

## A Global Approach to Engineering Education at EUITI Valencia

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**Abstract**  $\frac{3}{4}$  An approach to global training in Engineering followed at EUITI Valencia is presented which takes into account not only an upgrading of syllabi and curricula, but also three basic foundations for the learning and teaching process such as Teaching Innovation, an effective Industrial Placement System and International Relations. A detailed and comprehensive analysis of sound aspects of Teaching Innovation which foster successful performance in Engineering students is carried out, some of which include: special attention and support to students at the initial stages; co-ordination of related subjects, formative assessment and evaluation; and personalised tutorial support. This study also comprises specific features of Teaching Innovation projects at their three levels: institutional, multidisciplinary and specific. The expertise and practical experiences in innovation presented here are part of an attempt made by several Spanish universities (UPV, UPM, UPC...) to avoid an overall academic failure trend which has been found in students' performance in the past years. The percentage of students who finish their full university course in three years at the EUITI, is among the highest of all Spanish institutions. This is another practical reason that can give a significant support to the actual validity of the teaching and learning approach suggested in the paper.

**Index Terms**  $\frac{3}{4}$  Collaborative Programs, Core Technologies, Engineering Education.

### GLOBAL QUALITY IMPROVEMENT THROUGH INNOVATION: THE NEW ENGINEER

Following the definition of an engineer as that professional who is most qualified to meet the challenges within a technologically changing world, it is clear that we have to adapt our teaching and training in order to equip him/her with the necessary skills to be able to function adequately within the work place and within a totally new environment that is global in scope.

Thus the engineer who seeks success in our ever more global economy, will comprise a series of professional and personal abilities and attitudes in accordance with the many requirements which will be present in the working environment. In other words, this pattern would make our ideal engineer, if we paraphrase Umberto Eco, similar to a

'Saint Paul' who was born in Persia, came from a Jewish family, spoke Greek, read the Tora in Hebrew, lived in Jerusalem where he spoke Aramaic, and when they asked for his passport it showed he was Roman. Nowadays, therefore, it is no longer sufficient to feed our students with relevant information and technical knowledge.

Since our future graduates will very likely switch technology and/or change their jobs at least three times in their professional lives, they must be given a sound technological background in the fundamentals, that allows them to continuously update. Therefore we strongly suggest changing that trend of moving to the final years what should be put forward as an introduction to research work and be taught as part of Doctorate programmes.

We strongly believe that modern technical universities should commit themselves to quality and innovation, both of which are complementary and crucial, for their own benefit and for better serving the surrounding society. Therefore, EUITI is now undertaking a profound process of quality assessment through its Office of Quality Management, including many aspects of the daily routine of the institution. The pillars of this quality management and improvement are: Teaching Innovation, International Relations and Collaboration between the University and the Private Sector, such as local companies, industries, etc., all of which are founded on the idea of innovation.

### THE SPANISH SITUATION

Present Spanish Higher Education System dates back to the early eighties when a new law (Ley de Reforma Universitaria, LRU in the sequel) concerning the university structure was approved by the Central Government enabling the development of different syllabuses throughout Spanish universities in order to prepare us to face the 21<sup>st</sup> Century from a more advanced and flexible framework. This university reform law implied that universities would, on the one hand, share a common core in a given degree nationwide, and on the other, establish their own priorities according to their environment by being allowed to offer subjects relative to their social demands, and more importantly, to give the student the opportunity to design – up to a certain extent – his or her own curricula, mainly by means of Option- and Elective- subjects to be chosen by him/her in addition to the Core- (fixed by the Ministry of Education) and Compulsory- (fixed by each university) subjects.

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That LRU created a framework that made engineering education move into a credit system, with the theoretical contents of many subjects greatly reduced and many new 6-credit subjects added (4 hours/week during 15 weeks, since 1 credit equals 10 contact class hours). This meant reviewing the contents of all the subjects thoroughly.

Universities, within their given freedom to restructure their studies, sometimes went too far and created too many small courses which created a proliferation of different subjects taken at the same time by the students. This led the Central Government to introduce in 1998, after some years of testing different curricula designs at the universities, some mild restrictions to the number and length of the term and year subjects which can be taken since both kinds of subjects may coexist within a particular university curricular design. In this respect the minimum size for term subjects is 4.5 credits and 9 credits for annual subjects. On the other hand, in order to allow students to perform their own curricular design, within the foreseen period of time of their respective studies, they should not take more than nine different subjects per year or six subjects at a given moment, both quantities comprising the total number of term and annual subjects each student can take.

During 2002, there has been a new process of change within the Spanish university system, with the advent of the *Ley Orgánica de Universidades (LOU)*, which is leading us to new recruitment, promotion, representation and general management patterns. On the other hand, this law has not really changed the existing credit system.

Technical teaching and training, through the existing Option- and Elective- subject curriculum, should take into account the types of industry providing employment to the Institution's graduate students. In the School of Valencia we have included a large amount of elective subjects (172) to the so-called POD, i.e. Plan de Ordenación Docente (teaching management plan), as well as optional subjects which encourages an integral education and permits the student to acquire the status of 'know how to keep ground' as a step ahead of 'know how to do' and, obviously, of knowledge.

### INTERNATIONAL AND CO-OPERATION PROGRAMMES

The international meetings and agreements made at Italy and Prague, among others, are radically changing the way we look at training and teaching approaches in Europe at all levels.

At our institution, we have the objective of making this new European and global trends compatible with a training system that encourages teaching innovation and a type of technical education in accordance with the new market and industry environment: teaching abilities, including Humanities, foreign languages, core technologies, etc.

The economy increasingly moves within the central concept of globalization, thus giving a fundamental role to the knowledge of foreign languages and cultures. International exchange of students, and teaching and

administration/services staff should be encouraged. The latter professional group is central to making sure that our incoming international students are properly assisted and, more importantly, properly understood as regards the many daily problems that they come across within the receiving Institution.

With all this in mind, EUITI is involved in several tasks seeking Teaching Innovation for which it has favoured several programs which may be summarized in:

- Methodology innovation programmes and efficient use of multimedia technology used as a training tool.
- Involvement in international collaborative and exchange programmes.
- Relationship with industry.

Focussing on Collaborative Programs let us mention that EUITI participates in several programs since 1987: ERASMUS, SOCRATES, LINGUA, LEONARDO and TEMPUS. In addition, new international projects have emerged with the US and South America, for example ALFA. The ERASMUS Programme was created to prevent education from being left aside in Europe and to turn the European Common Market into a reality involving also university education. This programme meant economic support for universities, their students and staff, with the aim of promoting student mobility and co-operation in the field of higher education in another EU member state. Our students were given the opportunity to get to know other cultures and a better understanding of the implications of becoming the European Union. The European Student Exchange Programme, SOCRATES, is the successor of the ERASMUS programme. The LINGUA programme aims to help Europeans overcome language barriers, to improve quantity and quality of the teaching and learning of foreign languages, to achieve the better qualification of the future workforce, making competitiveness possible within the internal market. TEMPUS is an acronym corresponding to Trans-European Mobility Programme for University Studies, which was adopted by the Council of Ministers of the EC, May 7, 1990. It formed part of the global programme of community aid for the economic restructuring of the Central and Eastern European countries. Finally, EUITI also has participated in ALFA projects between the EU and Latin American universities, for instance *Luis Vives II* focused towards the improvement and innovation in industrial engineering education with the participation of 7 EU institutions and 7 Latin-American universities and *San Alberto* focused towards linking Environmental Euro-engineering with Latin American societies

We have a yearly average of over 120 outgoing students usually following a nine-month study stay, spread over the European Union countries (UK, Ireland, Germany, Finland...) and an incipient student mobility to Latin America (Uruguay, Chile, Argentina, Mexico and soon Cuba); we maintain relationships with several institutions in the USA and Canada. The number of teaching staff visiting partner institutions is around twenty five and the

administration and technical staff moving this year will be ten (including Laboratory Technicians and International Relations staff).

In spite of these facts and figures, together with the approximately 100 students received through European programmes, can be considered very positive, we still believe that the numbers fall far short of what future teaching should look like, one in which undergraduate students should benefit from a minimum stay of six months abroad, or, ideally, one full year at a foreign university giving the possibility of obtaining a jointly awarded degree.

### APPROACH TO TRAINING AND TEACHING ENGINEERING

The model of training and teaching promoted by EUITI is one which follows several parameters in relation with the following items:

a) *Learner-centredness*. As a result of taking into account the student abilities, we would like to develop a series of attitudes within the pedagogical process encouraging them to develop a strong interest in their own training, as students should understand that they have the main responsibility for their own teaching and learning process. On the other hand teachers have to select the necessary contents to achieve the appropriate goals. It must be emphasized that traditional teaching was in favour of giving a large amount of information, and in this process many teachers from their blackboards were mere givers of pages and pages of information which was copied, learnt by heart and answered back in exams by students.

b) *Active methodology*. It involves changing the roles of the teacher, who must become a motivating and counselling figure, and the student, who should be a more active and central figure within the learning process. We also should achieve a more global training that enables the future graduate students to shift from an interest in 'knowing' to a concern to 'know how to do' (with the subsequent active learning) and then to 'know how to stand'. All this can only be achieved if a substantial amount of 'chalk face' hours are complemented and devoted to student active work, in laboratories, computer classrooms or industrial placements.

c) *Pedagogically-driven use of core technologies*. The future must encourage a type of teaching which is increasingly more and more technified, with computer support in most of the subjects and teaching labs guiding the students' learning work. The mass media constantly report examples of how the Internet, for instance, improves student performance by 20%. And we are all well aware of the fact that the fields of computing and telecommunications account for a significant percentage of the newly created jobs in Spain. We have been encouraging the use of new and core technologies in teaching for over ten years now, because if students work with the same computer support and with a similar equipment for several subject matters, their performance and mastery of the resources increases accordingly.

Nevertheless, excuses can always be found so as not to change curricula or teaching methodologies. These excuses can be classified into four groups which correspond to the lack of technical and administrative staff, teaching staff, resources and space. And more often than not, they may be a combination of these. In order to face all these drawbacks, our suggestion is to put forward proposals so as to obtain what is required, and to take off and start taking measures even if all the needs may not be fully met yet.

In fact as consequence of the work of a team including Enterprise and University people it became clear that the enterprise world considers a series of abilities and certain knowledge corresponding to overall requirements within the labour market to be of prime importance for the training of University students, regardless of what the students' field or major is. Abilities are as important as University curricular contents. To give but a general overview, the required qualifications are: leadership and motivation, teamwork, project management, buying and selling processes, self-learning, personal development, quality, communication, information search and retrieval, oral and written expression, knowledge of foreign languages, etc. with two key demands perceived:

- To give predominance to learning in the learning-teaching balance.
- To train in professional and personal qualifications/abilities.

This should go together with a decrease in the expository content of teaching while keeping up with the integrity of teaching and the level of knowledge corresponding to Higher Education, and taking into consideration a context of general reduction of teaching hours within the new University curricula, and a greater balance between theory and practice required by a more comprehensive and efficient technical training.

Solving this important problem requires a greater use of technological resources for teaching and informative purposes, thus allowing the change in the role of teachers to become more motivating and stimulating. In order to achieve this goal, the use of computer classrooms, audiovisual and multimedia resources provides powerful tools which are relatively affordable and easy to implement. accordingly.

### EUITI EXPERTISE

The policy in favour of a greater technification has taken us to a need to train not only students (with subjects related to computing and multimedia) but also the teaching staff, with the development of courses for teachers that introduce us to the proper use of teaching technologies, which is consolidating the emergence of several research groups within the field of pedagogy.

Teaching in laboratory classrooms should allow for a full integration between theory and practice. It is necessary for these classrooms to be multidisciplinary, which is positive for a greater connection among disciplines and subjects and enhances the overall vision on the students' part. It also

allows for a sharing of resources which can reduce costs significantly.

From our experience, some recommendations for teaching for instance in the first year of Electronic Engineering are the following: A computer classroom as location for subjects that only require computer facilities such as Mathematics, Computer Fundamentals, Technical Drawing and Languages; a specialised laboratory classroom for subjects requiring not only computers but also other equipment, such as Physics Fundamentals; and External laboratories for subjects requiring complex facilities and installations, such as Chemistry.

For the second year of Electronics, two classrooms hosting about forty-five workstations with computer facilities and basic equipment, namely oscilloscope, generator, power supply, multimeter and logic analyzer are required.

For the third year we have experienced an improvement with the use of smaller labs, since more specialised equipment is required.

In order to achieve a more active participation of the students in their training from the start we teach a series of prerequisite courses, together with the development of experiences such as counselling students and tutor teachers.

We strongly encourage the students to carry out project work related to two or more subjects and which could be presented in and evaluated by different subject teachers. And in the second year the development of prototypes is a fundamental part of several subjects.

Different subjects make wide use of Inter- and Intranet bulletin boards to work which enables an innovative relation between students and teachers.

We have started the teaching of various subjects in English, as well as other subjects taught in companies and institutes of the Technological Park, which provides students with a wider (and probably more professional) perspective.

To develop other abilities among the student population, we are considering the possibility of teaching part of the curriculum as smaller seminars with fewer students, which allows for a closer attention paid to students by teachers, as well as a more active learning. These seminar rooms consist of ten to twenty computer workstations when required.

Another type of subject uses multimedia formats in its methodology, as well as the presentation of essays and works by students, thus encouraging the acquisition of abilities required by most of the job offers: teamwork, speaking to an audience, computer literacy and language skills.

During the last two years, the Polytechnic University of Valencia (UPV) has been implementing a global institutional project to promote innovative developments at all levels within the university. This project is called PROYECTO EUROPA, and has very many sub-programmes. The EUITI, conscious of its commitment to innovation as a pioneering University School in the field, is involved in each and every subprogramme of the project. As a matter of fact, several

actions which are now under the umbrella of the EUROPA project, have been traditionally carried out by the EUITI for some years now. Here are some more examples of these actions (others can be found in the previous paragraphs):

- Educational Innovation Projects (*PIDs*) for the coordination between different subjects within a given degree and for the development of new teaching materials and environments.
- Tutorial assistance schemes for national and international students, specially at the initial stages.
- Actions to facilitate the quick and successful adaptation of newly enrolled students.
- Creation of the *Consejo Asesor de Centro* (School Counselling Board), to provide advice and support on many aspects in order to improve quality at all levels within EUITI.
- Actions involving and encouraging new ways of assessment and evaluation of the students' work which are more active –through project work, for instance- and do not rely only on written exams (conventional evaluation).

All these lines of action, together with over on hundred Industrial Placements every year with an average duration of 6 months and a very large amount of Final Year Projects carried out within companies, provide EUITI students with an adequate adaptation to the industrial world, achieving a high percentage (over 95%) of employability of our graduates within six months upon graduation.

Nevertheless, although this is a fact well reflected by experience, the idea of quality for a modern and innovative institution implies that the situation is always subject to improvement and criticism, so we are continuously reviewing and upgrading the model, through innovation, quality assessment and careful study of the very many voices that can help us to improve every day. Examples of these are the professional world, the students and teaching staff or international agreements and convergence programmes, among others.

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