholders need to be involved in order to understand the present and (most importantly) to prepare a more responsible and adequate future of Higher Education Institutions in pursuing the best competences to provide to the Students, our most valuable asset.

In this sense, CISPEE 2018 intends to promote an inclusive and interactive event, enriched by scientific presentations and spaces of *fora*, with distinct representatives from governance, higher education institutions, associations, business/industrial sector, students, therefore bringing to the event a wide representation of Society in general.

With the motto “Changing Higher Education One Teacher at a Time”, one of the main goals of CISPEE 2018 is to stimulate debates and critical analysis, deepening the involvement of the various agents to potentially promote further translation into strategies and actions.

CISPEE 2018 Organisers are convicted that the resulting discussions and exchange between the participants of the Conference will have an important effect and impact within the Engineering Education topic and, therefore, towards the global community and society.

Bárbara Gabriel, Gil Andrade Campos, João Dias de Oliveira, Maria Manuel Nascimento, Robertt Valente, Victor Neto

University of Aveiro, June of 2018

<http://see.web.ua.pt/cispee2018/>



# Technical Museum as a Contribute to Civil Engineering Education

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**Abstract** — A Museum, when inserted in a Technical University, is a privileged place for the preservation of the historical memory concerning the construction techniques evolution along ages. The construction industry has been evolved in teaching methods, in the use of specific equipment and applied technologies, and in the way of presenting and making drawing. The Museum presents a reminder of how the technology advanced to the current methodologies of work. The Museum of Civil Engineering of the Instituto Superior Técnico (IST) contains a significant collection of elements offered by teachers and entities which is in exhibition, in a proper room, inserted within the University space [1].

Within the Congress some of the most remarkable elements related to the fields of Architecture, Construction techniques and Drawings, supporting the education activity, are described in detail: A wooden model reproducing the anti-seismic structure called Pombaline cage forming St. Andrew's crosses, created for the reconstruction of Lisbon, devastated by the earthquake of 1755 [2]. This element is frequently used to support the visit of national and foreigner seismic specialist, as the model represents with fidelity the structural organization of the innovative structural solution created to rehabilitation of Lisbon after; In addition, several wooden models of roof frames of buildings and samples of carpentry interior elements like stairways and doors are exposed. Those models made in wood identifies interior details applied in staircases and body guards, used in buildings design in the beginning of sec. XIX, so it is used to introduce this era of architecture in Portugal; The Museum has a wide collection of drawings executed by students, representing components, dating back since the formation of the IST until after the Second World War. Currently, the discipline of technical drawing promotes, in each semester, a session presented at the Museum, so students can confront the current track, based on current standards, with the held at the time. Drawing devices are also the exposed, clarifying, the student or the visitor, with the use of scale rulers,

squares and rulers "T"; The Museum contains the re-creation of the work room of the architect Álvaro Machado [3], first professor of architecture of the IST, and a collection of drawings of their projects, plaster models of masonry vaults and portals, the wooden models of decorative and functional emblematic elements currently used in Art of History classes. The drawings are used to support old methodologies of representing projects as they are confronted to current definitions of technical drawings.

The set of elements described in the text, was collected and kept in a Museum, and they are in exhibition in a proper space, integrated in an engineer school, the IST. The Museu has an important role in the dissemination of old construction methodologies contributing to a better understanding of the current building processes and applied materials. The described elements confirm the effective advances that occurred in construction knowledge, methodologies and material. The Museu also supports the historic identity of the school.

**Keywords** — *Museum; Construction; Education; Technology; Heritage.*

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# Historical Evolution of Technical Drawing in Engineering

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**Abstract** — Technical Drawing, in various aspects of engineering, is the main base of work: whether at the stage of perception and understanding of the problem to be resolved; or the analysis and study of the design solution; and, later, as a mean of accurately communicate with partners within a project work. Teaching Technical Drawing to engineering students has been progressed over the years in the history of engineering: Leonardo da Vinci [1], based on the resources and expertise achieved at his time, contributed to the two-dimensional graphical representation of three-dimensional machines supported in perspectives, shadows and descriptive notes; the influence of Gaspar Monge [2] in the graphical documentation of a project is enormous, with his new science the Descriptive Geometry; the director of the first school of engineering in Portugal, Alfredo Bensaude [3], recognizes the practice in the execution of drawings as essential for the training of engineers.

The beginning of the Technical Drawing as a science is supported in the concept of projections obtained over two orthogonal planar surfaces that are later put in a single plan. This notion apparently simple, immediate and obvious, was not so evident until Gaspar Monge (1746-1818), mathematician, physicist, engineer and a politically involved figure in the French Revolution, established in his writings the science of descriptive geometry, forming the basis of the current Technical Drawing. The difficulty of representing three-dimensional space surrounding component through a technical geometry, set on a plan, understandable, uniform, complete and rigorous was, until then, a difficult problem to be solved. Leonardo da Vinci (1452-1519), a talented artist of the Renaissance era, associating its great aptitude for the arts and the multifaceted creative capacity, sketched in many graphical documents his inventions. Through detailed sketches obtained under various points of view and using shadows he shows the details of shape and the functionality of the new machines. Alfredo Bensaude (1856-1941), the first director of the Instituto Superior Técnico (IST), of the University of Lisbon, creates the first national technical school of engineering based in the

international standards at the time, and contributes to introduce the Technical Drawing as an essential issue and training for the future engineers.

The various reforms over the years, in public engineering schools, have pointed to recognize a faculty with theoretical and practical capabilities. Both creators of engineering schools, Gaspar Monge and Alfredo Bensaude, respectively in Paris, in 1795 and in Lisbon in 1911, advocate the importance of bringing the theory into practice. The text describes this concern leading them to use: the Descriptive Geometry as a means to develop rigorous records of products to be manufactured (Monge); the Drawing as a way to develop components with the accuracy needed for students' workshop, committing the student into the manual manufacture (Bensaude). The text is focused in a brief historical evolution of the Technical Drawing as a science applied in projects and in the importance of its introduction in the engineering schools curricular programs.

**Keywords** — *Descriptive geometry; Technical drawing; Leonardo da Vinci; Gaspar Monge; Alfredo Bensaude.*

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# The role of education on the acquisition of 21st century soft skills by Engineering students

## Education and 21st soft skills in Engineering students

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**Abstract** — The globalization and the high-speed development of the digital era, the mixed of technologic, economic and societal cultures and the wide-range of the socio-economic world, boost deep transformations daily on every human being. In particular, students need to acquire personal and professional skills to be successful. Enterprises are looking for individual's knowledge but also for individual's contribution to the whole, to the culture of the organization, and the self-perspective an individual brings to the company. These issues may induce a great impact in the teaching process. Single-based knowledge, focused on compartmental subjects did not work in the past, currently fails and probably will not meet future needs. Teaching must be thought continuously as a system of overlapping and interrelated ideas and scientific areas, rather than isolated and different fields of knowledge. In this sense, students need professors with "personal and professional qualities assuming the students' independence in decision-making, the ability to act in difficult situations and the ability for individual study" [1].

The implementation of new teaching methodologies, namely active-learning (AL) [2],[3],[4], in engineering courses may help students develop soft skills, viz. self-motivation to learn, cognitive flexibility, leadership, ability to work under pressure and time management, negotiation and conflict resolution [5], [6], [7]. In this paper, we will discuss how the implementation of AL techniques in math courses in Engineering Bachelor Degrees at the School of Engineering of the Polytechnic of Porto, boost students' soft skills, needed in their personal and future professional lives.

**Keywords** — *soft skills; new teaching methodologies; active-learning; engineering courses;*

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# The employment expectations of Masters Engineering students

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**Abstract** - In the past 20 years, master's study has grown across the western world. The reasons suggested for this are numerous. They include commitment by many governments to widen participation at all levels of study in order to increase social mobility as well as furnishing the market economy with the necessary skills to prosper and achieve sustainability. Also, in recent years, due to the substantive increase of first degree graduates entering the employment market thus increasing competition for jobs, it is argued that more graduates have seen the postgraduate masters qualification as a means of helping them gain 'employment' rather than a vehicle to develop 'employability' skills later in their career through using this level of study as continuing professional development. The UK higher education (HE) sector has very much been part of this credential inflation. However, between 2011 and 2017, student numbers participating in master's study dramatically declined, most noticeably amongst UK and Overseas domiciled students [1, 2, 3]. Across Europe, a similar pattern of declining participation is also occurring.

In the UK, Science, Technology, Engineering and Mathematics (STEM) disciplines, especially engineering, have been greatly affected. Although intuitive reasons can be made to explain the decrease [4,5], there has been limited research looking at applicant and student motivations for participating at PGT level and the barriers they face. Without this knowledge and understanding, it is challenging to develop practical and effective strategies to reverse the decline. This led to independent bodies in the UK such as the Higher Education Commission commenting that 'Postgraduate education is a forgotten part of the sector' [6].

As a result, the Higher Education Funding Council for England's (HEFCE) Postgraduate Support Scheme (PSS) Phase 1 in November 2013 funded 20 projects from a £25 million publicly-funded programme to test ways to support the progression into master's education by working with universities and employers. The £2.7m Postgraduate Experience Project (PEP) was one of the 20 projects funded and the largest consortium comprising 11 universities. The project looked at understanding the expectations and attitudes towards postgraduate study and post-study outcomes from the perspective of applicants, students, universities and employers. This

paper will report the findings from one strand of the research which is the employment expectations of Engineering students and employers.

**Results** - There were four key outputs. Firstly, the research highlighted that demographic variables such as domicile status, social class, age and route into study were key factors in the participation and expected outcomes. Secondly, it highlighted the dynamics between the state of the economy and the impact on different industry disciplines, and the participation at master's level. Thirdly, it obtained the employers perspective on future course developments and delivery. Lastly, it helped identify ways to effectively balance and manage the expectations and outcomes of all stakeholders.

**Discussion** - PEP made sixteen recommendations about the sustainability of master's level study in the UK for different groups of participants and stakeholders across engineering and other science, technology and mathematical disciplines.

**Keywords** - *postgraduate; masters; engineering; employment; expectations; employers*

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# Promoting understanding and academic success using Guided Exercises supported by ICT

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**Abstract** — Current engineers are constantly dealing with uncertainty, incomplete data, and the demands of customers, governments, environmentalists and public. This requires skills in human relations as well as technical skills. So, it is necessary to incorporate more skills, social and technological, into their base knowledge because in professional practice, engineers must deal with reality and make decisions. Despite these challenges, the predominant model in engineering education remains like the traditional model using chalk and conference-based presentations. In this paper a different pedagogical approach based in Information and Communication Technology (ICT) was used.

Several studies reveal that the methodologies supported by ICT are useful to get attention of the new generation of students and make them interested in subjects. The use of methodologies supported by ICT can be a way of promoting active learning in Higher Education. In this work a case study is presented where a methodology supported by ICT called, Guided Exercises, was implemented. The Guided Exercise strategy is used with the aim that students work in their knowledge and, at the same time, develop their reasoning in problem solving. To achieve this, a Guided Exercise combines conceptual questions with calculations. It can be elaborate, for example, from a typical exercise of the end of a chapter. In this type of exercise, it is usually requested that students do some calculations. To carry out these calculations students need to mobilize knowledge and relate models. In this way, a Guided Exercise divides a typical exercise in several questions that students must answer in a logical sequence. Thus, a Guided Exercise allows students to relate models and help them to solve a complex exercise step by step. The aim of Guided Exercises is to encourage the students not only to apply formulas, but also, to associate the formulas with the underlying concepts. With the implementation of this strategy, it is expected that

students understand which models and reasoning are required to solve the exercises, and later apply this knowledge in new situations.

This paper presents the Guided Exercises methodology, a case study performed in a Soil Mechanics course of the University of Aveiro' Integrated Master in Civil Engineering in the academic year 2015/16 and finally presents and discusses the students' perceptions about this methodology and correlates the use of this strategy by students with their academic performance. The results show that students considered the strategy useful for the understanding of the concepts covered in the course. Analysing the academic performance, it can be concluded that students that used this methodology had better marks in the exam and, also, a better approval ratio.

**Keywords** — *Guided Exercises; ICT; Active Learning; Higher Education; Engineering*

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# CALOHEE: Learning Outcomes and Assessment in Civil Engineering

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**Abstract** — Existing approaches to assess quality of learning tend to look at processes and not at achieved learning by civil engineering students. CALOHEE applied a forward looking approach, focusing on what a graduate should know and be able to do in order to function successfully in life and contribute to society (learning outcomes perspective). The chosen approach brought evidence-based accountability into the teaching and learning role of HE institutions by focusing on competences acquired by students, which meet the needs of society and the graduates. The assessment framework included four strands: 1) Knowledge (theory and methodology); 2) Applying knowledge and skills; 3) Preparing for employability and 4) Civic, social and cultural engagement. CALOHEE also developed a set of reference points at 1st and 2nd cycles levels. The sets of learning outcomes' descriptors were prepared by teams from the respective academic communities, in close consultation with stakeholders and open to public scrutiny. CALOHEE developed the Assessment Framework for Civil Engineering Education that is based on a merger of the Qualification Framework for the European Higher Education Area and the European Qualification Framework for

Lifelong Learning. The Assessment Framework is built on a set of learning outcomes' descriptors and related framework that is precise enough to offer a basis for assessment and broad enough to encompass a wide range of programme profiles. This Assessment Framework of Civil Engineering describe the discipline in terms of multiple dimensions: key elements which define a subject area. For example: 'knowledge and understanding', analysis and problem solving', 'design', 'investigation', 'practice', decision making', team working', 'communication' and 'lifelong learning'. In sum, CALOHEE offers academic engagement, subject focused context and evidence based tools for analysis and diagnosis, serving Higher Education institutions and providing meaningful information to stakeholders and society. The ultimate result is meaningful increase of the quality of civil engineers.

**Keywords** — *Civil Engineering; Learning Outcomes; Competencies; Framework; Assessment; Tuning*

# A program to promote mathematical knowledge for students' integration in Engineering degrees: CeAMatE

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**Abstract** — Lack of elementary mathematical knowledge by students who take engineering degrees at Coimbra Institute of Engineering (ISEC – Instituto Superior de Engenharia de Coimbra) explain part of the failure and absence to evaluations on Differential and Integral Calculus (CDI – Cálculo Diferencial e Integral) curricular units. In this article, we present the results of two working years of Math Support Centre in Engineering (CeAMatE – Centro de Apoio à Matemática na Engenharia), a Centre that supports ISEC students to overcome their difficulties and to prepare them to a full integration on CDI curricular units and includes two components: CeAMatE-in and CeAMatE-on.

CeAMatE-in is a physical space dedicated to the support of mathematics learning, located at ISEC's Physics and Mathematics Department (a Portuguese acronym of DFM – Departamento de Física e Matemática), with a non-mandatory aspect, where resources and supplementary activities to the ones developed in the classroom are available, to help students overcome mathematical difficulties. The aim is to provide support and learning resources that allow students to overcome their difficulties, through independent study.

CeAMatE-on is an e-learning platform with tools that can meet students' interests, motivations and learning styles [1]. This platform relies on an organization that is based on the individual student's learning style and cognitive level. The development of this platform was carried out in the scope of work project of the Computer Science Engineering degree at ISEC and the contents are still under construction.

This project started in the academic year 2015/2016 and is directed, in first instance, to all the ISEC students who do not have the basic mathematical knowledge, necessary for a good attendance of the Mathematics curricular units.

It is used a methodology of diagnosis, referral and evaluation. The personalized and co-responsible support offered intended to induce self-efficacy behaviors and avoid demotivation and dropping out of classes. The basic instrument in the monitoring methodology applied in CeAMatE-in is the Diagnostic Test (Teste Diagnóstico - TD). The indication given by TD serves as a pre-test or as a flag

enabling (at the end of the process) to draw conclusions about the evolution of the student with respect to their specific learning. TD provides specific information on the mathematical content that should be worked with the student during his follow-up period at CeAMatE-in. For this purpose, it is defined an Individual Working Plan (PIT – a Portuguese acronym of Plano Individual de Trabalho), prepared according to the Mathematics for the European Engineer – A Curriculum for the Twenty-First Century [2], with some adaptations to the Portuguese education system. Core Zero is the main reference, with topics that were considered essential for the integration at CDI curricular units. PIT includes a training plan, with a selection of study cards and exercises taken from the MathCentre [3] and by reference texts in Portuguese, produced by the members of the Centre. This program can be redefined according the student's progress.

The participation results at CeAMatE-in are heterogeneous but induces new strategies to motivate and involve students in their autonomous learning processes. One of the possible updates will be the introduction of an e-learning component. We intend to deepen the investigation, to study the influence of the students' academic path at secondary education and to compare their mathematical knowledge before and after attending the Centre. To do this, it will be necessary to gather and to complete the information of all the students who attended the Centre.

**Keywords** — *Differential and integral calculus, Mathematical knowledge, Teaching, Learning*

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# Gender differences in first-year students' expectations towards a new engineering multidisciplinary curriculum

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**Abstract** — Research on engineering first-year students' expectations and perceptions is important to understand what influences interest, achievement and persistence. This is particularly relevant when assessing the impact of new engineering education curricula. The under-representation of women in engineering education and careers has raised the attention to potential gender differences. Understanding these differences would enable educators to meet the needs of all their students and create an inclusive and diverse learning environment. Studies have found that at the beginning of an engineering course, female students generally reported higher levels of anxiety, and lower levels of academic preparation than men.

This paper reports a quantitative analysis of a pre-degree survey targeting students' expectations at the very beginning of the new Integrated Engineering Programme (IEP), which spans across the whole University College London (UCL) Faculty of Engineering Sciences. Of a cohort of approximately 700 enrolled students, 309 completed the survey. Results suggest that, on graduation, both male and female students expect to have similar opportunities, such as to be able to contribute positively to the world. They also share identical learning expectations and educational experiences regarding their time studying engineering, although female students tended to consider activities and experiences to develop professional skills (such as leadership, team-working and communication) more enjoyable than their male counterparts. Results also suggest that female students were more aware of the societal impact of engineering, and less confident in their engineering specific skills.

**Keywords** — *engineering multidisciplinary curriculum; first-year students; gender; students' expectations; self-confidence*

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# Bridging Science Technology and Engineering Education. The Hands-on Science Network

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**Abstract** — The relation between engineering and science and technology is fundamental in the society of our days. The synergies that everyday are established between science technology and engineering are the key to the remarkable evolution we witnessed over last many decades. School education may play a fundamental role in the strengthening of those synergies. Science and engineering teaching at all school levels should be generalized aiming not only the sound establishment of a science and technology culture in our societies but also to guarantee a steady basis for the improvement of science and its technological applications.

We must guarantee the effective implementation of a sound widespread scientific and technological literacy but also to lead our students and fellow citizens to learn and use the experimental method behind the search for scientific knowledge and to find the thrill of discovering and understanding our world preparing themselves to act upon building a better future.

Aiming the promotion of hands-on experimental learning of science and technology as a way of improving in-school scientific education and Science literacy in our society, the Hands-on Science Network was established back in 2003, in the frames of the action Comenius 3 of EC' program Socrates, by twenty-eight institutions from ten European countries (BE, CY, DE, ES, GR, MT, PT, RO, SL, UK) and a transnational consortium (CoLoS)<sup>1</sup>. Now as an International Association, it enrolls as institutional or individual members, several hundred teachers researchers and educators, schools, universities, national and international associations, governmental bodies, science centers and museums, NGO's and companies of practically all countries of the European Union and from all over the world.

The Hands-on Science Network has a broad remit, aiming to promote and diffuse among schoolteachers, schools, and national and transnational educational boards, well established and newly investigated practices of hands-on experimental teaching of science math technology and engineering in all its disciplines. We will do this by fostering the development and use of hands-on investigative activities in the classroom so that students "do" science and technology rather than merely being "exposed" to it.

**Keywords** — *Hands-on; Science literacy; STEM, IBSE*

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# The importance given to the ethics education of engineering students in the academic production and dissemination

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**Abstract** — In the context of technologisation of contemporaneity and of the future, the role of engineering and engineers stands out, hence it is urgent to promote the ethics education of engineering students, steering their action towards the improvement of society, respecting human beings and nature [1]. The need for ethics education is even more relevant in engineering courses considering the almost unlimited range of action of engineering, as well as its actions' massive and even irredeemable consequences, both in the individual and collective present and future lives.

Faced with the arguments above and with the wide international acknowledgement on the need to promote ethics education in engineering courses, it stands out the fact that it is mostly absent from engineering courses in Portugal [2]. Bearing in mind that in Portugal the curricular organisation in higher education is a responsibility of the teaching body, it is questioned whether engineering teachers recognise this need.

Considering the reduced presence of ethics education in engineering courses in Portugal [2], it is important to ponder on some of the possible reasons behind it:

- Is the need for ethics education in engineering courses understudied and under disseminated?
- Is it not debated in Portugal?

According to Finelli et al [3], although there is a widespread consensus on the importance of ethics education in engineering courses, there should be more research on this issue.

For that reason, this study analyses the scientific production and dissemination on the ethics education of engineering students, both national and international. This study is justified by the need of reliable research and a wide dissemination on this issue in order to consider its inclusion in the courses' curricula.

Departing from the low presence of ethics education in engineering courses in Portugal, and considering the role of scientific production and dissemination, it was questioned whether this low level of ethics education (which translates the

conceptions of the teaching body [2]) could be related with a low scientific production and dissemination on this domain (and being so, with the low interest of the academic field in this issue).

Therefore, this study aimed to investigate the existence of reliable studies (submitted to a peer review scrutiny) about ethics education in higher education engineering courses, published in reliable scientific journals.

This study allowed to concluded that, although there is a significant number of international publications about ethics education of engineering students, there are only a few regarding the case of Portugal. This reveals a lack of debate on this issue, which may be due to the lack of awareness on its importance and need.

Combining the low presence of ethics education in Portuguese engineering courses [2] with the results from this study, it is possible to consider that the absence of studies on this subject results from a lack of awareness about this issue in the Portuguese academic field, or its depreciation.

**Keywords** — *ethics education; engineering courses; scientific dissemination; scientific production*

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# Strategy for promoting academic success in higher education

## Methodology for the early drop out detection

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**Abstract** — This paper seeks to advance our understanding of the drop out behavior of students in higher education. The transition to university requires that students have a variety of skills to adapt and succeed in school. Research in this area suggests that although 1st year students have elevated expectations of academic involvement and have been selected in the face of numerous class practices, these students encounter different demands and difficulties in their adaptation to university. The monitoring and support of university freshmen is considered very important in higher education institutions. Here is described the work developed by a study group created at Instituto Superior de Engenharia de Lisboa, with the aim of early detection of situations of school dropout and define intervention.

The level of education is closely linked to the capacity for learning, adapting to change and creativity - key factors in competitive advantages, economic growth and development. In the undergraduate courses of public education, the panorama is similar in university and polytechnic education, with dropout after 1st year around of 13% [1,2]. Studies on the Portuguese ES show that for those who enter the General Regime, the dropout rate is around 7, 8% and is lower than the overall average of 12.8%. Approximately 30% of the students who enter the majors of 23 and the holders of higher courses, dropout of school in the 1st year [1]. Although the general scheme is three times more numerous, most of the students who dropout in Portugal came under the special regimes [2]. This work group intends to carry out a work of proximity with the 1st year students placed through the different regimes establishing as a first approach the monitoring of the students' attendance in the classes and in the moments of continuous and periodic evaluation. The results of monitoring will be used to establish reliable indicators and definition

of intervention strategies to detect and avoid early school leaving as well as promote academic success.

The methodology scope is for 1st year engineering students and was designed to allow an early detection of whom is about to dropout. To implement the design methodology, the following steps were accomplished: i) Creation of an academic success commission (ASC) to evaluate the implemented structure and its response capacity to drop out issues and simultaneously identifying what responses are already available; ii) Identify and motivate lecturers assigned to 1st year's courses, emphasizing that they are the first interface between ISEL and students and showing them existing supporting structure; iii) Deliver attendance register in two different moments of 2017/2018 school calendar, namely at middle and at the end of winter semester; iv) Perform data management, focusing on the relation between students' course registration and corresponding course attendance. As conclusions, are presented correlations between collected data and students' academic success, tuition fees, register type and register status

**Keywords** — *academic success, drop out mitigation; engineering higher education*

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# Portuguese academic staff and students in UK's engineering higher education

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**Abstract** — In the United Kingdom, the Higher Education Statistics Agency (HESA) holds large datasets on all aspects of the higher education sector. This includes information about: students, qualifiers and graduates; academic and non-academic staff; universities and other education providers. These datasets can be assessed by subscribers (higher education providers and not-for-profits) on Heidi Plus – a software that provides access and enables tailored data analysis to answer to specific research questions.

According to public reports based on the analysis HESA Staff Data, the proportion of European (EU) academic staff in Engineering and Technology was 10% in 2006/07 and 19% in 2015/16. As for students, the majority of those entering a first degree in engineering and technology (undergraduate) in 2015/16, 71% were of UK origin, 6% from EU countries, and 23% from other nationalities. The opposite was found at postgraduate level, with only 25% UK, 15% EU and 60% other nations. However, these reports don't provide detailed figures for different nationalities for both students and staff.

In order to explore data trends of Portuguese academic staff and students (at undergraduate and postgraduate level) in the UK's engineering higher education sector, this paper provides data analysis on the most recent datasets. It aims to respond to the following research questions: (1) How has the number of Portuguese academic staff working in UK Engineering Higher Education institutions changed in the last years; (2) How has the number of Portuguese students in UK Engineering Higher Education institutions changed in the last years; (3) What is the distribution of Portuguese engineering students by level of study, gender, type of university and engineering discipline; (4) What is the impact of the UK's decision to leave the UK on the number of Portuguese engineering students.

The number of FPE (Full Person Equivalent) academic staff with Portuguese nationality working in UK's higher education institutions was around 50 between 2007/08 and 2010/11. For the reported period of data (2015/16), the number of

Portuguese staff almost tripled, with an increase of 150% for male, and 175% for female. The impact of Brexit on staff numbers working in engineering higher education institutions in the UK is still to be analysed once relevant data is published by national agencies, but anecdotes suggest an increase in departures of European staff from universities amid concerns over post-Brexit rights and funding.

Data on student numbers suggest that Portuguese students are more likely to study at undergraduate level in UK Engineering Higher Education Institutions, are mainly enrolled in mechanical engineering and electrical and electronic engineering degrees, and at institutions that are not part of the Russell Group. The number of Portuguese students registered in UK engineering courses after the Brexit referendum increased 23.5% since 2015/16, shooting up to the highest level in ten years of available data.

**Keywords** — *engineering students; engineering academic staff; level of study; gender; engineering discipline.*

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# Experience in implementing trainee works in business environment in a bachelor's degree of Civil Engineering

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**Abstract** — This article describes the experience in implementing trainee works in business environment in the last term of the first cycle (bachelor's degree) in Civil Engineering of the School of Engineering, Polytechnic of Porto (ISEP). The initiative began in the academic year of 2015/16, with 3 students, was extended to 8 students in the academic year of 2016/17, and is currently running with the participation of 12 students. The proposed approach has ensured a significant mobilization of multiple stakeholders, namely students, teachers and supervisors. The evaluation of the initiative's success was assessed using a two-fold criterion: by monitoring the degree of satisfaction of the different stakeholders through online surveys, and by the analysis of the classifications obtained by each student in the final report of the work developed at the host company. All the participants made a very positive assessment of the initiative, and above all, of its importance for the broader formation of students. It should be noted, however, that all were unanimous in considering that the duration of the trainee should be extended. In terms of future perspectives, the direction of the bachelor's degree intends to propose changes to the study plan of the course that value the importance of PROJI curricular unit, giving it a higher number of ECTS and thus allowing students to remain a greater number of hours in the host companies. Finally, it is important to highlight the contribution of ISEP in the implementation of new and innovative teaching models in the field of Civil Engineering in Portugal, directed towards a teaching in close conjunction with the companies and enabling the finalist students of the 1st cycle to have a professional experience at a crucial stage of their academic education.

**Keywords** — Civil Engineering; bachelor's degree; trainee work in business environment; pilot experience.

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# Performance Indicators to Support the Governance of Research Networks

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**Abstract** — Research centres to be excellent, increasingly need to develop or add skills to respond quickly to challenges of Research and Development (R&D) with increasing complexity. In this context, the route passes through the promotion of R & D networks where predominates sharing/transfer of knowledge and resources. In this way, the development of performance indicators focused on collaboration can help those in charge of managing research centres in decision-making processes and in defining best strategies. Applying concepts of social network theory, this article presents a model that allows to evaluate the performance of R&D centres and research networks according to various perspectives.

**Keywords** — *research networks; social network analysis; open-innovation; performance indicators; organizational management.*

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# Students' views and correlation regarding performance and attendance for a first year Engineering cohort

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**Abstract** — The correlation between regular attendance and academic performance in higher education has been the subject of various research studies including the ones reported by Aaron (2012), Gump (2005), Marburger (2001) and O'Dwyer (2011). Although a relatively small number of studies did not successfully observe a strong correlation between regular attendance and performance (Berenson et al., 1992), a clear majority (Gump, 2005; Clump et al., 2003) reported a significant or a positive correlation amidst them. Thus, in this paper, a case study is presented to assess both the students' views and correlation between attendance to lectures, laboratories and seminars and their performance in terms of final results. The population is composed by a group of first year undergraduate students at the department of Design and Engineering, Bournemouth University, in an Engineering Design unit. Attendance was monitored for a number of 19 students over one academic year (2016-2017). Students' views regarding the impact of some factors - such as clear expectations, content easy to understand, student collaboration and interaction, peer-pressure, and to be seen by the lecturer – on assessment performance have been surveyed. This data was obtained from a Likert scale survey ran over a population of 10 students in the 2017-2018 academic year. The data that correlates final marks with attendance (laboratory, lectures and seminars) was analysed and indicates a strong least-squares fit correlation between attendance and final marks, with a coefficient of correlation  $R^2=0.78$  when plotting final marks vs overall attendance (Fig. 1).

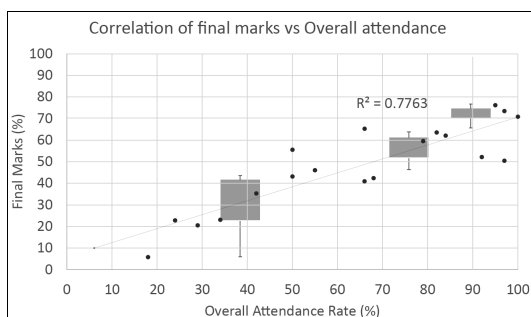


Fig. 1. Correlation between final marks and overall attendance.

The bar and whisker box plot in Fig. 1 indicate the variability and the degree of dispersion and asymmetry in the data for 3 considered ranges of: low grades (0% to 45%); medium/average grades (45% to 65%); and good/excellent grades (65% to 100%). Student's viewpoint, which was also considered as an important aspect of this study, conveys the benefits of attending the lectures and quantify some of the factors mentioned above including a minimum-maximum attendance rate for a good grade (first-class) or just a pass mark. The students considered that a 55% (mean) attendance of sessions will improve their chances for a pass mark (in the terminal examination) and that an attendance level of 90.5% in average will result in good chances to achieve a first class. Students perceive that the two main reasons for attending lectures are that, firstly, it makes it easier to understand the content and, secondly, they can get clear expectations on what they need to prepare and focus on.

**Keywords** — examination performance, class attendance, students' views, learning outcomes.

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# Mathematics or Mathematics for Engineering?

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**Abstract** — It is undeniable that mathematics is indispensable in education and practice of Engineering in all areas. In this paper we discuss the use of some active learning strategies on calculus applied in the first and second years of Engineering degrees.

Among other experiences we report a flipped classroom experience, autonomous study and self-evaluation using dedicated technological platforms and also active learning by solving proposed challenges outside the classroom where group and team work is encouraged in order to improve writing skills and the ability to communicate in mathematics.

**Keywords** — *calculus, Engineering, university teacher education, active learning, personal relationship.*

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# Designing and Teaching a Curricular Unit to Accomplish the Outcomes Related Learning Objectives

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**Abstract** — To create and improve a curricular unit the Plan-Do-Check-Act (PDCA) cycle is suitable [1]. This paper explains a four steps approach used in the design of a curricular unit discussing and illustrating how the teaching and learning methods are used to align the learning outcomes with the learning objectives of Advanced Techniques for Quality (ATQ), a curricular unit of the Quality and Environmental Master Course at a higher education engineering school in Portugal. According to [2] the quality of the learning outcomes can be enhanced if the teachers are able to ensure that students have engaged cognitive behaviours. The syllabus of the course, the instructional methods and the ways that students are assessed are the main tools available to promote students' engagement [3,4]. The first step consists of defining learning outcomes based on educational objectives and identifying the curricular unit contents focusing the unit in outcomes format, defining the instructional methods and assessment tools aligned with the intended learning outcomes. The second step is related to the selection and implementation of the teaching-learning methods to use so that the specified content could be delivered to facilitate the students' achievement of the intended learning outcomes. The third step consists in the definition of the assessment practices that must be aligned with the issues that the teachers want the students to learn and with the learning outcomes of the curricular unit. The last step is related with the improvement of the curricular unit where restructuring and adapting when necessary is vital so that the focus always be in the students' learning.

The example provided with ATQ curricular unit highlights the relevance of the four steps in the design and improvement of a curricular unit and the relevance of the instructional strategies and assessment methods to align learning outcomes with the specific objectives of the curricular unit enabling the students' process of achieving the learning outcomes. Some specific outcomes are related with the technical issues of the unit and refer to learning of

knowledge, skills, and/or attitudes related with quality engineering while some more generic outcomes that are independent of the technical issues are also relevant (e.g. oral communication, work in teams, critical thinking) [5]. The paper describes how an active learning project is used as an active learning instructional and assessment method to engage the students in the learning process and contribute to the achievement of the intended learning outcomes, especially those related with cross cutting competencies such as communication, collaboration, critical thinking. The introduction of a project chosen by the students engages them in higher order thinking tasks as planning, analysis, synthesis and evaluation and showed to be very useful in involving students doing things and thinking about the things that they are doing.

**Keywords** — *learning outcomes; student-centered learning, learning environments; active learning*

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# Utilizando atilhos para ensinar Resistência dos Materiais

## Aprendizagem Baseada em Problemas

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**Abstract** — Este artigo apresenta os resultados parciais de um projeto de pesquisa que utilizou a Aprendizagem Baseada em Problemas (ABP) em conjunto com aulas expositivas, visando potencializar a capacidade de compreensão de conceitos iniciais da disciplina de Ciência dos Materiais, por parte dos alunos de diferentes cursos de Engenharia. Levando-se em conta o alto índice de evasão em cursos de Engenharia, bem como a necessidade de se aprimorarem os métodos de aprendizagem, especialmente nas disciplinas básicas, utiliza-se a ABP, que aborda o ensino de forma integrativa e construtiva, potencializando o trabalho colaborativo. Trata-se do resultado de uma cooperação entre a Universidade Estadual do Rio Grande do Sul - UERGS e a Faculdade de Engenharia da Universidade do Porto – FEUP. O objetivo principal desta pesquisa foi identificar em que medida o uso de uma experiência prática com materiais que possam ser manipulados pelos alunos pode contribuir para a melhoria na compreensão dos conceitos da Ciência dos Materiais, em especial o conceito do Módulo de Young. Para mensurar o possível ganho de aprendizado com o uso do método ABP, aplicou-se o questionário cujas questões abordavam conceitos iniciais da disciplina de Ciência dos Materiais em duas turmas do segundo semestre de 2014, que não utilizaram o método, e em duas turmas do segundo semestre de 2015, que utilizaram. As turmas de 2015 participaram de uma atividade prática envolvendo o uso de atilhos, na qual determinavam o Módulo de Elasticidade do material a partir da crescente aplicação de cargas que promoviam o alongamento do material, cujos dados eram então inseridos em planilha eletrônica. Em virtude do que foi mencionado anteriormente, observando-se a melhora na compreensão dos alunos a partir da aplicação do método ABP (apresentando um aumento percentual nos acertos das questões dos testes, em comparação a turma anterior, que adquiriu conhecimento apenas a partir de aulas expositivas), concluiu-se que a inclusão do método ABP, não isoladamente, mas em conjunto com métodos tradicionais, pode aprofundar o conhecimento do aluno em relação a esses conceitos tão importantes por toda a vida acadêmica e profissional. O método ABP traz o aluno para um ambiente similar ao que irá encontrar ao longo de sua trajetória profissional, entre eles: capacidade de solucionar problemas e trabalho em equipe. A partir dos modelos matemáticos que estão sendo determinados e a futura utilização de realidade virtual com interação háptica no ensino de todos os conceitos envolvendo o diagrama tensão x deformação, tão fundamental para a compreensão da disciplina de Ciência dos Materiais, os alunos poderão determinar as principais características que influenciam diretamente no diagrama, como tipo de material, diâmetro e comprimento inicial;

participando ativamente da construção desse gráfico e tendo a capacidade de percepção entre as diferentes forças exercidas para cada material.

**Keywords** — *Aprendizagem Baseada em Problemas, Resistência dos Materiais, Educação em Engenharia.*

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# Perception level of hazard pictograms by future engineers

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**Abstract** — In the work environment, as well as day-to-day, the understanding of pictograms of dangerous chemicals is crucial, contributing to the minimization of accidents and the improvement of working conditions. Pictograms are a quick and clear way of identifying hazards, thus promoting a low chemical risk index.

The present study aimed to evaluate the visual perception of chemical hazard pictograms by higher education level students of engineering areas, regarding the proper understanding of their meaning. In this study, the method adopted was that of open-ended tests, which is recommended for evaluating the comprehensibility of symbols.

The results of this study are indicative of a low level of perception for the chemical risk on the part of the participants. In order to promote greater safety and better performance of these students in future workplaces, it is imperative to invest in their training in the area of occupational safety and health. The future engineer should be taken into consideration in the development of strategies on accidents and occupational diseases prevention.

**Keywords** — *chemical risk; hazard pictograms; education; accidents prevention.*

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# Use of computational thermodynamics in process engineering education

Case: HSC Chemistry and its possibilities

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**Abstract** — Thermodynamics can be widely used in various areas of science and practice. For instance, it is widely considered as one of the key elements in the higher education of process (or chemical) engineering. However, there is no general agreement on how thermodynamics should be taught. Some curricula focus on theory and scientific principles, whereas others emphasize the role of utilisation of thermodynamics in various applications. The programme of process engineering at the University of Oulu in Finland is based on a so-called DAS-formalism, in which studies proceed from descriptive studies to holistic synthesis via analysis-studies, that form the main core of the B.Sc. level curriculum. Methodological skills and knowledge (needed in R&D of process engineering) are emphasized in an attempt to bind theory with practical elements of engineering. It has been noticed that this helps to motivate also practice-oriented engineering students to study theoretical topics such as thermodynamics. Engineering courses emphasizing the methodological skills may be based on e.g. experiments, analyses or modelling. In comparison to experiments and analyses, modelling and simulation often offer an easier, safer and cheaper way to introduce methodological aspects to engineering curricula. This paper focuses on the possibilities to use computational thermodynamics (CTD) at different stages of higher engineering education using HSC Chemistry –software as an example.

**Keywords** — *engineering education; process and environmental engineering; thermodynamics; curriculum*

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# Proposal of a new taxonomy of the psychomotor domain for to the engineering laboratory

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**Abstract** — A new interpretation of the psychomotor domain taxonomy is presented. This new interpretation is based in a reflexive view to be applied to an engineering didactic laboratory. It is shown that the actual taxonomies were developed for the high school or initial level of the education, thus they are not adequate for the engineering courses. Even those taxonomies that are said to be devised for higher education, misses the experiment's conception. Conception in this work is understood as a way of organizing ideas. Conception is not done just by the professor who creates the experiment, but also by the student, who will follow the procedures using a laboratory script. Conception is the organization, the manipulation of ideas. Once the student has the conception of what will be performed in the lab, he/she can grasp the collected data, i.e. he/she can make the perception of data. The perception is the manipulation of the equipment for data collection. Finally, through the analysis of the results the student becomes conscious of what he/she accomplished. Based in a Simpson's taxonomy, a new taxonomy of the psychomotor domain is proposed to be used in the laboratories of the engineering courses.

**Keywords** — *engineering experiments; taxonomy of instructional objectives, psychomotor domain, conception, perception and consciousness;*

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# Investing in Entrepreneurial Skills - Creating an Entrepreneurial Mind-set amongst Engineering Graduates

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**Abstract** — The aim of this paper is to investigate how one third level college in Ireland has invested in entrepreneurial skills with the development of a multi-disciplinary entrepreneurship programme and explores its impact on the development of entrepreneurial mind-sets amongst its current students and graduates. The findings are based on results of surveys from twenty graduates from the programme who have come from a cross section of engineering and science disciplines.

The findings of this study indicate that a dedicated entrepreneurship programme specifically designed for non-business students has had an overwhelming positive impact on their entrepreneurial attitudes and intentions. In particular, students' understanding of entrepreneurship has been significantly changed since completing the programme, their level of confidence towards starting a business has increased and collectively the group have embraced the culture of entrepreneurship.

This paper will provide useful information to academics in developing third level entrepreneurship programmes for non-business disciplines. The paper provides an innovative example of entrepreneurship education and creates a framework for other third level institutions to develop similar initiatives to help lay the foundations for entrepreneurship to be the norm, and as such will also be of interest to researchers in this space.

**Keywords** — *Entrepreneurship, Engineering, Multidisciplinary, Higher Education, Pedagogy*

# Mentoring by Peers: A New Proposal of the Jaén School of Engineering

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**Abstract** — One methodological change in the university context had been the introduction of tutorial plans or mentoring programs as one of its essential pillars. From the Jaén School of Engineering (EPS of Jaén) the tutorial action is encouraged and offered as a service to all the students who wish to participate in it voluntarily. University counseling will involve students who participate in the development of academic, personal and professional competences. The mentoring program (PAT-EPS of Jaén) is the general framework in which the teachers-tutors and student-mentors (mentoring by peers) conduct an orientation to the supported students and advise them, help in their integration in the academic context and in their degrees as well as in various aspects related to their studies and future careers. Several formative group activities are organized throughout the course in the form of talks, workshops or meetings both for mentors and mentees.

To achieve these objectives, the Board Team of EPS of Jaén has supported the process since its beginning by providing technical tools / e-Learning platform ILIAS, organizational - Technical Committee – and administrative staff and dissemination news through its website, social networks, etc.

**Keywords** — *mentoring program; tutoring; engineering students; academic support; informal mentoring; peer-by-peer mentoring, leadership skills*

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# Transversal and transferable skills training for engineering PhD/doctoral candidates

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**Abstract** — Doctoral programmes are facing several challenges in modern societies. The societal role of the University, funded by the state, requires it to: a) increase the offer and admission of third cycle students; b) to reach industry/companies expectations; c) to ensure reasonable employability prospects for the PhD candidates. With the current demography, most candidates can only find a job in industry/companies. Therefore, significant pressure is being put on doctoral programmes to include transferable skills in their curriculum. This paper presents a course “Fit for Industry?” aiming at filling this need. The course design methodology is presented in detail. It includes: a) the involvement of industry since its inception; b) the joint identification of a small number of key competencies to be addressed; c) the inclusion of assessment and feedback mechanisms in its design; d) an immersive and international dimension. It was found that the course had a profound impact on the candidates’ perceptions of industry and valued by industry participants. Other stakeholders, such as PhD supervisors, also had a positive perception. The paper concludes with recommendations for those willing to replicate the course locally.

**Keywords** — *higher education; engineering education; doctoral education; transversal competencies; transferable skills; industrial careers.*

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# Portuguese language, didactics and engineering

## An (im)probable relationship?

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**Abstract** — The society of the 21st century has some keywords: globalism, transversality, skills. The realities they refer to affect every scientific area and should not be ignored by education, independently of what is being taught/learned.

Communication is related with all these tendencies. It is global and helps to install globalism. It is transversal, either in verbal or non-verbal form. It develops essential skills.

Furthermore, the mastering of communication in the mother tongue is an essential element in this context, which importance is recognized both in political statements and educational directives, including the Bologna Process, which is now being developed in Higher Education after its adoption during the first decade of this century. Being able to communicate effectively in one's mother tongue – in oral or written form – is an essential component of any profession, and the training necessary to prepare students for their future professional field may contribute to a better domain of the mother tongue.

In this paper, we intend to show that within the teaching/learning of Portuguese as a mother tongue, there are strategies and knowledge that can lead to the development of skills essential to be a good engineer in the 21st century working market and to show how they can be used within the teaching of engineering to contribute to the development of oral and written communication skills in the students.

**Keywords** — *globalism; transversality; skills; mother tongue; oral and written communication.*

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# A methodology for Virtual Reality interfaces assessment in Civil Engineering Education

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**Abstract** — The Architecture, Engineering, Construction and Operations (AECO) sector has been gradually experiencing developments in working practices and innovative Information Technology (IT) implementations [1]–[3]. Additionally, construction industry is recognized for being a multidisciplinary field, where several participants are actively involved in the project development [4]. To bridge the gap between technological implementation and user-performed operations, in recent years, new approaches have been tested. Indeed, research has been widely documenting potential benefits from the implementation of new methodologies and technological tools such as Immersive Virtual Reality (IVR) interfaces in the AECO sector and related fields [5]–[7]. These favorable outcomes are presented in several areas, such as Civil Engineering Education and Training [8]–[10]. Indeed, authors have stated benefits from the application of VR interfaces in Engineering learning scenarios [11]. However, there is a lack of common frameworks and methodologies to assess learning outcomes that may arise from the usage of IVR technologies in the particular case of Civil Engineering. Hence, the present document describes a methodology for the development of assessment tools to provide comparative, quantitative, and user-centered results in what regards learning outcomes from IVR. The methodology combines and builds upon similar research to assemble a conceptual map geared towards Civil Engineering and related fields of application.

**Keywords** — *Virtual Reality; Civil Engineering; Engineering Education; Engineering Training; Assessment*

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# Improving the Unreasonable University

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**Abstract** — We are feeling a fast changing world of information and communications. The media has intensely changed in the last few decades. We have now many powerful, simple and inexpensive ways of communicating, like the video conference. Very recent new media is used regularly by the common people to communicate and to learn. This has led to a transformation of teaching and learning methods, with all the consequences that this implies for university practices. In this article we make a summary of our combined experiences of nearly 90 years of working in Portuguese universities, particularly in teaching students for engineering physics degrees. Teaching physics and mathematics can be considered one of the hardest and most scientific courses in the university. We show the extreme need of soft skills either for the student, for the teachers and for all university staff. However, the urge of innovation motivates growing rates of scientific misconduct and pathological obsession, favoring areas more able to raise funding, and putting academia under the corporative type of management, instead of focusing on helping to advance knowledge and wisdom in our societies. Our statements are rooted in the Portuguese university and simultaneously we have a full agreement with the observations made by Joshua Spodek, from New York University, in his recent articles. In this time of a full overflow in books to read, articles to comment, easy access to any data, then it is essential that the university teach how to find what is the most important to learn, to give experiences on doing real projects, and to develop emotional skills for personnel and students.

**Keywords** — *Engineering Education, STEM Careers, Funding, Soft skills.*

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# A Didactic Processor and Simulator for IoT

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**Abstract** — Programming a processor detached from real world is no longer a valid approach in Internet of the Things (IoT) era. Nowadays a processor must interact with sensors and actuators and also with other systems through internet. However, introducing IoT concepts in a didactic and smooth way in beginners' classes of computer architecture is not an easy task. In this paper, we present the architecture of a didactic processor and simulator designed to seamlessly interact with sensors and actuators, intended to introduce IoT concepts in computer architecture and assembly language programming courses. This simulator can be executed on a Raspberry Pi nanocomputer, where it is possible to read and control sensors and actuators connected to the GPIO pins directly from the code executed by the simulator. Another extension implemented in the simulator is the access to external microcontrollers, such as Arduino and NodeMCU, connected to a computer using Firmata protocol. This access is performed via USB or WiFi connection, and makes feasible to control any device connected to the microcontroller's pins. As far as we know, there is no other educational tool, freely available for use, that offers such features at this architectural level.

**Keywords** — *Computer Architecture Education; Internet of Things; Didactic Simulator; Didactic Processor; Raspberry Pi; Firmata protocol*

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# Sustainable Projects of Students

## Using electronic waste to increase awareness of students

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**Abstract** — Society today recognizes the key role of recycling to move towards sustainable consumption and production. Therefore, society demands not only technically specialized engineers but also with responsiveness for sustainability issues. In fact, the European Commission stands on its Waste of Electrical and Electronic Equipment (WEEE) directive that treatment and recycling of electronics at the end of their life is essential [1]. According to the International Telecommunications Union [2], this scrap has a value of 55,000 million euros. Much of that value is due to the content of metals such as gold, silver, copper, platinum and palladium and only one of every five kilos are recycled. Recycling has gone from being a necessity for the conservation of the environment to a requirement for the sustainability of our economies.

For this reason, it is crucial to instill into society the importance of electronic recycling, as well as its importance to promote the care of the environment. The main problem we face in the management of waste is the presence of potentially contaminating substances if they are not subjected to the appropriate decontamination processes, prior to their treatment in recycling plants. The best environmental option is, whenever possible, the repair or reuse of the devices, thus preventing them from becoming waste.

This paper illustrates a case study on electronic students making a project about recycling materials found in the campus. The context is the electronics courses of the first and second year of our engineering students. Students develop not only the technical skills needed along the subjects, but the transversal competences related to a Project Based Learning methodology as well as sustainability skills.

The aim is to promote an innovative approach to electronic courses by using obsolete devices or electronic parts of broken ones. The idea is to encourage students to leave the overall vision of the devices and approach them disaggregating their various parts. Students should be able to: identify the different components of a device, detect the damaged parts and check the ones that work to reuse them, unsolder these components, search their database, and analysis of their electronic operation. After this, students, in a proactive manner will look for projects that can be made with the components found.

On the other hand, since abandoned components are free of charge, students are asked to quantify the savings in their project

while calculating the final cost of it. The sum of numerous basic and cheap components, such as resistors, diodes, capacitors, together with the use of more expensive components, such as recycled electric motors, has meant savings in some cases of more than € 130 per project.

The students have understood that the environmental benefit of the reuse of electronic devices is twofold. On the one hand, when an old device is conserved, it is avoided to take the product to a specialized recycling point and saving in its treatment. On the other hand, CO<sub>2</sub> emissions associated with the manufacture of new components are avoided.

Finally, this kind of projects help students to have a deeper understanding about sustainability, beyond the gained knowledge during the process. Students feel that they have had a deeper learning in these courses than on those with standard projects using PBL made in their degrees [3].

**Keywords** — *electronics; Sustainability; PBL; WEEE; Recycling*

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# Maintenance in civil engineering course and learning methodologies

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**Abstract** - The report of ASCE Vision for Civil Engineering in 2025 [1] highlights a global vision to create a sustainable world [2], enhancing the global life quality of society. In 2025, civil engineers will have a key-role in maintaining the built environment, integrating sustainable issues and using innovative technology. Therefore, Civil Engineers must be proactive in their profession and with multidisciplinary experiences and skills. In this context, the Civil Engineering course and the learning methodologies should fulfill the needs of the Civil Engineer in the near future and should focus on the interface-areas (Architecture and other engineering fields). This paper discusses the present Civil Engineering curricula at the Department of Civil Engineering, Architecture and Georesources, in IST, specially concerning the built environment maintaining and its inter-correlation between interface-areas (Figure 1), as well as its integration level with key issues [3, 4, 5, 6, 7], such as: performance, service life, pathology, diagnosis engineering, facility management, multidisciplinary knowledge, historical value, among others.

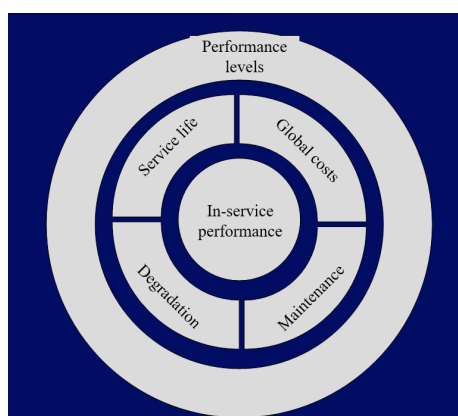


Figure 1 - In-service performance and interface-areas

The “Building Maintenance” shorten course that has been taught to the students of 5 year of the Master of Civil Engineering and the learning methodologies will be also discussed. The drawbacks and further actions will be highlighted.

**Keywords** - maintenance; civil engineering; interface-areas; education; learning methodologies.

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# Significant and Autonomous Learning of Scientific Writing by Active Methodologies in Portuguese Language Classes

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**Abstract** — The teaching-learning process undergoes transformations in order to strengthen the quality of education offered. With the implementation of new didactic models, which break with the traditional and reinforce the active posture of learners, based in Freire (1996), the use of active learning methodologies has been a constant for several teachers. Currently, studies such [6-8, 10] have shown a strong advance, in Higher Education, of using active methodologies to improve the quality of education as well as to promote student autonomy and meaningful learning. In this study, the main objective was to show, mainly from the perspective of engineering students from a federal public university, such as the use of active methodologies, in Portuguese language classes developed in the first semester of 2017, gave them more autonomy in studies beyond learning of scientific writing. For data collection, the techniques of teacher observation and the filling out of a form provided by Google Docs were used. With a response rate of 62,7%, the results showed that, although 13% were accustomed to the lectures, 98,6% considered that the use of strategies of active methodologies was useful for the development of oral and written communication competences. In addition, 88,4% said they learned a lot and knew how to seek information, when necessary, which reinforced the promotion of autonomy. On the other hand, in terms of active posture, 2,8% of all respondents assumed that they did not really care about learning, since they were not fully responsible and committed to the activities performed. Thus, it is concluded that the use of active methodologies stimulates the learner to learn, allowing him to take an active and autonomous stance in favor of meaningful learning.

**Keywords** — *Active methodologies; Meaningful learning; Autonomy; Portuguese language; University graduate.*

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# The offer of Engineering Programs in a scenario of Brazilian political and economic crisis: The case of the Federal Institutes

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**Abstract** — This article aims to outline the scenario of the offer of engineering programs offered by the Federal Network of Professional, Scientific and Technological Education (PSTE) and also discussing the expansion of this network in the last 10 years, highlighting the impact of the Brazilian political and economic crisis started in 2014. It also discusses how the economic growth verified in Brazil in the first decade of the 2000s resulted in a significant increase in the demand for engineers promoting the creation of public and educational policies and enhancing the number of Higher Education Institutions, which promoted some different initiatives by the Ministry of Education, including the creation of the Federal Institutes by the end of 2008 and the decision of offering engineering programs at these institutions.

**Keywords** — *Educational Policies; Higher Education; Engineering; Brazilian Federal Institutes.*

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# Project- and experience-based learning for communication skills development:

## Analysis of complementary studies courses for engineers

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**Abstract** — This paper explores strategies for communication skills development in the undergraduate courses of the Centre for Engineering in Society of Concordia University (Montreal, Canada). Utilizing a framework that combines experience-based and project-based learning, we argue that strategic use of applied research case studies and presentation methodologies is an effective way to respond to accreditation requirements and to the challenges of professional practice. Based on reflexive analysis of our experience teaching two distinct courses over multiple semesters, we map how project components of courses enhance communication literacies that span the technical, rhetorical, ethical and societal layers. In the context of undergraduate courses, and considering the perceived difficulty or non-centrality of communication skills for engineering students, engagement in stimulating research- and communication-centric projects allows multidisciplinary competencies to emerge. This paper contributes to the current debates on engineering communication education by (1) further addressing communication skills as critical attributes and (2) emphasizing the collaborative, iterative, and audience-centric character of practical communication skills in the context of project- and experience-based pedagogical strategies.

**Keywords**—communication skills; leadership; engineering curriculum; project-based learning; experience-based learning.

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# General Satisfaction in Chemical and Biological Engineering Courses: What Matters?

## A Students' Perception Study

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**Abstract** — Nowadays, it is essential that Higher Education Institutions (HEI) come across students' expectations and at the same time teachers' requirements. So, the vision and strategy of HEI must be aligned to perspectives of learning and teaching in a world in permanent evolution where adaptability, preserving quality standards, is a crucial condition. Moreover, it is important to identify factors, besides the quality of teaching, that contribute to student's learning, like students' satisfaction, [1], and HEI facilities, organization and services [2]. In this way, this study was developed in a partnership of five HEIs: three Portuguese and two Brazilian. The study included a questionnaire distributed and answered on a voluntary basis by Chemical and Biological Engineering students (1<sup>st</sup> and 2<sup>nd</sup> cycles and Integrated Master). The questionnaire aimed to identify and analyze the determinant factors of students' satisfaction in their courses covering aspects as educational and social university life. The questionnaire is based on a previous one [3], and adapted to the field of Chemical and Biological engineering. It comprises three main parts: I. student characterization, II. fifty-nine items, classified in a 5-point agreement Likert scale, and III. open question for students' suggestions (optional). The part II allowed to determine the student's perception regarding eight groups: Student Interest (SI); Teacher Involvement Perception (TIP); Student-Teacher Interaction (STI); Assessment of Student Learning (ASL); Course Organization and Functioning (COF); Infrastructures (IS); Academic Involvement and Management (AIM) and General Satisfaction (GS). After being semantically and statistically validated, it was delivered during the 2<sup>nd</sup> semester of 2016/17 academic year to all students enrolled in all years in the courses considered. According to the main goal of the study - to access the students' satisfaction level concerning teacher role, learning assessment, course organization, infrastructures and academic environment - only some of the collected data from five groups were analyzed. Some correlations were tested with SPSS to identify the items considered most important to students' general satisfaction with the course: In general, teachers perform positively (TEP\_8); In general, teachers have a positive interaction with students (STI\_5); The evaluation methodologies are effective and

appropriate to the different subjects taught (ASL\_2); The course is well organized (COF\_11); I am satisfied with the environment and working conditions of the School (GS\_1); I am satisfied with the academic environment (cultural, sports and leisure activities) (GS\_2). A total of 637 questionnaires was received from a population of 1420 students, however 523 (59.5% of the students' population) were completely answered and considered valid for analysis. 68% of students are female, with a mean age of 22 years. Significant differences between HEI in some items were revealed, showing that the study should be made considering HEI separately. Nevertheless, in average, the degree of satisfaction' agreement was higher than 3.2 in all HEI. Students' general satisfaction with the course (GS\_3 and GS\_4) and the level of agreement in each of the six referred vectors show a statistically significant positive relationship. Also, a positive teachers' attitude (TIP\_8), in general, reflects a positive interaction with students (STI\_5), highlighting the effect of teachers' positive attitude on the positive students' performance.

**Keywords** — students' perceptions; satisfaction questionnaires; Chemical and Biological Engineering courses; higher education

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# On the Motivational Aspects of Serious Games

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**Abstract** — The use of games as educational tools has gained increased interest over the last decennia. Referred to as serious games their primary purpose is to educate and train the player which differentiate them from pure entertainment games. Games are often assumed to possess an inherent motivational power through which individuals become immersed and absorbed in a game and experience the game play as enjoyable [1]. This engaging potential of games is brought forward to argue that games are also suitable in the educational context [2]. However, previous research indicates that the motivational appeal of games as demonstrated for entertaining computer games does not play out in the educational context [3].

The aim of this research is to investigate the role of different motivational forms in serious games and the influence of the game environment on students to get involved and stay involved in game playing.

A theory that has proven useful in explaining the motivational forces of students to learn is self-determination theory (SDT) [4]. A main focus of SDT has been the type of motivation that prompts individuals to engage in particular activities with the central argument that this engagement is based on the intrinsic needs of humans for competence, relatedness and autonomy [5]. It has been shown that autonomy oriented classroom environments are conducive to the intrinsic motivation of students whereas externally controlled activities prevent the emergence of intrinsic motivation [6]. However, not all educational activities are immediately perceived as inherently enjoyable by students. In addition, if motivation of game play is regarded as a cyclic process, it can be expected that the motivation of students to get involved and stay involved in game play will depend on game attractiveness, game learning, and game operativeness.

A mixed-method approach is adopted to get a better understanding of the motivational aspects involved in serious game playing. It can be best described as concurrent and replicated triangulation design that is used to strengthen and underpin findings obtained from different data source and data collection methods. The data collection centers around seven game cases implemented in a course environment in two consecutive years at the Department of Civil Engineering at the University of Twente. It combines observations, focus group discussions, and questionnaire surveys for all games in both years to determine the role of intrinsic motivation (IM), identified regulation (IR), external regulation (ER) and amotivation (AM) and the influence of game attractiveness, game learning and game operativeness on these motivational forms.

The results obtained from the seven game cases put the overconfidence in the motivational power and, thus, learning effectiveness of serious games more into perspective. More specifically, the research reveals that:

- All motivational forms (IM, IR, ER, AM) can co-exist when students play serious games.
- The use of serious games, either computer-based or not, does not automatically lead to intrinsically motivated students in educational context.
- Game attractiveness is a driver for intrinsic motivation but not sufficient to explain the existence of other motivational forms.
- Game learning can particularly explain the emergence of different forms of extrinsic motivation (IR, ER).
- Game operativeness is a basic condition for serious games to unfold their challenge and engagement potential which in turn will frame the learning experience of students.

Important implications from the study are that the design and use of games for education purposes should address multiple forms of motivation and should not only focus on the game content but on operational and learning issues as well.

**Keywords** — *serious game; motivation; self-determination theory*

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# Assessment and Evaluation Practices in Engineering Education: A Global Perspective

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**Abstract** — ‘Assessment’ and ‘evaluation’ are the integral parts of the engineering curriculum. These components have direct relevance to quality assurance in engineering education. Literature suggests that better assessment and evaluation practices require certain knowledge and skills about types and methods of assessment and evaluation. It is found that most of the engineering faculty members do not have concrete knowledge about ‘assessment’ and ‘evaluation’ types and methods. Further, it is argued that engineering educators are not aware of ‘feedback comments’ that are associated with assessment practices. Comments on students’ performances are essential because it helps them to know their strengths and weaknesses of a course. In this background, the paper critically analyses assessment and evaluation practices in engineering education setup across the globe. In particular, it discusses the challenges faced by engineering faculty members while assessing students’ performances. Finally, the paper offers suggestions to improve assessment and evaluation practices so that students doing engineering programs will be largely benefited.

**Keywords** — *Engineering Education; Assessment; Evaluation; Feedback Comments; Quality Assurance in Engineering Education.*

# New Approaches to Strength of Materials Teaching using Different Tools

## A pedagogical experience

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**Abstract** — The applied methodology on this ongoing study with haptic device [1-3] is a learning method, in which students interact using different tools such as: haptic device and rubber bands. Based on a methodology called Problem Based Learning (PBL) [4-5], which uses two different tools, haptic device and rubber bands, the goal of this study was to move from a traditional learning system to an active one. The main focus was to promote an active learning process, in which the students used the haptic device to simulate tension and compression tests. Besides of that, the students applied different increasing loads to rubber bands, measuring their corresponding deformations, which were deformed differently, depending on their cross section and their initial length. To test the students' knowledge improvement using the haptic, the group in study, which was in the third semester of an engineering class, was oriented to complete four different activities for about eight hours. Those activities were made of questions, exercises and problems, which had to be solved by the students individually or in small groups, using the haptic. The first test was an individual test about previous knowledge in Strength of Materials. Afterwards, two activities were solved in several small groups, ones used the haptic and others answered conceptual questions. At last, there was another individual test to compare the first and the result of the group's knowledge improvement. To test our hypothesis, we compared the initial and final test to the Wilcoxon test. There was a positive result, which established a significant improvement in the students' knowledge about Strength of Materials, the variance of p was less than 1 percent. This conclusion was obtained applying the methodology to 26 students of the third semester of engineering. For another approach of this subject, we used rubber bands with different dimensions. The freshmen students knew about the deformations, that depended on the hanging weight, and adjusted the tension-deformation diagram with the Excel software. It was noticed that this group studied a satisfying qualitative conclusion, but no quantitative one. Despite not having a statistical result for the improvement of the extension group, it only proved that there was a lack of previous knowledge for the engineering beginners, that could improve drastically by applying alternative learning methodologies such as PBL. This study has shown that alternative learning methods can improve significantly student's knowledge in a specific subject. Beyond the statistical analysis, interacting and orientating the students during the

application of those methods, it was evidential that the interest in the subject with the alternative method was much higher than it has usually been with the traditional method. It seems that interacting and active learning instigates the interest in the subject, which they are more concerned and conscious about, rather than having it solved and reproduced subsequently.

**Keywords** — *Strength of Materials; haptic interaction; engineering education; Problem Based Learning; Wilcoxon Test*

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# Nádúr Daonna (Natureza humana): An Intervention to Work with nature in the Intellectual Development of First Year Engineering Students

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**Abstract** — For most of the 20th Century there has been a debate among psychologists, educationalists and others as to whether nature or nurture determined the personality and capabilities of the adult person. Only in the last decade has an answer been found for that perennial question: the adult is the product of both nature and nurture. The genotype, the genetic inheritance from parents provides a template, but the expression of the genotype, the phenotype, depends on the interaction between the individual and their environment. Nothing is written in stone: the young child beginning education has almost infinite possibilities. [1]

In order for this to be realized, the educational system must act so as to maximise the potential in each individual's genotype. This is quite a tall order, and the resources required beyond most governments. There are alternatives to a tailor-made education for every individual, and that is to build upon what is known about the intellectual development of children and young adults and incorporate it into the current, far from perfect system.

This intervention centered on an open-ended design exercise given to first-year Engineering students taking a traditional Physics module to see if it had a measurable effect on their understanding. The results have been modest, but significant. Small interventions do make a difference, and if introduced on a larger scale across all modules on the programme could help students achieve their potential.

The initiative described in this paper was undertaken within a traditional first-year Mechanical Engineering three-year ordinary degree programme at Dublin Institute of Technology (DIT), Ireland. The learning activity required students to analyse an open-ended design problem, re-interpret it in their own words, and then outline and implement a workable solution. In preparation for this exercise, much of the relevant knowledge was encountered earlier in the semester in both the mechanics and physics courses, but not

previously integrated in any way, nor applied to a real world problem.

The students' conceptual understanding of the Physics involved in the exercise was tested before and afterwards, and analysed to see if any improvements had occurred. A statistically significant difference was found, validating the efficacy of this intervention, albeit with a small sample.

**Keywords** — *educational psychology, Kahneman, Type I and II thinking, conceptual understanding.*

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# Some considerations and reflections on Engineering Thermodynamics teaching and learning

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**Abstract** — Students' difficulties learning Thermodynamics and Engineering Thermodynamics, and hate on Thermodynamics, are well known all over the World. Disappointment and concerns of Thermodynamics and Engineering Thermodynamics teachers with students' frustrations and poor performances are also globally well known. These are, at the end, correlated with their own performances as teachers. There are many reasons for that, which, just for organization purposes, can be placed on the students' side, on the teachers' side, on the teaching/learning approach and on the teaching/learning resources. These reasons can be placed on just one of these sides, or as combinations of contributes from more than one of the referred sides. Present reflections and considerations, mainly based on the author's experience of some decades teaching Engineering Thermodynamics for Mechanical Engineering students, and on some studies reported in the literature aim to identify the main sources contributing for that. They aim to help to an enlarged diagnostic, and main causes' identification, but not specially to propose solutions for them. Once the sources of the main problems are known, it is easier to design and propose supported plans and go ahead with efforts, experiences and implementations trying to improve the Engineering Thermodynamics teaching/learning process.

**Keywords** — *Thermodynamics; Engineering Thermodynamics; teaching; learning; diagnostic; main problems' identification*

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# Evolving Pedagogical Artefacts

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**Abstract** — The evolution of technologies and the advent of Web 2.0 functionalities have enabled a new generation of e-learning platforms that go beyond the traditional online courses. Novel learning affordances are now possible as learners are no longer conceived as recipients or consumers of information and content, but participants, authors, reviewers, and collaborators within differentiated learning spaces. Pedagogical artefacts are evolving as they focus on complex interactions between human, textual, discursive and spatial dynamics that have pedagogical and epistemic repercussions grounded within reflexive and inclusive education. In this paper we present our experiences through a case study where we engage our graduate students in the development of these evolving pedagogical artefacts within our online environment, whereby, instead of memory work they focus their evidentiary work as knowledge artefacts created through digital media. Our e-learning portal supports, promotes and motivates the learners' knowledge representations assembled in the form of rich, multimodal sources employing any of the available media. Such representations are products of distributed cognition, where traces of the knowledge production process are as important as the products themselves, as well as the sources used, peer feedback during the making, and the social-collaborative intelligence employed.

This paper highlights the role of new e-learning affordances in contributing to the evolving nature of pedagogical artefacts, in an effort to add value to the entire e-learning experience. Numerous online courses delivered over our e-learning portal, called Common Ground Scholar (CGScholar) [1], have been developed with specific semantically-designed capabilities that are grounded within a reflexive pedagogical rationale. Our philosophy is based on Bloom's theoretical recommendations [2] on how to aim towards mastery learning, together with an educational model of new learning affordances [3], made feasible through new media. Three of such affordances relate to active knowledge making, multimodal meaning, and recursive feedback that subscribe to William's [4] formative assessment strategies while optimising the learners' cognitive awareness. Carlin-Menter [5] argues that such practices that focus on varying semantic architectures assist students to better understand the metacognitive tasks required to express themselves and represent their thinking.

In this paper, we discuss how we enable active knowledge making, encourage the use of multimodal meaning, and integrate recursive feedback within the online portal as

learners are encouraged to employ a variety of modalities to create experiential work while giving feedback to their peers.

TABLE I. PERCENTAGE USE OF MULTIMODAL FUNCTIONALITY

<i>Functionality</i>	<i>% Use</i>
Multimedia elements	72.83%
Reviews completed	81.42%
Peer-reviews done	80.95%
Updates done	83.06%
Revision changes performed	79.26%
Views to updates	87.98%

New media offer students the possibility to refine and represent their understandings and acquired knowledge in multimodal ways, where traditional textual knowledge can be supported by image, diagram, video, visualization, dynamic dataset, and embedded external media. In this paper, we have described a new e-learning environment for active knowledge making through multimodal knowledge representations, CGScholar. Our trials have demonstrated the capacity for students to create a new genre of pedagogical artefacts, offering them opportunities to represent their understandings that far exceeds those of traditional word processors. The richness evidenced in their submitted work (Table I) is statistically measured, as well as their affinity to employ the adequate medium to express whatever they need to transmit to their peers and tutors through recursive feedback has also been recorded and analysed.

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# MOOC Técnico ways of learning

## One year of online courses

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**Abstract** — Técnico Lisboa, of Universidade de Lisboa ([tecnico.ulisboa.pt](http://tecnico.ulisboa.pt)) has been aiming to position itself in the latest developments of *Massive Open Online Courses* (MOOC), in a pathway that started in 2013 with a definition of a strategic plan [1]. This strategy takes into account both the Portuguese higher education context in the areas known as *Science, Technology, Engineering, Mathematics* (STEM) and, on the other side, the education in STEM elsewhere in the world for Portuguese-speaking communities.

The first online courses were launched by the end of October 2016 in a proprietary platform MOOC Técnico ([mooc.tecnico.ulisboa.pt](http://mooc.tecnico.ulisboa.pt)) based on Open edX [2, 3]. Over a period of one year and few months, eight online courses were produced and run for the first time, several of them even resulted in successfully reruns. Around 4000 participants enrolled in the MOOC Técnico online courses. Presently, seven more courses are under production and are scheduled for launching during 2018.

The completion rates for the courses (participants who score greater or equal 60% of the course' activities) are very encouraging, ranging between 25% and 58% the percentage of participants who receive the free certificate for having successfully conclude the course. Comparing these numbers with the usually average of 7,7% of completion rates among participants in edX courses [4], the MOOC Técnico courses achieve a figure of success rate far above average. Three of the online courses: Energy Services (esX), Valores Próprios (vapX) and Dynamic Energy Budgets (debX) were used in a flipped-classroom strategy for on-campus enrolled students in both undergraduate and graduate Técnico Lisboa courses.

In the mini-symposium *Teaching, learning and assessment in Higher Education* we'll present an analysis of the analytics data from MOOC Técnico platform enrollee records, from participants' answers to online pre-course and post-course questionnaires, and from several interviews [5]. We will then attempt to answer the following questions: a) what are the main motivations of MOOC Técnico learners? b) how MOOC Técnico courses are structured and which

are the interaction and communication modes that are promoted in the courses? c) how much time do participants dedicate to the different course activities, including assessment, and which are the main difficulties encountered? d) which are in general on-campus students' feedbacks to their flipped-classroom experiences with MOOCs?

**Keywords** — MOOC; STEM online courses; MOOC learners; flipped-classroom; online assessment

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# What is an Engineer? Students and teachers' perceptions of Physics of the 12<sup>th</sup> year

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**Abstract** — In recent decades, there has been a weak demand for a vast number of engineering courses, on the other hand, a high drop-out rate for students entering engineering courses. The academic training of engineers is based on a strong component of mathematics and physics content. However, during performance of his duties, the engineer has to master, such diverse areas as new technologies, teamwork or problem solving. It is important to analyze the perception of students and teachers of Physics of the 12th grade, what does it mean to be an engineer and how they manage curricula, the emphasis they give to content in terms of higher education curricula, and the interdisciplinary work they develop with teachers from other areas, in order to contribute to a global training of the student.

This is the object of study of qualitative research presented here. In this initial phase, interviews are being conducted with teachers and students of Physics of the 12th grade and the analysis of their perceptions will be presented and discussed here.

It also reflects on the contributions of the study to the teaching-learning process, in particular for the curricular area of this study. According to the work carried out in recent years, the way to reverse the situation is to change curricula, to start in earlier teaching cycles, with the introduction of methodologies and contents associated to the execution of engineering. The peer group in the classroom with the titular teachers is also relevant in these initial cycles, since they do not always dominate the contents of engineering areas.

**Keywords** — *engineer, curriculum, physics, skills*

# Optimized Methodology Using Multi Choice Question Tests on Paper

## From question authoring to grade publishing

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**Abstract** — The introduction of the *FCT Curricular Profile* at Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, a pioneering pedagogical model in Portugal, allowed to accommodate transversal skills, such as research and entrepreneurialism, soft skills and contact with industry in all its BSc, MSc and integrated MSc curricula. Since these skills are increasingly being recognized by employes, the chances for the Faculdade de Ciências e Tecnologia of Universidade Nova de Lisboa's students to be successful in the job market tend to increase [1-3]. However, the calendar changes resulting from this pedagogical model imposed serious management problems concerning assessment using on-paper tests, specially to courses with a high number of enrolled students (ranging from 200 to 800).

Here we present a methodology that is being used since 2012 that proved to successfully overcome those difficulties. The methodology embraces the whole process of assessment using on paper tests from its beginning (test authoring) to grades publication. The methodology implementation enabled a significant decrease of faculty's exam/test proctoring time, reduced the grading time for less than an hour, and permitted a much more efficient use of university's rooms dedicated to tests. Moreover, allowed many professors to convey many hours previously spent in related test activities to their research and teaching innovation activities.

**Keywords** — *Multiple-choice question test; MCQ; on-paper test; optimized methodology; FCT Curricular Profile; FCT NOVA*

### ACKNOWLEDGMENTS

None of this work would be possible without Remark. Thus, our special thanks to FCT NOVA direction for providing funds to buy Remark's license.

Such a methodology can only be tested and improved if used in real circumstances and for a long period of time. Therefore, we thank professors Fernando Parente and

Maria Adelaide Jesus for their support to the method's implementation in the *Big Number Courses* coordinated by them.

Over the years, the method has been improved relying on the input from other colleagues and due to the challenging test structures that have been designed. Nevertheless, the contributions from professors José Paulo Santos and António Paiva have been particularly relevant.

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# Engineering Students perceptions on Learner Autonomy

## A mixed methodology approach

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**Abstract** — Student-centered learning requires students taking responsibility for their own learning, and becoming autonomous learners [1], [5], [6]. Using a mixed methodology approach with a sequential explanatory design [7], [8], this paper reports some results from an ongoing research about learner autonomy of mechanical engineering students (Bologna first cycle with three years) from the School of Engineering of Polytechnic of Porto in Portugal. For the purpose of this paper, the focus is the relationship between learner autonomy and academic achievement and the way it translates to students' perceptions of autonomy in learning, its characteristics and importance, and how having students talk about learner autonomy can be useful to improve their learning and build a bridge between research and practice in Engineering Education. Self-direction was used as an indicator for learner autonomy, and was measured with the Portuguese adapted version [2] of the PRO-SDLS [1], which is an operationalization of the PRO model [3], that identifies four dimensions of paramount importance for the development of learner autonomy: control, initiative, motivation and self-efficacy. The Portuguese validated version [2] has 12 items, and keeps the factor structure of the original version. Being a five point Likert scale, the maximum score in the adapted version of the PRO-SDLS is 60 points. To collect the qualitative data, regarding students learner autonomy, the researcher used semi structured interviews. For the quantitative data collection, convenience sampling was adopted. A total of 425 students agreed to participate in the study. For the qualitative data collection, a smaller sample was used, with 10 participants from the 425 sample. The selection of this participants was random, and was done based on criteria regarding their level of learner autonomy and their grades, and ensuring that participants from all curricular years and genders were included. For the study of the intensity and the direction of the linear type association between self-direction in learning and its dimensions and academic performance, Pearson's correlation coefficient ( $r$ ) was calculated. The audio recordings from the interviews were transcript and content analysis was done. The corpus was coded, using exploratory categories about learner autonomy: characteristics, importance and self-perception. The results show that students have positive perceptions about their own learner autonomy and its importance. A positive moderated statistically significant correlation was found between learner autonomy and academic achievement, which is mainly due to the control dimension of learner autonomy. Students lack initiative, as no statistically significant correlation with learner

autonomy was identified. Because of this, promoting actions that increase students taking initiative seems to be a way of improving learner autonomy. However, the actions taken have to consider that for some students, learner autonomy requires perseverance and is difficult to maintain. So, even though for most students, having opportunities to improve may be enough, less autonomous students may require that the action of teachers and the curricular activities proposed, promotes an academic environment that encourages and supports autonomy in learning.

**Keywords** — learner autonomy; self-directed learning; higher education; engineering education; mixed methodology

### ACKNOWLEDGMENTS

Doctor Susan Stockdale for sharing the English version of PRO-SDLS scale and allowing its adaption for Portuguese.

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# Multimedia teaching aid to laboratory tasks on analog communication training setup

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**Abstract** —The paper presents new multimedia guide primarily created for Master distance curriculum at Tomas Bata University in Zlin, Czech Republic, to ease the work on analog communication training setup in the laboratory of communication and signal processing. PROMAX company manufactured the analog communication training setup in Spain, and the devices of the setup are described in the original documentation in English and Spanish together with the printed version of the labs that could be performed on this setup, also in English and Spanish. Since the students of the given distance curriculum should focus on the practical exercises of the communication, the necessity of creating such teaching aid appeared. The paper describes the communication setup and the created labs that could be performed on it, the created teaching aid and the way how it was created.

Finally, there is the students' evaluation of the teaching aid in the form of the questionnaire. The created multimedia teaching aid was used during classes for some years by students of distant Bachelor curriculum. There were suggested students to measure the prepared labs according to the created students' video manual and then they could verify their results by watching the created teacher's video manual. But they did not have to. Instead of the video manual, they could use the printed version of labs in the paper. In purpose of the feedback from the students, there was created the questionnaire with following questions:

- 1) Do you use the created teaching aid during classes? [Yes/ No]
- 2) How often do you use it? [Very often/ Often/ Occasionally/ Never]
- 3) Have you used similar aid in the different subject before? [Yes/ No]
- 4) Have you watched the created aid at home? [Yes/ No]
- 5) Will you use it in future? [Yes/ No]

The created multimedia teaching aid was evaluated by students using the created questionnaire. On the whole, the obtained results from the students' knowledge and the questionnaire proved us the effectiveness of the created tool. The tool was used in 2 two groups of students; each group could have 12 students as its maximum value. Remaining 4 group of students with the similar number of the students, again around 12 students in each group, used "the classical way" of measuring in a lab based on the printed documentation in English only.

Students with the printed documentation only had one extra exercise before measurements in labs to study and understand whole topics in the documentation and the tasks to measure and realize. The teacher had to help them with the proper terminology translation even if they tried it using online translators. So firstly, the created tool helped students to become more familiar with the topic without less explanation from the teacher. Secondly, the tool decreased the time necessary to understand the work in the lab by 2 hours, i.e., one exercise.

There were more significant differences between groups which used this tool and which not. The students using this tool just watched the selected task on the video, and without any need, they created proper connections of the systems and successfully measured the task. While the students with printed documentation only spent more time with connecting the system and usually asked the teacher to help them. After measurement, they asked the teacher if the obtained results are correct. From teacher's point of view, the group of students using tool worked almost without any help of a teacher. The teacher only checked in which phase of measurement they were. So the created tool saved teachers' time in the lab. From student's point of view, students in the group using the tool worked faster, finished earlier and, finally, left the class sooner. So students in the groups using the tool were more satisfied.

The created tool also has one more added value. It helps to make the curriculum more attractive. And it is necessary because it stopped the decrease of students' interest to study the technically oriented curriculum.

Finally, it was decided by the teacher who guarantees the subject taught in this lab after three years' usage of the created tool that in future school years the tool is used in each group of students in the lab.

Teachers who taught this lab should be selected according to the specific needs according to work with students "in the ground." The proper profile of the involved teacher should include for example the knowledge of the motivation of the students, the communication and interaction skills, the ability to find and explain a practical example of using the tested methods in the lab, and mostly to be "expert" in the field of signal processing.

**Keywords** — *analog modulation; communication; multimedia; questionnaire; teaching aid*

# Application of QCA method to GUESSS data in search of factors' configurations behind engineering students' entrepreneurial intention and activity

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**Abstract** — The *sustainability* is an essential keyword to the development of a Country. However, it is not easy to integrate economic, environmental, and social concerns, and the reasons are the wide range of actors involved, its material outcomes, and the forms of governance needed to regulate processes of economic greening.

In this paper, authors identify the new firm creation as a crucial point for the national economies and, in particular, they focus attention on the important role of young generations and on the participation of the students as to the competitiveness, growth and economic development. In fact, studies have shown that a small proportion of students are able to found their enterprises before graduation, making student entrepreneurship a potential and important source of competitiveness, growth and economic development [1,2].

Different from the other papers present in literature, authors want to capture the complexity of the problem, recognizing in the entrepreneurship the four main elements of the complex systems: dynamics, irreducibility of elements, interdependencies, non-proportionality [3,4].

The first step of the work is to identify both cognitive and contextual factors which make engineering students [5] more favorable towards entrepreneurial intention and propensity.

So, authors recognized in the Theory of Planned Behavior (TPB) [6,7,8], for the cognitive factors, and in the Institutional Theory [9], for the contextual factors, the more appropriate theories to apply.

The 2016 Global University Entrepreneurial Spirit Students' Survey (GUESSS) database is used for the research applying an approach based on the qualitative comparative analysis (csQCA).

Results and main implications are discussed in the conclusions.

**Keywords** — *Entrepreneurial intention, Engineering, GUESSS, QCA, complexity*

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# Introducion of experiment for the improvement of learnig in eletrostatic

(Attempt to minimize the evasion of the course Science and Technology – UFPA ANANINDEUA)

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**Abstract** — This article deals with the basic elements of capacitors, part of physics that studies the storage of electric charges to be used in the future, a "*Leyden bottle*" for the practical understanding of the basic concepts of capacitors, capacitance and electricity, being considered a high voltage capacitor. And it was used for the better understanding of electrostatics, together with the students of Science and Technology of the Federal University of Pará (UFPA) – Brazil, Ananindeua campus. Aimed at improving the training of students. In the article it is presented processes of obtaining the experiment and the way of facilitating the teachings.

**Keywords**— *Capacitor, capacitance, voltage, electrostatic, dielectric.*

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# Strength of materials laboratory of the civil engineering department at ISEP

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**Abstract** — This paper describes the experience of the Strength of Materials Laboratory of the Civil Engineering Department of the Instituto Superior de Engenharia do Porto (ISEP) in supporting various civil engineering disciplines, within programs which are fundamental to an education in the field of engineering, as well as the continued study of other disciplines. Equipment and laboratory tests are described, as well as the creation of new tests, which all complement the teaching and increase student motivation. The article also describes laboratory activities in programs and projects with younger students, which were initiated in order to encourage creativity and reflection in these students.

The student of Civil Engineering should, during his academic course, gain mastery of a large set of theoretical knowledge in the field of Statics, but also acquire knowledge and sensitivity for the physical phenomena involved. Teaching laboratories are precious tools in this learning process, since they facilitate an easy explanation and resolution of structural problems, as well as the student's perception of the various mechanical and structural phenomena.

These laboratories should help the teacher to increase the motivation of his students in relation to the classes he teaches them. Students often do not pay attention to the programmatic content developed in class because they simply do not see a practical application for the concepts taught or because they believe that it is unlikely that the subject will be useful to them in their professional lives. One solution to this problem is to complement each subject with the analysis of a suitably prepared physical model, with which the student can work, and analyze the results. In this way it will be possible to arouse the interest of the student, motivating him to study.

The Strength of Materials Lab (LRM) of the Civil Engineering Department of ISEP is essentially devoted to the teaching of the disciplines of the scientific sub-area of Structures: Statics, Strength of Materials and Theory of Structures and to support the development of “Seminar” projects or of “Integrated Project” works.

Thus, in the laboratory classes students are invited to conduct or accompany the performance of experiments that allow obtaining answers to previously posed problems. In the end-of-course projects, students have the possibility to design, build and test new models on a reduced scale, as well as create new experiments.

An annual competition was created among groups of students, with the submission of reduced models of Bridge

structures using spaghetti, with the objective of motivating the interest in the search for efficient and creative structural solutions in the resolution of engineering problems.

The LRM has also supported initiatives related to high school students, as well as being present in various Technology Fairs / Expos, with the objective of encouraging creativity and reflection in students, through the presentation of scientific projects, in the area of Civil Engineering.

A survey was designed to gather students' opinions about the LRM and its usefulness to the learning process. The Directorate of the LRM hoped that the answers collected would enable it to achieve three objectives, namely: a) to know the students' opinions about the interest and / or suitability of the set of experiments they have carried out; b) justify any proposals for changes in the composition of this set; c) to support proposals for modifications to be made on the existing experiments.

Thus, a short questionnaire (only eight questions) was prepared with a guarantee of anonymity to the respondents. In this questionnaire students were asked for answers on a qualitative scale of five grades, from 1 (“very unsatisfied”) to 5 (“extremely satisfied”).

The results of the survey were extremely positive. All the interviewees considered the laboratory experiments to be adequate and that these experiments have helped them understanding of the subjects taught in the theoretical classes.

The opinion of the professors of the disciplines that use the laboratory is unanimous. They all consider the experiments very helpful because, they help the students in the learning process.

The Directorate of the LRM has established, as the main aim to attain, the development of new physical models. These new physical models should address subjects not yet covered by existing experiments.

**Keywords** — *Strength of Materials; Civil Engineering; Teaching Laboratory; Testing; Creativity.*

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# Evaluation of group work in the Chemistry and Biotechnology laboratory

## A case study

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**Abstract** — In the laboratory classes of Biotechnology Bachelor course, students are joined as groups of 3 to 5 members to execute several laboratory protocols and attain measurable physical results. There are four main phases for each weekly task: 1st preparation before the lab class, 2nd organizing the material inside the lab class, 3rd executing methodology and 4th elaborating the technical written report. All these phases are performed as a team work in each group, which must organize themselves to attain the objectives. In order to better understand how each group worked, students were asked to voluntarily answer a quiz about Self and Peer assessment. The method applied was the online Sparkplus [1] which had four categories: Efficient functioning of group, Leadership, Number crunching and Writing report. Each category had 3 to 6 criteria that students had evaluated in a slider scale from Well Below Average to Well Above Average.

work inside their group. A small number of cases need to increase these skills and so the application of this methodology is necessary.

From the teacher's point of view the results offered a validation of the teamwork perception obtained from observations during classes and, in certain cases, the results added new information about the issues a group of students faced during the phases not performed in classes.

The application of this methodology was just informative, as it was a preliminary stage, and did not influence the individual grade of the students. The engagement of students in undergraduate engineering and technology courses benefit from this simple and quick quiz by enhancing the judgment skills of the individuals regarding teamwork [2]. It was also an opportunity, in a technology course, for the students to develop the collaborative skills, as group work is a mandatory competence.

Since students said that it was unfair to have an equal reward when there was an unequal contribution to the teamwork [3], using a confidential and systematic method like this quiz avoids such situations. This and other benefits may be perceived in the academia.

**Keywords** — Sparkplus; Laboratory group work; Self and Peer assessment; judgment skill; teamwork.

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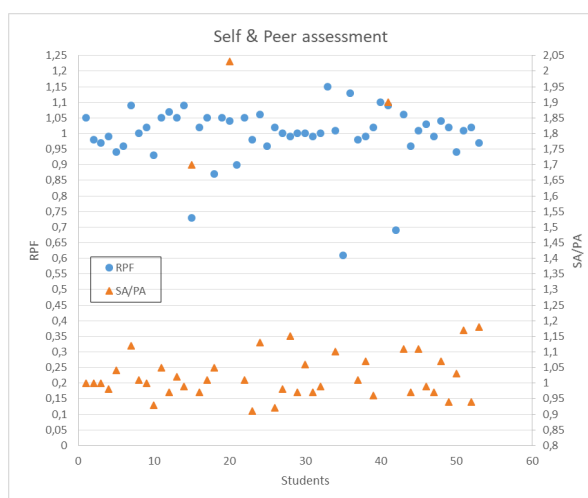


Figure 1. Relative Peer Factor (RPF) indicate hetero-evaluation and SA/PA indicate self-evaluation of students.

The results from 86% of the 51 students enrolled in the classes until the end of the term were analyzed. Self-evaluation (SA/PA) revealed 3 cases of overvalued students which had a SA/PA higher than 1.2 (Figure 1). Hetero-evaluation (RPF) showed 4 cases of low contribution to the group work which is shown by a relative peer factor lower than 0.8, but the majority of students were between 0.85 and 1.1. These results indicated that the majority of students were self-aware and conscientious of each member contribution to group

# Educational innovations in Engineering education

## sustainability of funded projects developed in Portuguese higher education institutions

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**Abstract** — The importance of promoting educational innovations in higher education has been highlighted by the research community (e.g. educational researchers) and also by the academic community (e.g. university teachers) [1]–[4]. Educational innovations could be educational resources and/or teaching, learning and assessment strategies for the purpose of improving teachers’ academic practices and/or students’ learning achievements.

Educational innovation that is here under consideration here relates to the introduction of an idea, resource, process, and/or strategy with the aim of improving a certain practice [5]. International studies [6]–[10] keep on demonstrating that, besides the impact of such educational innovations on students’ learning, they also contribute for teachers’ academic development. Building closer links between research and teaching has become an important way to enhance the quality of HE across the world [11].

This paper presents a study focused on the sustainability of educational innovations developed in engineering courses, with a particular emphasis on the teachers’ role. These innovations were developed by educational researchers and/or engineering teachers of public Portuguese Higher Education Institutions (universities and institutes) in the scope of financed projects.

A collective case study was carried out in order to characterize projects supported by national research funding agencies, between 2006 and 2015. Document analysis of the projects’ materials (e.g., scientific reports) was carried out and interviews with coordinators of selected projects were conducted. These aimed to determine the extent to which these projects have considered the impact and sustainability of educational innovations, since their conception. The sustainability involved at least part of the implementation, the modification and/or the expansion of the educational innovation in other contexts (e.g., other Engineering courses) by participants of the project (e.g. university teachers).

Results showed that some of the developed educational innovations were sustained after the end of the funding, but that this issue should be analyzed further. Guidelines are proposed herein to enhance the sustainability of educational innovations developed in higher education following the conclusion of projects, in order to provide more information to educational policies, funding agencies and involved actors (e.g. teachers).

**Keywords** — *Educational innovations; Engineering Education; Sustainability of funded research; Portuguese higher education institutions.*

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# Multiple Approaches to the Economic Dispatch Problem -- a Pedagogical Perspective

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**Abstract** — This presentation addresses the problem of economic dispatch problem for optimal operation of power system resources (ED). In its simplest form, the ED problem consists of choosing the most economical operating point for each power unit in such a way that power demand requirements are satisfied. It is a problem of nonlinear optimization: minimize a nonlinear objective function subject to a linear equality constraint.

In all literature [1-9], the problem is always addressed in the same way: Write the Lagrange function by augmenting the objective function with the constraint and a corresponding multiplier, the famous lambda. Obtain the necessary conditions for optimality by making all partial derivatives equal to zero. Lambda is then called “system lambda” and represents the incremental operating costs for all generation units. This is an interesting approach, and is designated below as “classical approach”.

In this presentation we take four approaches for the ED problem:

1. The classical approach, based on Lagrange multiplier lambda being the incremental cost for all operating units;
2. An approach based on the concept of slack generator, which leads to an unconstrained optimization problem and whose optimality condition is that the incremental costs for all units must equal the incremental cost for the slack generator;
3. A graphical approach, in which a graphical description is plotted together with the constraint plane; the optimal point lies at the intersection between the cost surface and the constraint plane at the minimal cost point; this is shown graphically;
4. An approach based on the saddle point theorem, in which one shows the maximum dual and the successive minima of the Lagrange functions.

All four approaches are presented with illustrative figures, figures with cases of different number of generating units and different types of operating cost curves. For some of the figures there are cross-sections of cost surfaces and contour plots.

A few more words about the fourth approach. This approach requires cost function, constraint, Lagrange function and dual function. The problem of visualizing graphically the Lagrange function is already non-trivial as it is a three-variable function for a two-unit problem. We offer different views. For example, one cross-

section to view the concavity of the dual function, while another view where the duality points are centers of families of contour graphs.

We believe that the presentation of the ED problem by four different approaches makes an interesting pedagogical contribution for the understanding of the powerful Lagrange methods and of the important concept of slack generator. Of particular interest is the approach based on the saddle point theorem, as one can illustrate such a powerful, unfamiliar theorem in a such a simple, familiar context.

**Keywords** — power systems, economic dispatch, optimal operation, constrained optimization; Lagrange and primal-dual optimization

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# What's going on - mapping the evolution of engineering education research in Europe via European Journal of Engineering Education publications

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**Abstract** — Responding to growing international interest in the growth and evolution of engineering education research (EER), this paper reviews three recent studies [1, 2, 3] that used analysis of publications in the European Journal of Engineering Education (EJEE) to provide insights into the evolution of EER in Europe. The studies reviewed cover the UK, Portugal and three Nordic countries Sweden, Denmark and Finland.

The present work aims to complement an earlier analysis by [4] that looked broadly at the role of EJEE as a venue for research publication. In this study, the authors synthesize the findings of the three studies and arrive at the following overall conclusions:

- In addition to its role as a public research repository, EJEE also has potential for tracking and mapping the evolution of EER in various parts of Europe both in terms of measuring the quantity of research output and of identifying areas of focus;
- The geographical areas in the 3 studies analyzed show a positive evolution of EER in the periods under study;

The authors conclude by recommending that this kind of analysis be carried out for other parts of Europe so as to allow the European Society for Engineering Education (SEFI) to build up a more complete picture of the evolution of the field of inquiry at a Europe-wide level.

**Keywords** — *evolution of engineering education research; European Journal of Engineering Education; mapping European research*

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# Civil Engineering Master hands-on challenge to motivate first-year students

CIVIL'in 2017-2018

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**Abstract** — The CIVIL'in program started in the academic year of 2015-2016 with the goal of integrate and monitoring the new first-year students on the Master of Civil Engineering (MIEC) study cycle of the Faculty of Engineering of the University of Porto (FEUP) [1].

The monitoring is conducted by tutorial during the first year, being assigned to the new student a single tutor that is a student attending advanced years. The tutor support is monitored by a MIEC teacher, which will assess the difficulties, give some advices to the issues raised by the tutor and observe the student's progress.

This program aims a better integration of MIEC new students at FEUP allowing the tutors to develop relationship, socialization and team spirit that will be relevant to the acquisition of personal soft skills that are important for its future integration in job environments.

In the academic year of 2017-2018, after some experience in the CIVIL'in Program by promoting different activities like the “best Civil Engineering photo”, the “best Civil Engineering Department video”, it comes the idea of presenting an hand-on challenge where students can learn in a friendly environment with young and older students and teachers of the different areas of Civil Engineering.

The challenge, developed and monitored by CIVIL'in teachers, was considered an interesting activity. Students could understand construction processes by building a wall and they could analyze the qualitative thermal and acoustic behavior of the built wall by comparing experimental results from different built walls. This was also an opportunity of visiting Civil Engineer laboratories, using the equipment and anticipating some concepts, which first-year students will explore and learn later in the study cycle.

The walls, built with mortar and plastic bottles, glass bottles or cans, presented some interesting results that fascinated the students.

**Keywords** — *Hands-on; integration; teamwork; soft-skills.*

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# Personalized Student Assessment based on Learning Analytics and Recommender Systems

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**Abstract** — This paper presents a process based on learning analytics and recommender systems with the objective of analyzing student assessment in order to provide clues that can help teachers in scaffolding the students' performance. For this, a set of tests was used to evaluate students' competence in direct current circuits. The tests had multiple versions and to solve them each student had to use multiple approaches. The results indicate a better performance in calculus and simulations approaches when compared with hands-on and remote laboratories approaches. The analyses also provide support for the recommendation step allowing the configuration of a knowledge base. The process is consistent in what regards its ability to make suggestions to the students as they complete a given test and to provide teachers with information that can help them formulate strategies to positively impact students' learning.

**Keywords** — *personalized student assessment; learning analytics; recommender systems*

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# Implementing active learning through pedagogical coaching in Control Systems lectures

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**Abstract** — In Higher Education, lectures are mainly expositive. For the Millennials, a generation bound to digital technologies, this class profile seems to gather few supporters. This paper presents a Control Systems engineering course case study. It describes the classic methodologies used in class and the effort made to apply active learning methodologies using digital technologies to engage student's participation. The lectures were attended by a pedagogical coach to give support and tune the application of new methods. The impact of both teaching approaches is assessed comparing the respective students' performance in the course.

**Keywords** — *active learning; formative assessment; Kahoot; engineering lectures; pedagogical coaching.*

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# What about using a project management Agile methodology supported by online platforms in the classroom?

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**Abstract** — Project-based Learning (PBL) is one of the most heard buzzwords within academic discourses in the last decade. It represents a shift in the way the study of engineering is conducted in undergraduate and even graduate programs. However, despite its popularity, the application of PBL is specific to each engineering area and subject. In this paper, we present our experience in applying PBL to two subjects of computer science: Software Engineering and Distributed Systems. We describe how we use online platforms to implement PBL principles and discuss the impact of our approach on the learning performance of students. The automation of work assignments along with the adoption of an Agile methodology from the software industry for collaboration between students, allowed us to implement a continuous evaluation framework that promotes the motivation and the continuous work of students.

**Keywords** — *Project-based Learning; Collaboration Platforms; Scrum; Agile Methodologies*

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# Mens sana: An Investigation into the Relationship between Psychological Traits and Academic Success of First Year Engineering Students

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**Abstract** — In 1904, the French government asked the psychologist Alfred Binet to devise a general test of intelligence that could be used to identify pupils who were behind their age cohort, in order to give them extra help to bring their level up to that of their peers.

For most of the 20th century, intelligence testing has played a major role in education, unfortunately to categorize pupils at an early stage in the life, rather than to help them. In the last two decades, much work has been done in broadening the testing of students, especially in examining the relationship between so-called non-cognitive factors and academic success. This paper looks at that relationship for seven common factors, the American Psychological Association's 'Big 5' Personality Traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism, often represented by the acronym OCEAN), Stanford psychologist Carol Dweck's Mindset test [1] and University of Pennsylvania psychologist Angela Duckworth's [2] Grit test (defined by her to be a combination of passion and perseverance).

The paper examines the correlation between scores on these tests and academic results. The results were surprising, in that the Irish students showed little or no correlation between their Grit scores and their academic success, contrary to the American experience. One positive was the internal consistency of the results, with students' scores in the APA's Big 5 trait closest to Grit, conscientiousness, also showing no relationship to academic success.

Carol Dweck's work in particular is very important, as it identifies a serious block to learning in those students who have closed mindsets. Given that Professor Dweck has shown that such

students, once identified, can change their mindsets and so go on to achieve much more academically. It would be sensible for engineering educators, instead of trying to squeeze in another few hours of computational fluid dynamics to consider testing students to ascertain their psychological profile, especially Mindset, and put in a few tutorials to facilitate a change to growth. This could be the single most important intervention that educators make in a student's life.

**Keywords** — *Human nature, nature vs nurture, engineering education, educational psychology*

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# Dew Point Humidity Sensor for Instrumentation Engineering Classes

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**Abstract** — In this work we propose a simple low-cost implementation of a humidity measurement device for engineering classes. The working principles are based on the assessment of the dew point temperature, environment temperature and atmospheric pressure measurement by using the psychrometric equation. System development was based on two temperature sensors and a dew point temperature detector. The obtained results showed that the proposed methodology can provide accurate results and be an effective low-cost alternative to high-end commercial dew point meters. This simple approach also introduces the advantage of allowing specific tuning of the system's components.

**Keywords** — Humidity, psychrometry, temperature

## INTRODUCTION

Most science-based courses include practical experimental activity in the laboratory and without this the education is incomplete [1]. In fact, one of main goals of engineering education, in particular, is to prepare students to practice engineering, which means, to be able to deal with the challenges in a world in constant development. Laboratory work, as claimed by several authors, is crucial in technological scholar curricula and the level of such activities are related with the success of students' formation [2], [3]. Additionally, the laboratory is by definition an optimal place for active learning and to maximize the acquisition of knowledge and experience. Students can interact with a real or simulated system while in a safe controlled environment, work their soft-skills while integrating teams, work on experiment planning, discuss approaches or theoretical support for each situation and reason about the obtained results [4]. For the student with a technological profile this brings an additional motivation because in the laboratory they "learn by doing" and they can gain insight and deeper understanding of real contexts and applications, as opposite to the theory courses [5]. The big challenge is placed on the educator's side that often has to translate complex concepts into practical learning experiences [6]. Many of these are based on guides that require a structured process to meet students' requirements. Another approach is to develop real world, fully working systems that are supported by theoretical concepts and can represent components or integrate devices.

## CONCLUSION

In this work a simple low-cost implementation of a humidity measurement device was proposed, aimed for the teaching in engineering classes. This represent a contribution to the inescapable necessity of re-enforcing laboratory work in technology and science degree. The students' engagement during the system development and their final feedback allows us to conclude the main advantages of this approach:

The students had to study the main theory and plan the development steps. They had to imagine a functional approach and to build the full system.

Skills such as designing, creativity, team work, communication, evaluation, critical thinking, demonstration and reporting, not to mention ethics, were involved in the process and can be highly developed and stimulated by involving students in such kind of teaching/learning experience.

On the technical side we believe that further studies should be done in order to use hygrometer solution standards for calibration purposes which could open additional possibilities and create bridges with more advanced topics.

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# Intercultural management for engineers

## A teaching design for intercultural competences in a French graduate school of Engineering

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**Abstract** — This paper examines to what extent graduate engineering students involved in an intercultural management training program develop intercultural competences. Firstly the context, the objectives and contents of a teaching design dedicated to an intercultural management seminar will be presented. Secondly, there will be the analysis and explanation of concrete situations of the 3-day intercultural management seminar including the examination of how engineering students carry out an international engineering project requiring technological and managerial skills including intercultural competences. Thirdly, some results of the learning outcome of the students involved will be provided followed by the analysis of the limitations of the teaching design itself. Finally, the perspectives for a possible improvement of our two-tier pedagogical approach will be explored.

**Keywords** — *Intercultural Management, intercultural competences, teaching design, French Graduate School of Engineering.*

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# Massive Open Online Courses design: guidelines to enhance user experience

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**Abstract** — The advancement of technology has triggered changes at an unprecedented pace. Information and mainly the knowledge become key factors impacting on the economy, the labor market and everyday life. These changes are also reflected in education leading to the emergence of new paradigms, more open and flexible, with new and more adapted pedagogical practices to explore the potential of technology. The application of these technologies to education is a major challenge: provide and foster the acquisition of knowledge eliminating the temporal and geographical distance between students, teachers and institutions. In this context, in recent years, Massive Open Online Courses (MOOCs) have aroused the interest of the educational community and their number has been growing at a very fast pace. Thus, MOOCs are considered, as a formative offer, a strong opportunity for democratization in access to knowledge and have generated considerable interest in higher education worldwide [1]. A summary analysis of MOOCs development on a global scale shows that there are quite different approaches in terms of pedagogical practices, course design, assessment and objectives. According to [2], in 2017 there were 9400 courses (6850 in 2016), with more than 800 universities and 81 million students involved. The courses in the areas of Economics (18.5%) and Technology (Computer Theory and Programming) (19.9%) continue to constitute the largest offer of proposed MOOCs, while the area of Engineering (7.1%), as in previous years, represents one of the least invested areas of MOOCs[2]. It is important to harness the energy, empowerment, number of participants, relationship building and community that MOOCs introduce in learning and teaching. However, data on MOOCs suggest that only 10% of those who sign up to attend a MOOC complete the course [3]. According to studies [4] and [5], among others, several factors contribute to this high failure rate. The poor course design is a transversal element in all studies, since this aspect can condition students' access and motivation. In this context, it is essential, during the design phases of MOOCs, analyze the contents, quality of learning, poor engagement of weaker learners, accreditation, pedagogy and exclusion of learners without specific network skills. These methods, when applied to MOOCs design, mean for students a well-designed system that helps them learn faster, with easier learning, and improves their performance for the proposed tasks. Similarly, for teachers, it is a system that helps to develop contents easier and faster, allowing interaction with a large number of students and requiring less time to help them to achieve learning objectives. This paper explores the design theories of MOOCs learning resources, and presents principles and a comprehensive model for the design of MOOCs learning resources, so as to improve effectiveness and usability of MOOCs and finally user experience.

**Keywords** — MOOCs; design principles; model; usability; user experience;

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# Application of active learning techniques on Electrical Machines course in classroom environment: Pedagogical strategy and results

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**Abstract** — In the course unit Electrical Machines (EM) of the final year of an engineering degree it is crucial, and increasingly necessary, to provide students with the work out and development of a wide range of competences beyond the technical ones, so that students can be able to adjust to the modern economy needs [1]. However, the application of the traditional teacher-centred approach does not foster the students' key competences. Generally, there is little recognition of the importance of those competences to consciously turn them into learning outcomes of the several course units in an ongoing and structured way in most of Portuguese tertiary education, where teacher-centred approach still prevails [2]. These issues are not discussed systematically within faculty or in awareness-raising sessions organised by the departments' scientific teaching areas. In fact, the recognition of those competences, and their integration in the learning outcomes, would imply the implementation of a new pedagogical project based on the learner-centred approach. Aware of this problem, the entire pedagogical structure of EM was modified in order to implement the learner-centred approach. The main motivation of the application of this approach is to improve the soft skills and contribute for a better academic performance by applying active learning techniques. This approach implies a teacher's change of attitude and an ongoing reflection in the act of teaching and learning [3, 4]. In this sense, it is the teacher's responsibility to construct the entire pedagogical structure and to design and establish the means and conditions of teaching, learning and assessing, according to a detailed planning duly aligned with the contents, and its degrees of depth, objectives and skills to be achieved. Throughout the learning activities of EM's course unit seven active learning techniques were chosen and applied, depending on the learning outcomes, contents, students' skills to be developed, initial students' cognitive conditions and the available time to achieve the intended objectives. The teaching activities were framed and adapted to the contents and learning outcomes and interconnected with the learning activities. Also, three teaching methods were used during classes. The application of the learner-centred approach provides the active participation of the students which respects their cognitive, personal and self-realization construction [5]. This active participation generates a teacher-student relationship of authenticity and congruence which contributes

as a facilitator of the teaching-learning process [6]. Most of the students really appreciated the new methodology, showing more commitment and dedication during the learning activities. In short, in the final paper, this pedagogical experience on the implementation of the learner-centered approach is described and the results of the investigation based on surveys carried out on students for summary analysis and consequences are presented.

**Keywords** — *active learning; pedagogical techniques; learner-centred approach; learning activities; teaching activities*

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# Teaching Mathematics in Tertiary Education Through Collaborative Work

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**Abstract** — First year students' integration into tertiary education courses is hampered by their adaptation to the operations of a higher education institution, a new teaching-learning process and a new society [1]. In the special case of tertiary technological courses and engineering degrees, the lack of mathematical background by students is a major contribution to the worsening of this adaptation and the consequent early school drop-outs [2, 3]. In order to overcome these problems, the application of a learner-centred approach in mathematics, in which the student takes responsibility for its own learning process and the teacher assumes the role of facilitator of that process, is presented in this paper as a valuable tool [4]. The final paper arises from a study conducted on a new mathematics' course unit of a tertiary technological course taught in a polytechnic institute where the pedagogical strategy adopted was the Project Based Learning (PBL). Most of the technical course units within the course schedule were aggregated to PBL. However, the mathematics' course unit was not included on the learning activities by projects due to the strong technological nature which characterises the course. In order to establish links with the other technical course units taught in PBL, active learning techniques were applied in the mathematics' course unit. The design of the constructive pedagogical alignment of this course unit integrated the objectives, contents, assessments and the information obtained in the surveys carried out on students, as well as the training techniques chosen. The collaborative working group was the main active learning process chosen in this application of the learner-centred approach. In this active learning process students are requested to develop academic skills as well as key competences, contributing to the change from the typical students' passive attitude to an active one. In a collaborative working group its members support each other around common targets that are negotiated between them [5]. The established interpersonal relations do not take into account any kind of hierarchy and so the leadership is shared or allowed, existing mutual trust. Language is the mediation facility and the key for the good understanding between the group members. As consequence communication skills are developed and the co-responsibility in actions shared by all members is emerged. Also autonomy, visualisation and conceptualisation are achieved. Thus

students possess greater self-esteem and social integration and more ability to withstand changes, adjustments and tensions that come with academia [6]. Challenges, difficulties and benefits from applying this active learning process are considered in the final paper. Some outcomes of the academic performance are also presented and discussed.

**Keywords** — *learner-centred approach; collaborative work; active learning; project based learning.*

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# Students Learn while Teaching

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**Abstract** — Understanding the bases of electric circuits is fundamental in the formation of an electrical engineer, but also an added value for the generality of the engineers, being important the existence of an electrical circuits course in any engineering degree. However, it seems to be more attractive to use some electronic devices programming them, such as microprocessors or even more evolved computers or robots than to acquire the competence given by the domain of circuit analysis tools. The new learning paradigm promotes the theory that knowledge is not delivered but is constructed. In the new paradigm, the focus of education is to learn, not to instruct [1]. It is intended that the environment and the learning process be cooperative towards the student's learning [2].

We currently lead students through various experiences, beginning with the more traditional ones, such as lectures, laboratory work or computer simulations, students have come to play the role of teachers. With this change we have obtained better results both in the evaluation that the students make of their learning as in the overall evaluation of the discipline and its final result.

In the classes, students are expected to solve problems that are part of a course book. To obtain the solution of these problems, each one must use the computational simulation in addition to the analytical resolution. Each student should do it autonomously, despite being encouraged to interact with colleagues and the teacher.

In addition to this work, each student should, during the semester, present three problems and their resolution (analytical and simulated, according to the Workflow block diagram, of the figure). The work of researching and solving the problems encountered requires a proactive attitude. Here the student needs to wear the teacher's skin. He should seek an attractive question with a degree of complexity commensurate with his involvement into the subject. These problems

are more valued if they solve a real world problem. At the end each student presents his proposal in a short pitch, in the classroom, followed by a brief period for clarification.

So, in short, each student must conceptualize a problem, present his analytical and simulated approach to the peers in the classroom. In a semester course, 3 projects are presented, with a quotation of 10% of the overall evaluation, each one.

In 3 years the percentage of approvals rose 10%. We have expectations that this trend will be statistically relevant.

**Keywords** — *active learning; flipped learning, learning paradigm*

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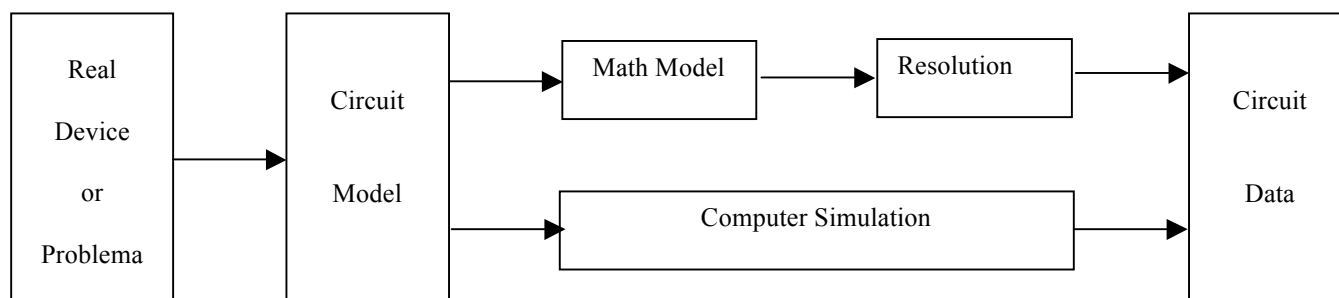


Fig. 1. Workflow block diagram

# Social Responsibility in Technology Promotion

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**Abstract** — Competition in higher education levels is currently an important factor with fundamental relevance and consequences for organisation management, making increasingly necessary the existence of indicators showing not only the quality of teaching and research but also the promotion of social responsibility in young people [1], encouraging them to actively participate in community development and to solve their problems, making this interaction with the community the third mission of Higher Education Institutions [2].

Aware of its role in society, CASPAE, a Private Institution of Social Solidarity has always valued the creation of networks for the pursuit of its objectives, which necessarily translate into actions and projects concretization, aimed for citizens quality of life. Through projects in co-promotion with the various Organic Units of the Polytechnic Institute of Coimbra (PIC), the aim is to generate dynamics in a flexible, creative and innovative environment that can reveal a strong potential for creating opportunities in development and research and in achievement of social responsibility in Higher Education Institutions. At the same time, CASPAE promotes its institutional image and ensures that the social responses it implements have the quality and brand of the PIC.

The actions and projects presented reveal the existence of close cooperation between the Private Institution of Social Solidarity and the Coimbra Institute of Engineering (ISEC). The reported initiatives illustrate the unequivocal existence of the development of social responsibility, inherent to the mission attributed to Third Sector Organisations (TSO) and assumed as a differentiating factor in the provision of education service by Higher Education Institutions (HEI). As well as describe the relationship between the partners and shows that this type of relationship has been a success in promoting technology in education.

In the first place, the importance that ISEC attributes to Social Responsibility (SR), as a relevant indicator in the evaluation of the quality of Research and Development (R&D) activities, is highlighted, and is not limited to the scientific production of its researchers, revealing the pertinence of the dissemination of results and transfer of knowledge and technology, including the promotion of scientific and technological culture and strengthening the linkage

of R&D activities to society, particularly in social, cultural, artistic, economic or technological aspects, contributing to the national open science strategy, in the terms defined for Portugal and for the European Union.

In this context SR's awareness translates into cooperation with CASPAE, in various formats, explaining the strong involvement of the resources involved in this co-promotion.

Linking to elementary schools makes it possible to implement projects that promote competencies considered crucial in the basic education of the individual and, conversely, enable the dissemination of the quality of the education service provided by the PIC, as well as its training offer, allowing better clarification of the students in their vocational orientation.

With regard to CASPAE, and within the context of its action with schools, a clear commitment is made to the positive promotion of the institutional image, when it is linked to an HEI that gives it assurance to the quality of the provision of the education service it promotes. In fact, the jointly defined strategies for the diffusion of technology and the development of digital skills are strengthened and applied in a bi-univocal way, which benefits both sides and allows the scope of cooperation to be extended to future projects with possible expansion of partnership networks, improving the level of mutual trust and interactions with society.

**Keywords** — *Co-promotion, Third Sector Organisation, Higher Education Institutions, Technology, Education, Community.*

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# Challenges in Teaching Electrical Circuit Analysis to Millennials

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**Abstract** — Electrical Circuit Theory is a mandatory course on Electro-technical Engineering degrees. Although circuit theory basic concepts have long been established, several new challenges have surged on the last two decades, arising from the need of motivating students from the 21<sup>st</sup> century, as well as preparing them for more advanced courses in new areas such as RF and nano-electronics. This paper addresses the use of e-learning techniques as a way of motivating students for apprehending circuit theory concepts and helping them build-up their circuit analysis intuitive skills.

**Keywords** — *circuit analysis; elearning; student-centered methodology.*

Over the last two decades the problems arising from the need for motivating students to circuit analysis courses have been duly identified. Several papers addressing the need for adapting circuit analysis courses to today students have been published. Although electrical circuit theory basic concepts have long been established, several new factors have to be considered when the optimization of the transfer of knowledge is envisaged. From the high education institutions point of view, the increasing number of students makes it impractical for the professors to guide students in their individual learning process. In [1] and [2] the authors propose an increase in laboratory activities as a way of motivating students to circuit analysis. Although these proposals are highly effective, the increase in the number of students is a severe obstacle to embracing these approaches.

Another very important issue to take into consideration is the fact that millennial students are impatient and eager to get immediate gratification [3]. The main objective of the methodology described in this paper considers the concomitant use of both self-regulated with teacher-regulated approach, as a way of dealing with the ever-growing students' need for immediate gratification. It may be considered as a teacher-oriented self-regulated approach. Having in mind the specificity of basic electric circuit courses, the three main vectors supporting the course are: the theoretic classes, the e learning based individual work, and the practical classes. In the theoretic classes a teacher-centered approach is followed where the basic concepts/methods are presented and simple examples are used to demonstrate their application. In these classes, students are invited to solve the examples, using advanced calculators. Students are then given a set of exercises supporting their individual study. This set of exercises

comprises a relatively extensive number of circuits to be analyzed using the concepts previously addressed in the theoretic class. The problems consider cases with a growing level of complexity, starting from examples similar to those previously solved in the theoretic class. Solutions of the problems are submitted via moodle questionnaires and a score is given, that will contribute to the final grade. This constitutes an immediate gratification to students, contributing to their motivation in studying circuit concepts.

During the last two years, i.e., 2015/2016 and 2016/2017, the proposed methodology was followed in a course of electrical circuit analysis for students of the first year of electro-technical engineering. The course duration is around thirteen weeks and students were required to answer seven questionnaires on moodle. For a better interpretation of results, a whisker chart of the successful students' final grades is represented in Fig. 1. As illustrated, in the academic years when a teacher-centered approach was followed, i.e., 2013/2014 and 2014/2015, the final grade median was thirteen, whereas in the following years, the median rose to fourteen and fifteen

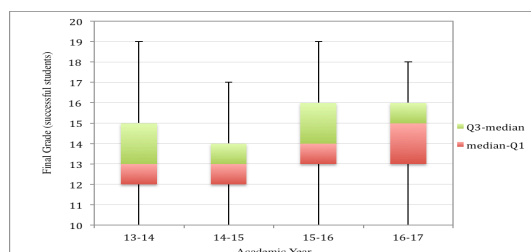


Fig. 1: Whisker chart of successful student's grades.

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# Mind the gap: bridging the transversal and transferable skills chasm in a public engineering school

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**Abstract** — Transversal and transferable skills are the single most important skill gap identified by employers of engineering graduates. This gap can be a very effective chasm in the early careers of otherwise competent graduates. In this paper we address the end-to-end implementation of a transversal and transferable skills training programme in an European public engineering school. The training addresses master and doctoral candidates. The needs assessment, the programme design, delivery and assessment are presented. Relevant stakeholders are involved throughout. They include employers, master and doctoral candidates, faculty, graduate course directors and teaching staff directly involved in the programme. The programme includes methodologies of self-evaluation and course evolution. It is found that the programme is perceived as very important by the trainees and that there is an increasing number of enrolled trainees. The challenges of a sustained delivery of such a growing programme are shortly addressed.

**Keyword s**— *higher education; engineering education; transversal competencies; transferable skills.*

# We Won't Waste You, Design for Social Inclusion

## Project Based Learning methodology to connect the students to the society and the environment through innovation

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**Abstract** - The global impact on the planet of solid waste generation has been rising rapidly every year. According to the World Bank, 3.5 million tons of solid waste were produced globally per day in 2013, and by 2025 this number could reach 6 million. In Portugal alone, 13,616 tons of solid waste were produced per day in 2012, and this number should reach 15,886 by 2025. This scenario presented itself as a great learning opportunity to design professionals who have the responsibility to outline a new way of thinking about product creation activity. The challenge was presented to a group of design students by applying the Project Based Learning methodology in connection with the society and the environment through innovation, resulting in products created from discarded materials as eggshells, seaweed, sugar, plastic bottles, ropes and fishing nets. This paper presents the context and manufacturing stages of these products developed in collaboration with the City Council of Matosinhos.

**Keywords** — waste; circular economy; project based learning; product design; industrial design; social design.

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# Industry needs in Requirements Engineering

## XXI century challenges for an IT curricula

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**Abstract** —The Requirements Engineering (RE) community must be prepared for XXI century challenges, such as Industry 4.0. Considering this, we collect the requirements engineering needs and challenges indicated by ten enterprises that operate in the Portuguese information technology (IT) market. We aim to bring to the wider IT academic community, awareness of the challenges the industry is confronted with in the area of RE, to inform IT engineering curricula, and foster industry-academia cooperation. These needs and challenges were collected in a workshop (<http://re2017.org/pages/conference/rept/>) that brought together academia and industry members of the Portuguese community.

The main challenges faced by IT industry nowadays are: (1) dealing with legal requirements - volatility, variability, lack of clarity, large quantity, and the new privacy requirements imposed by the European legislation; (2) the need for new techniques to deal with high volume of requirements, and the innovative nature of requirements (flexible, and non-consolidated requirements, including new tools that leverage reusable and combinable cognitive elements); (3) the lack or incompleteness of the requirements, often described by customers at a high level of abstraction/low level of detail with poor quality description. Some other challenges are related with the lack of courses in requirements engineering, lack of knowledge transfer between academia and industry, or knowledge areas where more work is needed; (4) university graduates presenting an insufficient level of expertise in RE; (5) difficulty in the relation with customers when using an agile paradigm in the RE activities; (6) the difficulty in contractualization of quality requirements (known as non-functional requirements) (7) needing more knowledge on how to adapt RE processes, proposed by academia, to specific development and customer contexts; (8) needing more knowledge on the identification of the most adequate set of tools to support the whole development life-cycle, including the requirements collection and definition; (9) the lack of tools to support (requirements) traceability

over the entire lifecycle. Another difficulty reported was (10) the lack of support, from senior corporate management, of innovative projects to search solutions for the needs/challenges encountered in the RE area. This fact indicates a lack of awareness by senior managers of the cruciality of RE and its impact in quality.

The importance of RE was very well underlined by Sarah Gregory (Intel Corporation), the keynote speaker of the workshop: “Requirements Engineering is a practice that seeks to bring certainty and clarity to product definition, design, and development efforts. Engineers and executives want to know that we’re going after the right market, designing the correct product, and meeting all of the requirements that are needed to bring about success.” This acute awareness of the critical role of RE was very well demonstrated by the good adherence of the IT industry to this “academia meets industry” event in the specific subject of RE. This is a sign of the maturity of the IT Portuguese industry, which we are very happy, and proud, to testify. Let’s work together to edify IT engineers to leverage sound RE practices to cope with the challenges to successful IT product development.

**Keywords** — *curricula; computing; software engineering; requirements engineering; academia industry relation.*

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# Technical Courses in areas related to Engineering in Higher Education

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*Abstract* - This work intends to contribute to the discussion of the education and professional training policies in Portugal, namely the role of higher professional training courses (CTeSP) [1] on the Polytechnic Higher Education, and specifically in the Engineering, Industrial Management, Design and TICE areas, according to the National Classification of Education and Training Areas (CNAEF) [2].

A “one-size-fits-all” model does not fit the needs of human capital formation, at intermediate and regional levels. Engineering education and other related fields require worldwide competitive knowledge, for a strong ability to adapt to activities of mobilization of knowledge to emerging opportunities in industry. This work is based on teaching experiences of a new typology of courses in the engineering area.

Using the experience of Aveiro University mainly, through its integrated Polytechnic Schools, the results of the Professional Higher Technical Courses (non-degree courses) are analyzed, in relation with the region.

Factors such as the definition of the training offer, the design of curricula, the strong technical component, the training in the work

environment (internship), the creation of mixed teams of teachers, and the results of employability are analyzed.

The attractiveness of unconventional students to higher education, closer proximity to industry and cooperation with society and the encouragement of applied research are also investigated. It is also important the significant number of credits (ECTS) that CTeSP grants on undergraduate studies – 1<sup>st</sup> cycle. Results show a high and diversified number of candidates seeking this type of training, a strong affinity of students and employers with curricula plans, high levels of employability and very satisfactory rates of higher education studies progression.

*Keywords* – higher education technical courses, areas of education and training, vocational education, polytechnic education

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# Implementation of a PBL/CDIO methodology at ISEP-P.PORTO Systems Engineering Course

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**Abstract** — The earlier engineers start their creative process, the faster they can be useful to industry and economically compensated. The academy therefore has the duty to take the first step as an educational agent.

This paper describes a teaching and learning experience for the integration of new students in Systems Engineering Course, taught at ISEP-School of Engineering, Polytechnic of Porto (ISEP-P.PORTO). This degree was designed following the principles and recommendations established in the CDIO (Conceive-Design-Implement-Operate) initiative. During the first 4 weeks of the first semester, the students attend a single subject, Engineering Labs I (LENG1), where a PBL (Problem Based Learning) methodology is implemented. The study presented refers to the 2016/17 edition, attained by 48 students, where two projects proposed, respective activities and results are described. The students' comments regarding their acquired competences and motivations are also presented.

The PBL teaching and learning methodology provided a context of design and project, an active and experiential learning in a multidisciplinary environment. Thus, students obtained a set of ethical, social and technical skills, such as teamwork, research, inter and intragroup communication and report writing, which will be useful for the rest of the course and their professional future. Projects worked out were motivating for the students to learn different areas of engineering and integrate them in the class, ISEP campus and city and established good principles of commitment in teamwork.

**Keywords** — PBL; CDIO; Engineering; Prototype; Soft Skills.

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# CIVIL'in

## A tutorial program for new first-year students on the Master of Civil Engineering

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**Abstract** — The Master of Civil Engineering (MIEC) at the Faculty of Engineering of the University of Porto (FEUP) is a 5 years' study cycle. To integrate and monitoring the new first-year students on MIEC, by other students who attend advanced years, the CIVIL'in program has been developed. The monitoring is conducted by tutorial during the first academic year, being assigned to the new student a single tutor, who has the responsibility of helping the new student in its integration from the beginning of the study cycle until the end of the first academic year.

A teacher, who will assess the difficulties, observes the progress of students and gives some advices to the questions raised by the tutor, monitors the performance of the tutor in this new and challenging mission.

This initiative, in addition to allowing a better integration of the new students in FEUP, also enables the tutors to develop soft skills such as positive attitude, teamwork, leadership and communication skills that will be relevant for their future integration in enterprise environments.

**Keywords** — *tutoring; integration; teamwork.*

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# Industrial Engineering and Management at the University of Aveiro: a 30 year journey

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**Abstract** — Industrial Engineering and Management (IEM) programs currently present a high degree of attractiveness for new students as well as high rates of graduates' employability.

The need for this type of programs in Europe has been emphasized by [1]. In that work, from 1992, it is pointed out that the formation in IEM can help to increase the competitiveness of the industry, whether it be manufacturing or services.

The University of Aveiro introduced this program in 1988, which was the first in Portugal with this designation. At that time, there was an effort to create a study cycle that combined an engineering base with knowledge from the management area, and that also promoted the development of soft skills in their graduates. The program was created with the input of the rich industrial surrounding that exists in the district of Aveiro.

According to [2] IEM professionals are expected to address industrial problems that require the application of knowledge from diverse domains but also have the ability to manage the implementation of the devised solutions. It was with this same idea in mind that the IEM program was planned so as to provide its graduates with the necessary skills to meet those requirements.

Since then the program has evolved and adapted but always maintaining high levels of attractiveness and employability.

In this special year for the IEM program, as it completes its 30th anniversary, the purpose of this work is to present the evolution of its curriculum over the years and how it has been revised to accommodate the requirements of different stakeholders, namely students, companies and future employers, the University and other higher education regulators.

The current situation of the program within its national context and considering other available IEM programs, as well as a comparison to its international counterparts, will also be described.

**Keywords** — *Engineering Curricula, Industrial Engineering and Management, IEM programs*

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# The UCL MSc Engineering and Education

## Towards formal education and training for Engineering educators

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**Abstract** — Engineering is at the very centre of our ability to address global social, human welfare, environmental and economic challenges. However, our capacity to deliver solutions to these challenges is dependent not only upon the supply of talent to engineering and hence on diversity and openness, but also on the quality and nature of engineering education and skills at all levels. It is increasingly accepted within the engineering profession that this can only be achieved by adopting new and fresh perspectives to the education and training of engineers at all levels. This calls for the professionalisation of the engineering education and training role, which includes, amongst other initiatives, the introduction of formal training and education in engineering education.

In this paper we argue that ad hoc education and training of engineering educators has failed to address the challenges faced by the engineering profession. We suggest that the development of research-informed formal education and training programmes for engineering educators will serve as an incubator for the new thinking that is needed to make engineering education at all levels more effective. To this end we propose the newly constituted MSc in Engineering and Education at University College London as a potential vehicle for the delivery of the necessary engineering educator training and education.

Engineering educators and trainers, especially at university level, tend to have extensive training in the technical and scientific aspects of engineering, normally involving education to masters and PhD level. However, training in engineering education tends to be informal, and the quality is variable. This means that engineering educators and trainers often lack foundational knowledge relating to the complex interplay between society and engineering practice and its implications to the design and delivery of engineering education. In addition, engineering educators and trainers often lack the skills to implement and critically appraise interventions in the design and

delivery of engineering education. The recently constituted MSc in Engineering and Education seeks to address these issues.

We have developed an MSc in Engineering and Education that enables engineering lecturers in further and higher education as well as engineers working in the national and global economy who have an ‘educative’ or workplace development role to:

- i) be introduced to current debates about the contribution of education and work in developing engineers’ expertise to assist them to design/redesign/contribute to engineering courses that develop 21st century skill needs;
- ii) upgrade their engineering knowledge by providing them with access to research in their engineering specialism or new developments in engineering;
- iii) stimulate and support research and innovative approaches in engineering education.

The MSc Engineering and Education is the first of its kind in the UK and it fills a void which has been left unaddressed for a long time. The MSc will provide a formal channel for delivering education and training for engineering educators. This is likely to lead to parity of esteem between research and teaching, as well as leading to more informed approaches to the development and growth of the engineering profession.

**Keywords** — *Engineering education, Engineering profession, Professionalisation;*

# Professors' Competences Through the Perspective of STEM Students

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**Abstract** — Tertiary education institutions educate a great number of individuals of all ages every year with the aim to assist them in developing a set of skills, knowledge, competences and attitudes. The overall aim of the education process is dual: employment and contribution to society. While teachers in all levels of formal education are trained in specialized institutions and acquire formal teaching qualification, higher education professors lack such education in most cases. Consequently, the question raised is what competences a university professor should have to reach a quality teaching practice. Therefore, a study was conducted as an attempt to determine which competences are considered most important by the stakeholders most influenced by the teaching process in higher education institutions – students. Overall, answers from 318 STEM students, from 11 different nationalities and many different fields of studies, were gathered. They were asked to rank professors' competences [1] by order of importance. This research has shown how professors' competences are perceived by students in European STEM education. It identified several competences and their indicators, which were acknowledged as highly important among students. Results from the survey show that students highly ranked the ability of professors to “CC2: Explain with clarity and enthusiasm”, “PMC6: Assess implementation of the program regarding learning and acquisition of competences; detect

weaknesses and introduce improvements to ensure achievement of outcomes”, “TC4: Act for the good of the team” and “InnC1: Analyze the teaching/learning context to identify areas of improvement and apply innovative strategies and/or resources, respectively”. Indicators that students value the least are “MC10: Use different formative assessment strategies” and “CC8: Use body language as appropriate”.

**Keywords** — *STEM Students, Professor's competences, Survey analysis.*

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# The transversal skills agenda: profiles for mechanical and industrial engineers

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**Abstract** — One of the latest trends in computer aided design technology is based on high level cloud computing using dedicated engineering design software suites [1,2]. These software packages allow real-time access to vital design information, available to and from anywhere on the planet. This makes data, tools, and much more available to multi-national work teams, contributing to the success of engineering design on a global scale.

Current collaborative engineering design software tools focus mainly on the technical challenges that engineering tasks usually comprise, allowing and enhancing concurrent engineering [3] to achieve the desired technical goals. Nonetheless, to contribute to the success of such technical endeavors, efficient communication channels must be made available to collaborating engineering design work teams. The combined use of mobile technology and social media communication tools with the engineering software packages may enhance the communication and dialogue of collaborative engineering design teams.

However, communication and dialogue in international teams is not easily achievable or made effective when students are unprepared to handle intercultural clashes and negotiations. These require practice in intercultural communicative skills (most of the times through a foreign language) as well as in transversal skills, such as creativity, critical thinking, and tolerance of (cultural) ambiguity. In order to train these skills, a pedagogically collaborative framework is needed to enhance the use of above-mentioned ICT and web-based technologies.

Tele collaboration [4] or virtual online exchanges, may be a preferred pedagogical approach when there is the possibility to match classes in two or more different countries, during which students are taken into near-authentic communication scenarios where they start by working on their self-identities, progress to compare their particular preferred ways of doing things and thinking with those of others and eventually end up by collaborating on a common project in international teams, where they are expected to communicate effectively and negotiate points of view [5].

In these conditions they experiment with and develop the ability to do team work, through project-oriented learning and task-based learning [6]. The pedagogical emphasis of these learning tasks is on oral and written (formal and informal) communication skills, teleconferencing, networking for contacts and advice, presenting new

ideas and alternative strategies, but also on key competences for the 21st century, such as communication in foreign languages; learning to learn through computer aided technology; social and civic competence development as global citizens, who are able to work and communicate effectively in international teams that may be very culturally diverse; sense of initiative and entrepreneurship; and cultural awareness and expression [7], which will certainly contribute for the global success of engineering design tasks/work teams.

The purpose of this study is to throw light on the collaborative cross-disciplinary or interdisciplinary pedagogical approach to mechanical and industrial engineers instruction. A dedicated framework on the subject is proposed, presented and discussed. Further implications on the ways to promote such set of skills in current and future engineers are also addressed. The body of knowledge that has been created here is meant to support mainly students and lecturers dedicated to engineering education and the role of transversal skills on the profiles of current and future engineers

**Keywords** — *engineering design, CAD/CAE software, international team work, telecollaboration, transversal skills*

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# Using 3D technologies in materials teaching

## Engaging students in early R&D activities

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**Abstract**— Additive manufacturing (AM) is a set of technologies that shape different materials by assembling them layer-by-layer. AM emerges as an interesting way for the industry to produce highly customizable products without recurring to molds. Enabling a task force able to operate with this disruptive technology, the education system and curriculum should be adapted accordingly. Typical curricula have laboratorial courses, and practical works structured for groups of students to experience, gain practical knowledge and develop skills oriented for the industry. However, due to the low maturity of AM in the industry, the skills needed for AM operation diverge at some point from the other common manufacturing technologies. The technologies are not enough for the students to correctly assimilate all the concepts and develop the required skills and competencies for operation. Moreover, AM needs a set of skills that range from material science to CAD. During a semester, it is impossible for first year students to experience all the AM technologies. Usually, fundamental concepts of the technology and technical aspects of the building process are explained. AM technologies like fused deposition modeling (FDM), stereolithography (STL) or robocasting (R3D) are first introduced. In demonstration sessions the operations are not done by students. Teaching this way leaves important aspects behind that are better experienced firsthand by active learning activities. It is a strenuous task to teach AM if the students have a poor background and lack of the appropriate skills and knowledge needed to operate 3D technologies. To surpass these challenges and within the scope of an R&D project in partnership with a ceramic industry, three first year bachelor students from Product Design and Technology (PDT) (two) and Technology and Production Systems (TPS) were challenged to participate in a small-scale project. By the time they were recruited, they did not have the basic knowledge of AM, materials science, product development and CAD modelling. The purpose was to design and produce highly customized porcelain tableware products and develop porcelain slurries suitable for R3D process. The impact of

the participation of the students was remarkable, as they worked in the slurries formulation and concept development. They also used other AM technologies to validate those concepts. The materialization of a self-stirring mug was done by R3D and STL. By comparing both technologies results, the students understood the robocasting process and refined the concept, which culminated in a functional prototype produced by R3D. They also realized the basic principles that governs a ceramic slurry, drying and sintering processes and some mechanical properties. Providing small hints and guidance early on helped motivate the students, which became fully autonomous, not only being able to operate the robocasting system, but also refining and improving the CAD concept. Participating in the project not only proved to be useful in the development and enrichment of competencies related to materials, AM and computer assisted design, the work was extremely rewarding for them as it was presented in national and international events, and were later engaged in related projects involving R3D technologies and CAD modelling.

**Keywords**—*Teaching, Robocasting, Additive manufacturing, R&D*

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# A marketing strategy to enhance active and flipped learning

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**Abstract** — Active learning and flipped learning are approaches to teaching that have shown their strengths. However, in order active learning can be used, students must show up in class. Similarly, for flipped learning to be implemented, students must do beforehand, outside class, what is required from them. In this talk we explain a marketing strategy that has the potential to lead students to do what is expected from them in order to facilitate the mentioned approaches.

The strategy to be discussed was applied in the academic year 2017/18 to a curricular unit of the area of mathematics (Calculus I) of a group of courses of the University of Aveiro. At least it had the merit to convince more students to participate in the class activities and to lead more students to be assessed.

Due to its universal character, we believe that the used strategy can be applied in any scientific domain.

**Keywords** — *active learning; flipped learning; marketing*

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# Challenges and benefits in implementing problem-based learning in an elective MSc course

## Application of Geosynthetics in Civil Engineering

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**Abstract** — An elective module on geosynthetics was designed and made available to Civil Engineering students (within a 5 years' integrated masters). This paper describes the problem-based learning (PBL) model implemented. Two different types of problems were used: summative, marked for assessment purposes; and formative, in-class problems used to drive the learning on topics not directly covered on the summative problems, thus creating PBL environments for all the course. A questionnaire was used to assess the impact on the students of the PBL model implemented. The students' perceptions of the model are summarised. The advantages and disadvantages of implementing a PBL model, from the teachers' perspective, are described and some suggestions for teachers willing to use PBL models are included, to contribute to successful experiences for both students and teachers. Although using PBL will increase the workload of the teacher, if successfully implemented, the students' enthusiasm is quite rewarding. For a successful PBL course close to graduation, previous experiences of PBL or other inductive teaching models are ideal, for both students and teachers. One of the key messages to teachers is to start small and develop the PBL model gradually, making sure that students appreciate the teachers' effort and understand how the students will benefit from those models, both short- and long-term.

**Keywords** — *problem-based learning; teacher's perspective; recommendations*

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# Evaluation of the quality of teaching and learning for 1st year engineering programmes – an initial contribution

## The case of the University of Aveiro, Portugal

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**Abstract** — A system for evaluating the quality of teaching and learning implemented at the University of Aveiro, Portugal, is briefly described. Data for five modules on the 1<sup>st</sup> year engineering programmes was collected (using questionnaires and reports filled in by students and teachers) and analysed using quantitative and qualitative approaches. The “strengths” and “weaknesses” emerging from the data were discussed. Both teachers and students showed a reflective attitude by focusing on their different roles in the teaching and learning processes. Students identified two main sets of strengths, related to material resources associated with the modules and the type of assessment, but also related to their attitudes (interest and motivation). The assessment methods, in particular the number of assessment elements, were identified as strengths by both groups (students and teachers). Teachers also identified the alignment of the modules as a strength. The weaknesses identified by students were related to their attitudes (attendance and punctuality, and the reduced number of times they contacted the teachers outside the timetabled slots) and to the teachers (their lack of/or limited support, feedback and availability). Students answering questions on the teachers’ competencies perceived those as strengths, including their pedagogical competencies. Such competencies may not have been put into practice adequately, as students did not feel supported properly by teachers in the learning process. Teachers identified the use of teacher-centred strategies and passive and deductive teaching approaches as weaknesses. However, the data analysed did not show any evidence of shifting the teaching and learning approach from teacher-centred to student-centred. The authors believe that there are several possible reasons that shape the resistance to more active learning approaches to learning and teaching: teachers are often overwhelmed by the workload associated with implementing student-

centred strategies and active and inductive teaching approaches; what is verbalised and what is implemented by teachers often differs. This may indicate a “single-loop learning” approach, focused on the quality of teaching, without linking it to that of learning. Additionally, career progression often ignores completely the performance of academics as teachers, focusing on research performance. To improve the quality of teaching and learning, and academic success of students, while reducing dropout rates for 1<sup>st</sup> year engineering students, additional strategies are needed. Those include adopting student-centred teaching and learning approaches. Thus, higher education teachers should be supported and given adequate pedagogical training and resources. Simultaneously, teachers implementing such approaches to teaching and learning need to be encouraged and rewarded by their institutions.

**Keywords** — *quality, evaluation, teaching and learning, student-centred approaches, quantitative, qualitative, engineering education*

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# Improving the employability of graduates by strengthening the relationships between higher education and enterprises. The Erasmus+ Voyage international cooperation project

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**Abstract** — A major concern of higher education institutions is the employability of their graduates. In order to increase those prospects a close match between the training the university provides to their students and the requirements of the industry must be achieved. Understanding and effectively knowing the needs and requirements of enterprises and the industry in terms of employee's knowledge and competencies is crucial to higher education. On the other hand a major effort must be constantly pursued in order to advertise and illustrate the level of quality and competence of our engineering graduates.

Bridges must be established and strengthened to allow the university to understand the needs of the industry and the requirements of society while making clear what major contributions the university gives to the development of our societies and humankind. In this line to sought international cooperation projects were developed involving several universities from EU countries and abroad lead by the Almalaurea consortium promoted by the University of Bologna. In this communication, we will present the ERASMUS+ project "VOYAGE" of cooperation, in these lines, between EU higher education institutions and Vietnamese universities with the involvement and support of EU and Vietnamese enterprise associations and government bodies.

The VOYAGE project lays on a bottom up approach that starts from the graduates and its university, for modernizing and developing the higher education sector within society, strengthening the relations between university and enterprises and improve in turn the quality of higher education in place. An extended exchange of experiences activities in mutual benefit was promoted. Strategies were explored of transfer, to the Vietnam's higher education system, of good practices in engineering, and most of the other subjects, education on

the effective monitoring of the higher education training system and the labor market, as well as the links between them, and to forecast skills and knowledge requirements of the labor market.

**Keywords** — *higher education; engineering education; employability of graduates; international cooperation*



# Using different and complementary teaching tools in project-based learning

## Application to Civil Engineering - courses on Soil Mechanics

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**Abstract** — Nowadays, to address current industry requirements, Civil Engineering graduates and postgraduates should be equipped not only with broad technical knowledge, but also with significant generic competencies and soft skills. Some competencies can be included in both categories - the ability of using computing and specific software can be included in both technical knowledge and soft skills. In an era in which digital transformation is deeply affecting the economy in general and construction in particular, the importance of using computing and software in engineering practice has been increasing continuously, as the capability of computers and of implementing complicated numerical models increases. Thus, it is essential for graduates to be prepared to do such analyses and to develop a critical attitude towards the use and the results of these analyses preparing them with the right skills to follow this movement of change.

This paper describes the use of different and complementary teaching tools on two consecutive courses on Soil Mechanics. In these courses of the integrated master in Civil Engineering degree in the University of Aveiro, project-based learning with collaborative or cooperative teamwork was implemented. The teaching tools adopted and described herein include text processors, spreadsheets and presentations, as well as specialized geotechnical software. The students' perceptions were collected using a questionnaire and the impact of those different tools on the students' perceptions are analysed. Some considerations for future implementations of similar approaches are put forward. The students' perceptions collected allowed concluding that using different and complementary teaching tools in project-based learning can be effective in promoting students' learning.

The use of such tools may contribute to the development of both technical knowledge of students and of soft skills. For this case study, the results show that the students considered the computer tools useful in promoting and facilitating the construction of knowledge and in developing several competencies, i.e., in developing their learning processes. Developing and training critical thinking and engineering judgement is key to prepare successful professionals. Nevertheless, a positive attitude and commitment by both the students and the instructors are essential to successful teaching and learning processes. Getting students on board, by discussing the aims of using specific strategies, is key to promote academic success. Therefore, students must be the centre of all the teaching and learning processes.

**Keywords** — *computing tools; project-based learning; perceptions; soft skills; questionnaire*

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# Engineering Education (Research) in European Countries: An overview based on publications in journals

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**Abstract**—The interest in Engineering Education (EE) and Engineering Education Research (EER) has been increasing all around the world. Nevertheless, it is not easy to understand what is the current state of the art of engineering education based on research that is being made in specific regions of the world. Considering that engineering educators are practitioners of EE and sometimes also researchers in EER subfields, this discussion paper aims to make an analysis of the state of the art with respect to EER in European countries, higher education institutions, authors and journals. The approach chosen was to make an exploratory study based on document research using Elsevier Scopus indexing service. Considering the Scopus database, the time threshold was defined as 1970 to 2017. Using the search-term “engineering education” was possible to identify 19074 journal documents, being 4604 from European affiliated authors. Based on the study the authors conclude that EER is growing in Europe and have outreached the USA in the last years, but the relative position to the whole world is decreasing. Additionally, it was possible to identify the most prolific authors, countries and institutions. Notable, in the last 10 years Spain become the country with the higher number of published papers. The analysis of the keywords showed that there is a strong focus in computer-based tools to support engineering education. A few top authors have been focusing in specific areas of the curriculum processes, namely in Problem and project-based learning.

**Keywords**—Engineering Education; Engineering Education Research; Active Learning; Project-Based Learning.

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# How Portugal is doing: A comparative look at the evolution of engineering education

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**Abstract** — In 2015 van Hattum et al [1] published a study of the evolution of engineering education research (EER) in Portugal where they concluded that EER had been receiving increasing attention from researchers in Portugal and this manifested itself in a growing number of publications in international journals. These authors also commented that although the majority of these publications were focused upon classroom interventions, there were signs of a growing maturity of research activity in this field of inquiry in Portugal as evidenced by a broadening of research themes and by contributions to international theoretical knowledge.

Given that the data presented in [1] were collected up to 2014, the present study aims to build on the earlier work by examining more recent data on articles submitted to and those published by the publications European Journal of Engineering Education, IEEE Transactions on Education and the Journal of Engineering Education. These allow us to compare publication trends of Portuguese affiliated authors with those in other EU countries, Australia and the US.

Whereas few authors from Portugal submitted articles to IEEE Transactions on Education and Journal of Engineering Education in 2017, data for the European Journal of Engineering Education in the

period from 2011 to 2016 show that this journal has been a popular submission venue for these researchers and the publication success rate of 30 % is broadly comparable with that Ireland and the UK in the same period although lagging behind that of the US, Australia and the Nordic countries.

The findings suggest that the overall trend identified in [1] can still be observed which suggests that there has continued to be a positive evolution of EER in Portugal in recent years.

**Keywords** — *engineering education research; Portugal; journal publication data; bibliometric analysis*

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# Towards Excellence in Engineering Education

## The profile of Higher Education Teachers on Engineering Programs

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**Abstract** — True excellence in higher education, namely in engineering, is a difficult concept to define and attain. Engineering programs tend to value the later years as the most important in terms of training and scientific depth, while the first years are relatively neglected. At the same time, there is still a tendency to look at teachers' achievements in terms of research and knowledge, detached in a certain way from pedagogy. On the contrary, more focus should be put into analysing the profile of teachers and its adequacy to the different approaches needed across the years and course units of a master program. Added to this, are the distinct “perceived realities” between (i) what teachers see as a satisfactorily provided service, (ii) what students need and feel to be the quality of the learning experience, and (iii) what society expects (and will expect, in the future) from engineers. Different views and different alignments, from different stakeholders, require careful assessment and analysis, since the quality of the teaching and learning (as assumed in this study) is strongly related to an individual (or group) perception.

In this paper, a methodology is introduced that involves the main stakeholders in defining the quality of teaching and learning, focused on the first year of engineering courses at the University of Aveiro (Portugal). For this, a set of meetings and discussion forums provided the required context for identifying attributes of the mentioned “perceived quality”. As an outcome, a new model is presented, inspired in methodologies usually applied within the field of product design and development. The first layer of results is presented, together with a preliminary analysis and discussion. Future steps towards the goal of defining the best profile of higher education teachers for achieving (a higher level of) excellence in engineering education are also indicated.

**Keywords** — *Engineering education; HEAT model; Perceived quality; Higher Education Teacher profile; Kano model.*

# Promoting IoT Education for Pre-university Students With Coloured QR Codes

## Colour multiplexed QR codes

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**Abstract** — Internet of Things (IoT) is certainly a relevant concept in the education of the future engineering students, providing important instruments to adapt the teaching and learning methodologies [1]. Among those instruments, multiplexed QR codes [2] are unique tools due its intrinsic properties such as fast and easy readability and larger information storage capacity, in parallel with its increasing popularity in the last years associated to daily routines as they offer a simple physical means for quick access to web sites. We propose a project-oriented approach tailored for pre-university students to develop their skills in the field of IoT, namely, programming and prototyping development in straight connection with school activities. The students experimental assessment of the project was complemented by the expertise of the team from the University shortening the classical loop between the student problem solution and teacher feedback with fruitful improving the students self-awareness and their overall performance in multidisciplinary issues in the field of IoT contents, with impact in the school day life and promoting the engagement in Engineering University level degrees. This work is an example of a project-based learning involving IoT that was tailored to make students active in the learning process due to the required experiential activities. The resulting benefits for the future engineers in what concerns skills development towards team and collaborative work, addressing multidisciplinary areas in engineering, critical thinking, and computational thinking were unequivocally demonstrated, with a clear impact in the motivation to study and address learning beyond classroom time oriented activities. The post project assessment by the high school teacher reveals that the students have increased their grades in the physics course and currently they are studying in different Universities nationwide in engineering degrees.

**Keywords** — *project based learning; IoT; QR Code; photonics*

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# Strategic analysis of dimensions and indicators of social responsibility in HEIs

## A case study in IPVC

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**Abstract** — Social responsibility in organizations is crucial for sustainable community development, integrated and responsive to current development needs. Economic, community and social development has been integrated into the strategic guidelines of organizations, considering the positive impacts that can result from the empowerment of communities, at local, national and international levels. Social corporate responsibility assumes itself as an empowerment tool that becomes available for organizations in general, enhancing sustainable economic growth of communities. Higher Education Institutions (HEIs) are those that take care of the development of people with whom they interact, their relationships with each other and with the environment, and also with the labor market and global communities. Thus, actions of social responsibility of the HEI indicate their commitment with their ethical, political and social roles. A socially responsible campus implies a broader vision, than that traditionally associated with the infrastructures and physical characteristics of the space occupied by HEI, valuing the involvement of all members of the academic community and integrating social, environmental and cultural concerns [1]. The construction of socially responsible HEI involves several dimensions and depends greatly from the integration of the work teams of the IES itself [2]. Literature puts in evidence several proposals of dimensions of social responsibility within HEIs, as a result of different worldwide conducted studies. Such an example is an exploratory case study in Brazil which is based upon Ethos indicators, which can be applied to any corporation, and present eight domains specifically defined for the HEIs [3]: values, transparency and governance, internal public, environment, suppliers, consumers and clients, community, government and society. Another study developed in Portugal, in two HEIs in Alentejo, considers four main groups in which HEIs can produce impacts regarding the implementation of social responsibility: organizational and environmental group, educative, cognitive and social [4]. Yet another study conducted in Brazil, in a private university of Distrito Federal, proposes a model with 6 dimensions that include teaching, labor and career, inclusion, training, volunteering and communication. This presentation aims at comparing and discussing some of these approaches that we have

encountered when analyzing IPVC social responsibility performance and activities that won the Volunteering Academic Prize by Santander Totta in December 2017 and recently (June 2018) had the work entitled “System of aid and improvement to the mobility of blind people”, developed by one of the students of the Technology and Management High School, in the top 3 with an honorable mention, of the IV Edition of the GRACE Academy in the scope of the Uni.Network project and under the thematic “Technology at the Service of Corporate Social Responsibility”. Both awards symbolize the recognition of the path that is being taken by the institution in social matters. We also make a reflection upon the benefit of a common approach, within the broader scope (e.g. European level and OCDE level) and how it would enable a comparative analysis of performance and results.

**Keywords** — *corporate social responsibility, HEIs.*

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