The European Project Semester at ISEP

Learning to Learn Engineering

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***Abstract*—The European Project Semester at ISEP (EPS@ISEP) is a one semester project-based learning programme addressed to engineering students from diverse scientific backgrounds and nationalities. The students, organized in multicultural teams, are challenged to solve real world multidisciplinary problems, accounting for 30 ECTU. The EPS package, although focused on project development (20 ECTU), includes a series of complementary seminars aimed at fostering soft, project-related and engineering transversal skills (10 ECTU). This paper presents the study plan, resources, operation and results of the EPS@ISEP that was created in 2011 to apply the best engineering education practices and promote the internationalization of ISEP. The results show that the EPS@ISEP students acquire during one semester the scientific, technical and soft competences necessary to propose, design and implement a solution for a multidisciplinary problem.**

Keywords—European Project Semester; engineering education, project-based learning; teamwork, multidisciplinary projects.

I. INTRODUCTION

The European Project Semester (EPS) is a one semester project-based learning programme addressed to engineering students from diverse scientific backgrounds and nationalities. The goal is to offer engineering students a programme not only focussed on developing scientific and technical competences, but also on soft transversal skills, which are in high demand by the market.

The programme is offered by a selected group of European universities. In order to run an EPS programme, the candidate university has to apply and follow a set of mandatory requirements. As a result, in 2010, ISEP applied to run the programme and, in 2011, the European Project Semester at ISEP (EPS@ISEP) was launched. For ISEP, the programme is regarded as yet another tool to apply the best engineering education practices, increase the employability of its graduates and promote internationalization.

This paper includes the following sections: introduction, EPS background, the EPS@ISEP programme, related programmes, the EPS@ISEP results and the conclusions.

II. BACKGROUND

The EPS was created in Denmark by Prof. Arvid Andersen in 1995 to foster the development of international competences, project organised learning, teamwork and complementary transversal skills among engineering graduates [1]. In 2013 EPS was offered in Copenhagen, Denmark, 's-Hertogenbosch in the Netherlands, Oslo in Norway, Lodz in Poland, Kiel in Germany, Valencia and Vilanova i la Geltru in Spain, Vasa in Finland, Tarbes in France, Antwerp in Belgium and Porto, Portugal [2]. The Hague in the Netherlands in the autumn of 2013 and Pölten in Austria in 2014 will join the group. These universities share a common site – the EPS Providers site[1] – where prospective candidates can get information on the programme as well as on the providers.

The EPS programme is a 30 European Transfer Credit Units (ECTU) package structured generically as follows: two thirds (20 ECTU) for the project module and one third (10 ECTU) for complementary modules. The complimentary modules are focussed on the development of soft skills such as communication or teambuilding, project-related activities such as project management and transversal topics such as sustainability.

The EPS providers have discussed, agreed upon and posted on the EPS Providers site[1] the set of mandatory European Project Semester programme features. These are the so-called "10 Golden Rules of EPS" that all providers must follow:

1. English is the working language of EPS.
2. EPS is multinational with a group size of minimum three and maximum six students, being four or five the ideal number; a minimum of three nationalities must be represented in each EPS group.
3. Ideally, but not necessarily, an EPS project is multidisciplinary.
4. An EPS semester is a 30 ECTU package, the duration of which is not less than 15 weeks.
5. An EPS project has a minimum of 20 ECTU and the complementary subjects account for a minimum of 5 ECTU and a maximum of 10 ECTU.
6. The main focus on EPS is on teamwork.

[1] http://www.europeanprojectsemester.eu.

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7. The subjects included in the EPS must be project supportive; English and a basic crash course in the local language must be an option.
8. The subjects must include Teambuilding in the very beginning and Project Management in the beginning of an EPS semester.
9. Project supervision/coaching must focus on the process as well as the product.
10. EPS must have continuous assessment including an Interim Report and a Final Report.

A. Teams and Proposals

The EPS candidates are composed of international and national students. Before the start of the semester, the EPS candidates receive, via email, a Belbin questionnaire and are asked to fill and send it back to the provider. The goal is to determine the individual worker profiles and, thus, design balanced teams composed of complementary elements from as many diverse scientific backgrounds and as multinational as possible, according to rule 2.

Before the beginning of the semester, a set of project proposals regarding real world problems are collected by the provider. The proposals tend to be multidisciplinary, *i.e.*, require the integration of multiple technical and scientific competences. The origin of proposals varies and includes industry, services, R&D institutions or the provider itself.

B. Seminars

The seminars or complementary modules support the main EPS activity – the EPS project. The aim is to provide soft skills such as communication, teambuilding, intercultural relationships or English, multidisciplinary topics such as sustainability or ethics and deontology, project-related themes such as project planning, management or product-related subjects such product design and marketing.

C. Team Coaching

Each team is assigned one or more supervisors that act as coaches or consultants rather than leaders or instructors. The team and supervisor(s) meet at least once a week and feedback is provided by the supervisor(s) to help the team improve their process performance and maintain focus and motivation. The supervisor(s) should not lead the meeting nor impose views on the team, but rather promote brain storming, foster the ideas of the team and act as a facilitator between the team and the real world (businesses, institutions or experts). The team must feel in charge and fully responsible for the project.

According to the EPS Guidance Notes [3], the main contribution of the academic supervisor is to help students to understand the content of their project and to ensure that they are making progress. It is also to nurture and facilitate the group work and the group process. The supervisor must make sure that the advantage of working together in groups is sustained.

D. Deliverables

Each team has to produce several types of materials. The interim and final presentation, the interim and final report and the product or prototype are mandatory deliverables. Then, depending on the provider, there are additional contents that the students must hand in such as posters, papers and videos. These deliverables constitute the EPS repository and are used by the providers to showcase the programme.

E. Team and Individual Assessment

The assessment is an essential component of the EPS programme. There are two assessment periods: the intermediate assessment by the $7^{th}/8^{th}$ week and the final assessment in the last week (15^{th}) of the programme. Since assessment strongly influences learning, any programme that intends to improve peer learning and collaboration must adopt an assessment approach that promotes both. Self and peer assessment is a valid solution for promoting these objectives and overcoming potential inequities of equal marks for unequal contributions. Group members are responsible for negotiating and managing the balance of contributions and then assessing whether the balance has been achieved [4]. Therefore, in EPS both assessment periods include a self and peer component where the students grade themselves and their team members. This assessment involves seven dimensions and uses a scale between one and five. Whereas the interim assessment is intended for feedback purposes, allowing the teams to work on their weakest points, the final assessment is for the final grading.

The assessment is performed according to the EPS Guidance Notes [3]. The assessment is based both on the individual project execution and oral presentation as well as on the team performance and quality of the deliverables.

III. EPS@ISEP

ISEP – Instituto Superior de Engenharia do Porto – is the engineering school of the Polytechnic Institute of Porto, the largest polytechnic in Portugal. ISEP was created in 1852 and offers 1^{st} cycle and 2^{nd} cycle engineering degrees to an universe of approximately 7000 students. Furthermore, it accommodates several R&D groups with strong industrial and academic links both at the national and European levels. In terms of internationalisation, ISEP has a long list of active partners including European, African and South American institutions.

The mainstream learning methodology followed at ISEP is a balanced combination of sound scientific-technical background together with a strong practical approach. As a result, project-based learning comes as a natural choice to promote a pro-active autonomous learning attitude among the students.

A. Study Plan

The EPS@ISEP programme includes Project (20 ECTU), Project Management and Team Work (2 ECTU), Marketing and Communication (2 ECTU), Portuguese (2 ECTU), Energy and Sustainable Development (2 ECTU) and Ethics and Deontology (2 ECTU) modules. These seminars are organised around each team project. For example, communication, which includes English, contributes to the development of the project deliverables; project management focuses on task identification, human resource allocation, task planning and scheduling, resource management, plan enforcing and eventual

rescheduling; sustainability addresses the product ecological footprint; and marketing tackles the market analysis, segmentation and positioning.

B. *Resources and Organization*

The EPS@ISEP structure is light. It involves a coordinator, the international relations office, a set of invited teachers that lecture the complementary modules, a group of supervisors that coach the teams and guest lecturers from the other EPS providers. Furthermore, it relies on the ISEP laboratories, facilities, technicians and in-house experts.

In the spring of 2011 the human resources included twelve teachers, eleven ISEP teachers from six departments and one teacher from another school of the Polytechnic Institute of Porto. The students had a dedicated space at room F314 – a laboratory of the Electrical Engineering Department. The coaching meetings took place in room F502.

The spring of 2012 counted with twelve ISEP teachers from seven departments and, in 2013, the programme involved thirteen ISEP teachers from seven departments. In both semesters the students occupied room F403 and the coaching weekly meetings took place in room F502.

Depending on the complexity of the projects, the average cost of an EPS@ISEP project in terms of materials is approximately 350 €.

C. *Modus Operandi*

The EPS@ISEP follows the EPS formula, *i.e.*, follows the "10 Golden Rules". There are specificities namely in the supervision, deliverables, modules and tools adopted.

During the preceding semester, the supervisors meet to start the project proposal gathering and to decide on the short list of proposals. This process is highly distributed and multiple proposals are collected for analysis. The ones that regard real world problems, require several competences and have sufficient budget are selected for the final list of proposals.

Project selection occurs during the first week of the programme. In this initial week students engage in several team building activities and, by the end of the week, send their choices by email. Typically, the projects are attributed on a first-come, first-served basis. However, in 2011, the same problem was proposed to two teams.

The supervision is performed by the panel of supervisors. This joint supervision model is unique. The panel of supervisors is composed by seven teachers from different departments: physics, mathematics, chemical engineering, electrical engineering, mechanical engineering and informatics.

Several electronic tools are used by the teams and teachers such as Dokuwiki, Dropbox, Google Mail, Google Calendar and Moodle. Moodle is the Learning Management System (LMS) adopted at ISEP and is used in all modules to share materials and information between teachers and students. The Dokuwiki is used by all teams as the project log. Dropbox is used as a shared file system between all those involved in the process.

The wiki is a key tool in the EPS@ISEP process. The EPS@ISEP Team provides a wiki template structured in home, work plan, logbook, deliverables and report. The teams are expected to use it as a repository as well as a log. In the Work Plan area the teams include all data relevant to the project management (identification of tasks, task allocation, Gantt chart, *etc.*). The Logbook registers the evolution of the process. Every week the teams need to write a short weekly report (one or two paragraphs), define the agenda for the upcoming supervision meeting and, then, add the minute of the meeting. The Deliverables area is intended for show casing all materials produced: interim and final report, interim and final presentation, paper, video, leaflet and poster. The Report area contains the wiki version of the report. Templates are provided for the report, paper, presentation and poster. Fig. 1 presents the main page of a project wiki.

The report structure is provided beforehand and includes as mandatory sections the introduction, state of the art, project development, marketing, sustainability, ethical concerns and conclusions. The marketing, ethical and deontological concerns as well as eco-efficiency and sustainability measure chapters are produced and refined within the corresponding complementary modules. The structure and presentation of the deliverables are addressed in the communication seminar.

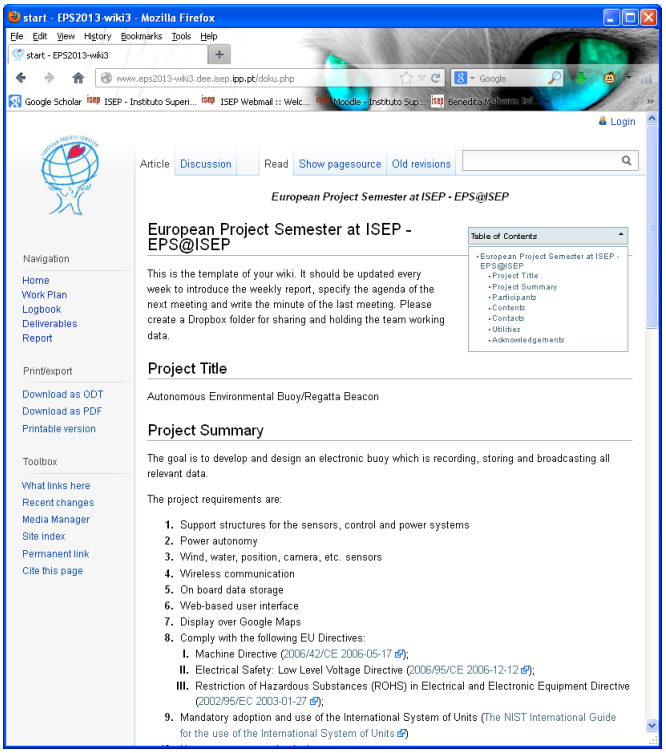

Fig. 1. Example of an EPS@ISEP wiki[2].

Finally, a Google email account has been created and used as the email box for all EPS@ISEP related affairs and Google Calendar is used for scheduling all activities.

[2] http://www.eps2013-wiki3.dee.isep.ipp.pt.

D. Coaching

In a standard engineering capstone project, the problem to solve is usually well defined, the solution is outlined and the technologies are chosen or suggested beforehand to the students. These standard projects are highly focussed and, typically, encompass only one engineering scientific area. Both the supervisor and the student(s) share the same area of study, with only incidental incursions into sustainability and marketing. The supervision is assured by one (at most two) teachers usually from the same nationality as the students.

In an EPS project, the problem is not well defined, alternative solutions have to be identified, studied, proposed and the technologies to use are undefined. The focus of the project is more holistic, encompassing the sustainability and marketing areas.

The panel of supervisors acts as a consulting committee rather than "directors". As far as communication is concerned, the supervisors have to be aware that they are interacting with people from diverse scientific and cultural backgrounds. Furthermore, in the weekly supervision meeting only the topics previously specified by the team in the wiki agenda are discussed.

The greatest contrast with standard projects is the dynamic nature of EPS projects. While a standard project proposal includes typically the project guidelines, the EPS project proposal only states a broad problem and specifies a budget. It does not intentionally specify instructions, approaches or technologies. During supervision new problems, alternative solutions and competing technological approaches may arise each week. Additionally, the solution to a specific problem may also lie outside the supervisors' expertise. In this case, the supervisors have to admit their lack of expertise and find scientific support within their school peers. In this sense, supervising is also a scientifically enriching experience.

Students who take the EPS project usually have no prior experience on large projects or as working within a large team. It is therefore expected that they could lose motivation as they face difficulties. The fact that projects are organised in two stages, with clear and well defined milestones, allows students to timely reconsider their options, learn from the mistakes, recover, and successfully finish the project. Additional motivation comes from the fact that the students feel that they are in control of the project, *i.e*., they decide the approach, the design and the technologies.

Another very important aspect of the coaching methodology is the prompt feedback given to the students by the coaching team. Students meet with supervisors once a week in a meeting room, where they discuss the topics the team has previously indicated in the wiki agenda. This way, extremely productive discussions are generated since the supervisors know beforehand which aspects will be addressed in the meeting and can get prepared in advance.

Supervising EPS projects is both challenging and uncomfortable. From the supervisor point of view, it widens the somewhat over focused perspective of the classic engineering teacher. It is a very enriching experience since the main driver of the project is not the proposal, but the team of students. The supervisor acts as an expert consultant that helps the students to achieve their goals. And the reward of all the coaching effort lies here.

E. Conflict Resolution

Disagreements and conflicts arise naturally among team members during project development. While the majority of these differences tend to contribute positively to the process, some are irreconcilable. As a result, it is necessary to put in place a conflict resolution mechanism.

EPS@ISEP has adopted the mechanism proposed by [2]. Once the teams are made, one of the first tasks the members are faced with during teambuilding activities is to define their set of conflict resolution rules. An initial set of rules is provided and, first, each member identifies and orders them according to his/her own opinion and, then, as a team, order them together by relevance. The resulting document is signed by all team members and archived in the team folder.

The supervisors are responsible to identify when irreconcilable views or tensions arise among team members and recommend the application of the conflict resolution mechanism.

F. Assessment

EPS@ISEP uses the assessment scheme proposed by [2]. The assessment occurs twice during the semester and has two components: self and peer (S&P) and supervisor assessment. The S&P assessment takes into account the quality and quantity of the technical contribution, openness to others ideas, teamwork performance, leadership, attitude and initiative shown. The S&P assessment is handed in by the students prior to the interim and final presentations. Students get individual grades.

The interim assessment is intended to give individuals and teams feedback about their performance so far from the point of view of their peers and of the supervisors.

The final assessment includes again S&P and supervisor assessments. The S&P modules the process performance mark which accounts for 35 % of the final Project module grade.

The final EPS@ISEP student grade is the weighted average of the grades all modules, where the weights are the number of ECTU of each module.

IV. Related Programmes and EPS@ISEP

This section presents EPS and Global Engineering Teams (GET) programmes and makes comparisons between the EPS and GET approaches as well as between the EPS@ISEP and other EPS programmes. The related programmes covered include the EPS programmes at Copenhagen University College of Engineering, Technical University of Catalonia and Technical University of Valencia as well as the Global Engineering Teams programme.

A. EPS at Copenhagen University College of Engineering

As stated in the previous section, EPS was created in Denmark by Prof. Arvid Andersen in 1995 and was based on Denmark's long tradition for project organised and problem based learning. By 2010, this exchange semester for

engineering students at Copenhagen University College of Engineering had already involved 1148 students from 35 countries. According to Hansen [2], EPS has been a great success and students acquire international competences and soft skills at the same time as they learn from the technical project work.

All existing EPS programmes generically follow the Copenhagen University College of Engineering EPS matrix.

B. EPS at the Technical University of Catalonia

The EPS programme offered at the School of Engineering of Vilanova i la Geltrú (EPSEVG) – Technical University of Catalonia (UPC) strongly emphasises the introduction of competences in sustainability and human technology [5]. At this school the complimentary modules (seminars) include courses in Sustainable Technologies, Business and Sustainability and Human Technology, among others. The projects are real-life projects proposed by local companies and research groups that must meet a set of criteria, namely, be multidisciplinary, complexity adequate for final year Bachelor students, difficulty adequate for project completion in 12 weeks and the company has to provide a supervisor and facilitate all the information needed to carry out the project in English. Since 2008 the number of participants has increased from 9 in 2008 to 30 in 2011. The students, who have participated in a total of 15 projects, have come from 16 different European and North American universities and from over 18 different academic disciplines, and more than 40 teachers have participated in the EPS either as teachers or supervisors [5]. The assessment of the programme shows excellent results as all the students who have participated in the EPS at the EPSEVG have successfully passed the EPS programme and, most importantly, the programme has always been very highly rated in the internal questionnaires addressed to teachers and the comments from students have always been very positive.

C. EPS at the Technical University of Valencia

The School of Design Engineering (ETSID) – Technical University of Valencia (UPV) started the EPS in September 2005 [6]. This school selected as supervisors professors with experience working with foreign students and with a good knowledge of project management. For the seminars, ETSID counted with the help of lecturers from other universities who were experts in team work and project based learning. Teachers from ETSID also participated in the fields of communication and cultural activities. On the first year the EPS ran with 21 students from 12 distinct universities. By 2007 there had already been conducted 14 projects by subtends from 18 different countries and a wide range of fields of study, including Process Engineering, Environmental Technology, Agronomy, Export Engineering, Mechanics, Electricity, Electronics, Industrial Computing, Industrial Design, Interior Design, Ergonomics, Business Management, Economy and Human Technology, among others. As with the case of EPSEVG, the projects are proposed by local companies. Some of the students participating in EPS have used the program as a part of their Master studies, some as a part of their Bachelor degree. However, for ETSID students, it represents their Final Project [6].

D. Global Engineering Teams

A somehow similar project in its objectives is the Global Engineering Teams (GET), that started in 2004, based in the previous experience of Technische Universität Berlin (TUB), which has been one of the pioneers of the development of international, blended learning and project-oriented engineering courses, with activities in this field starting in 2002 with the Global Product Development (GPD) course [7]. GET is a multinational, intercultural and geographically dispersed team-based approach at solving practical engineering problems, and each edition lasts for about six months between April and October. The groups in the GET programme are virtual teams (a challenge in using virtual teams is the availability of high-speed Internet access) consisting of students located in different countries and usually across multiple time zones. GET aims to foster teamwork and digital collaboration among students with different technical and cultural backgrounds by engaging them in challenging industry-sponsored projects. GET has three main objectives: (*i*) solving engineering tasks in international groups comprising students from different countries; (*ii*) using interdisciplinary project-oriented principles based on 'learning by doing'; (*iii*) considering engineering tasks holistically to promote global sustainability in terms of economical, ecological and socio-political principles. In summary, GET is a programme that promotes project-oriented tasks in virtual student teams working in collaboration with industry partners [7]. There are two main conditions for GET projects: they should be challenging and sponsored by industrial partners. The industry partner who orders a project is treated as a normal business partner. That provides a realistic situation in which the students are motivated to work as regular professionals. In this sense, GET provides exposure to 'real' engineering, sometimes interdisciplinary, hands-on, industrial-specific problems. Therefore, students have an opportunity to use their knowledge and creativity to solve real-world problems contracted by industry. Academics from the participating institutions and industry partners serve jointly as project supervisors. Supervisors and students communicate by using modern telecommunication tools (*e.g.* Skype, videoconferencing, SMS and email) in order to deliver an engineering project, particularly in the area of sustainable product development and manufacturing.

E. EPS versus GET

Both EPS and GET programmes are similar in terms of industry sponsorship of projects and the idea of students working in teams, and one of the GET program objectives is also to foster soft skills and, in particular, teamwork in students, aspects which are not usually covered in many engineering programmes. However, students participating in EPS have to write an end of programme examination whereas students in GET are assessed at different milestones during the programme. Teams in EPS comprise mainly of European students, whereas GET facilitates collaboration between students from developed countries (*e.g.* Germany) and developing countries (*e.g.* South Africa, Botswana, Brazil and lately Chile).

Finally, Oladiran *et al.* mention other programmes worldwide that promote innovative approach towards student

learning, namely Engineers without Borders (EWB), Engineers for a Sustainable World (ESW) and Engineers in Technical, Humanitarian Opportunities of Service Learning (ETHOS) [7]. These programmes, namely, EWB, ESW and ETHOS, have shown that project-oriented multidisciplinary teamwork is highly effective in promoting design experience and international collaboration.

F. EPS@ISEP versus other EPS Programmes

By comparing the EPS@ISEP programme with these other programmes, it is possible identify a few process differences. A major difference resides in the fact that in the EPS@ISEP the project supervision is assured by a team of supervisors, from distinct scientific areas and with different backgrounds, whereas in the other programs the teams are usually supervised by a unique supervisor. The EPS@ISEP coaching approach presents advantages since the projects developed are inherently multidisciplinary and the joint supervision provides a larger scientific and technical support to the teams. In terms of support tools, the wiki plays a decisive role in the EPS@ISEP process. The way the complementary modules are organised, *i.e.*, as project supportive modules and, thus, focussed around each team project, motivates students to address non-technical topics like ethics, deontology or broad range topics like sustainability.

Another significant distinction has to do with the fact that all enrolled students in the programme, up until this last academic year, have been from European countries; other institutions running the programme have received students from other non-European countries.

Finally, one last distinction has to do with the project proposals offered to the students. In the EPS@ISEP the vast majority of the projects are based on suggestions by the supervisors or ISEP internal research teams, while in most of the other programs the projects are offered by industrial companies. This is due to the severe financial crisis that Portugal is facing and to the fact that it is preventing companies from investing in applied R&D developed by Higher Education Institutions.

V. RESULTS

The EPS@ISEP has been running for three years. In this period 37 students have successfully accomplish the programme and nine prototypes were implemented.

The EPS@ISEP programme was launched in the spring of 2011 with eight students from four nationalities and four different engineering backgrounds. These students were organised in two teams of four students and both teams were confronted with the same project proposal/problem: how to maintain the humidity level in a data centre within a pre-specified range? The teams adopted diverse approaches to address this problem and the two prototypes were handed to the client – ISEP data centre. The decision to propose the same problem to both teams, which was based on the available funding, produced surprisingly interesting results. The prototypes, although fulfilling the requirements, were quite different in terms of technical approach and design.

The spring 2012 welcomed sixteen students from seven nationalities and ten different engineering backgrounds. These students were organised in four teams of four students and each team chose a different project proposal. The project proposals included an interactive table, a fluid disinfection system, a smart object and a level monitoring system for oil containers.

Thirteen students from six nationalities and ten different engineering backgrounds participated in the programme in the spring of 2013. They were organised in two teams of four students and one team of five students. The teams developed a solar algae dryer, a pet tracker and the structure of an autonomous environmental buoy/regatta beacon.

TABLE I. presents the EPS@ISEP students per nationalities and semester. Although nine different nationalities have been represented in this three-year period, Poland is by far the country with more students.

TABLE I. NACIONALITIES

Nationalities	**Number of Students**		
	Spring 2011	***Spring 2012***	***Spring 2013***
BE			2
DE		2	2
ES		3	
HU	2	1	
FI			2
LT		2	
PL	2	5	5
PT	1	1	1
SP	3	1	1

TABLE II. shows the distribution of nationalities per team and the list of projects developed.

TABLE II. PROJECTS VS NATIONALITIES

Project Title	**Nationalities**								
	BE	DE	ES	HU	FI	LT	PL	PT	SP
Humidifier with a Web interface control				1			1		2
Humidifier with a Web interface control				1			1	1	1
An Interactive Light and Sound Table			1			1	1		1
Fluid Disinfection System using UV Technology			1	1			2		
The Smart Object		1	1			1	1		
Level Monitoring System for Waste Oil Containers		1	1				1	1	
Solar Algae Dryer	1	1			1		2		
Pet Tracker					1		1	1	1
Autonomous Environmental Buoy/Regatta Beacon	1	1					2		

TABLE III. provides an overview of the diversity in terms of engineering background. The EPS@ISEP students range from bio-related areas to construction mechanical engineering, electrical or industrial design engineering.

TABLE III. STUDENTS SCIENTIFIC BACKGROUND

Engineering Background	Nationalities								
	BE	DE	ES	HU	FI	LT	PL	PT	SP
Automotive				1					
Biomedical							2		
Biotechnology							1		
Building and Civil	1								
Chemical									1
Computer									1
Electrical and Computers								3	
Electrical				2			1		
Industrial Design	1								
Industrial – Electrical									3
Industrial and Management					2		1		
International Purchases and Sales		2							
Management							1		
Materials and Marketing			3						
Mechanical and Machine Construction							1		
Mechanical and Applied Computer Science							4		
Mechatronics		1							
Printing						2			
Sales and Marketing		1							

Fig. 2 and Fig. 3 present the aggregated S&P assessment results, where the numbers represent the seven S&P assessment components: (1) quality and (2) quantity of the technical contribution, (3) openness to others ideas, (4) teamwork performance, (5) leadership, (6) attitude and (7) initiative.

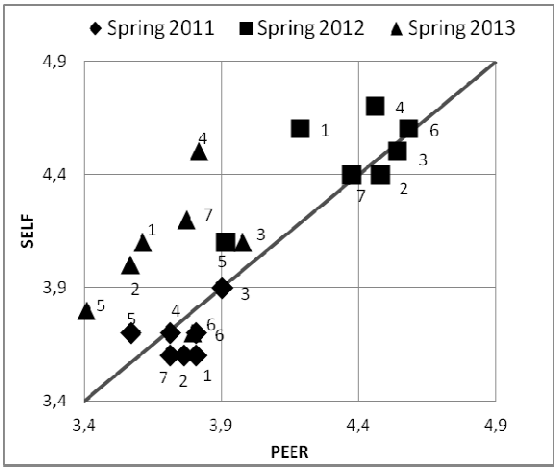

Fig. 2. S&P assessment results.

These results show clearly where there are deviations between the self and the peer perceptions. In the spring of 2011, which was more homogeneous regarding scientific backgrounds, the peer assessment is higher than the self assessment. On subsequent years, the self perception of personal regarding the technical quality contribution is higher than the peer assessment. The rather different backgrounds, associated to cultural differences, explain partially these results. Regarding team work, there also is a high disparity between the self and peer assessments, *e.g.*, there are differences of more than three points in a scale from one to five.

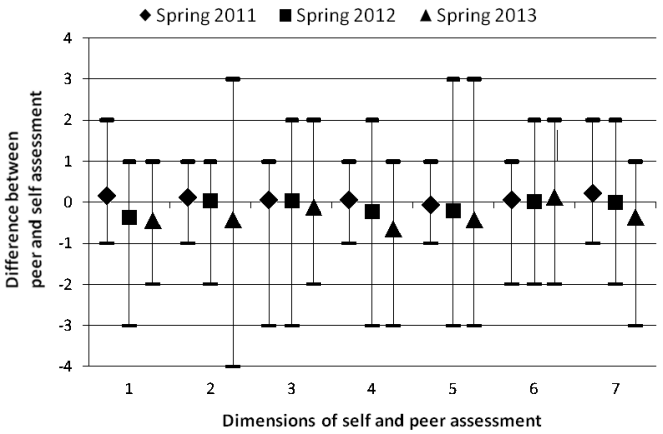

Fig. 3. Difference between S&P assessment.

In the spring of 2013, an overall deviation between the peer and the individual teamwork appears on the results. Fig. 4 provides a detailed analysis of the results from this period. The Team 1 (T1) results are of particular interest since there were problems in the interaction between the team members that, naturally, affected the project outcome.

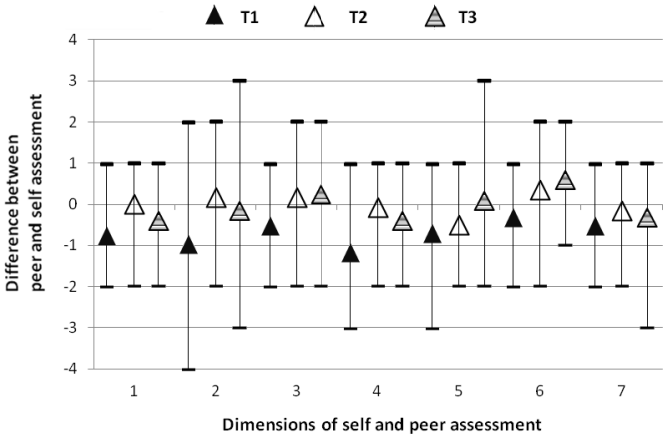

Fig. 4. Difference between S&P assessment in the spring of 2013.

In terms of external recognition, the four projects from the spring of 2012 were submitted and accepted for the Conceive Design Implement Operate (CDIO) Academy Exhibition 2013, which took place at the Massachusetts Institute of Technology, Cambridge, Massachusetts, USA in June 2013 [8]. Two former EPS@ISEP students presented their projects and represented the EPS@ISEP programme at this international engineering project display involving teams from the most prestigious engineering schools in the world. Additionally, two projects from the spring of 2012 have been accepted as posters at the 1st International Conference of the Portuguese Society for Engineering Education 2013: the interactive light and sound

table [9] and the level monitoring system for waste oil containers [10].

VI. CONCLUSIONS

The programme was implemented in 2011 and has, since then, run always in the spring semester. The results are, so far, encouraging both in terms of student performance as well as in terms of external recognition.

The project module acts as a pivotal unit around which the team, supervisors and complimentary modules revolve. The complimentary modules are project supportive modules and, thus, are focussed around each team project. This instantiated approach is a strong incentive for engineering students to address non-technical topics like ethics, deontology or broad range topics like sustainability. Even project management skills are easier to develop with a project to run with predefined intermediate and final milestones.

The experience gained with the EPS@ISEP reinforces the recommendations of Mills *et al*. that urged the adoption of project-based learning as a key component of engineering programmes and that, as such, should be promulgated as widely as possible [11].

A. Discussion

The EPS@ISEP programme is a tool for the internationalisation of the EPS students as well as for the school. The success of the programme is based on the methodology, the process, teamwork and diversity in terms of cultural and scientific backgrounds. It is a project-based learning programme intended to prepare engineering students to work in international teams and, thus, tries to replicate the international engineering environment.

The students are motivated to work together since the first week where teambuilding activities are proposed. The teams are then encouraged to be autonomous, creative and responsible. They are expected to lead their project and solve their problems. For the students the approach is novel and challenging. Not only they work in multicultural teams and use a foreign language, but, for the first time, the team is in control of the process, *i.e.*, they decide how to solve a problem. The variety of deliverables they have to produce, including a report, a poster, a paper, a video and a user manual, and the interim and final presentations promote their communication skills.

The adoption of the wiki as the team log, deliverables repository, project showcase and team-supervisor interface proved to be correct. The wiki prevails once the students have finished and remain as a testimonial of the EPS@ISEP process.

The results and the interpretation presented are based on the dataset available. Further data would allow a more accurate interpretation and, eventually, additional conclusions.

The EPS@ISEP staff is a dedicated group that works also as a team, follows the process guidelines and enjoys contributing actively to this metamorphosis where engineering students learn to become engineers.

B. Future

The EPS@ISEP can be further consolidated and improved, *e.g.*, every year the requirements of the deliverables have been refined and the templates perfected.

The short list of project proposals should be made available sooner so that the students can investigate and prepare on their own prior to their arrival. The number of companies involved, *i.e.*, contributing with multidisciplinary problems and funding, needs to be increased.

The feedback provided during the programme can be strengthened to allow the fast identification of and recovery from internal team conflicts.

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