

The European Project Semester at ISEP (EPS@ISEP) Programme Implementation Results and Ideas for Improvement

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ABSTRACT

EPS is a one semester student-centred capstone programme designed by Arvid Andersen in Denmark, being currently offered by several European engineering schools. Its goal is to promote the development of scientific, technical and soft skills in students through multicultural teamwork and open, multidisciplinary project based learning. EPS, while an active learning framework, is focussed on problem-solving, communication, creativity, leadership, entrepreneurship, ethical reasoning and global contextual analysis. The School of Engineering of the Porto Polytechnic is an EPS provider since 2011, offering a 30 ECTU package with two-thirds assigned to the project module and one-third to project supportive complementary modules. A total of 138 students from 18 countries participated in the EPS@ISEP, while developing 28 multidisciplinary projects. Based on this experience, this paper identifies strengths, weaknesses and proposes ideas for the improvement of the programme.

Conference Key Areas: Skills and Engineering Education, Curriculum Development, Sustainability and Engineering Education

Keywords: Engineering Education, Project based Learning, Multicultural and Multidisciplinary Teamwork, Sustainable and Ethical Practices

INTRODUCTION

The challenges faced by engineering education are multiple and hard to address. Institutions and students are experiencing constant changes, including financial constraints, focus shifting and the need to develop new competences. Project and problem based learning approaches are particularly fitted for engineering education, but no longer provide *per se* all the competences required in future engineers, which

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are expected to act in the global market, work in multicultural multidisciplinary teams, hold expertise in a specific engineering field and be proactive lifelong learners. This is the context that led to the creation of the European Project Semester (EPS) [1].

The EPS framework is a one semester student-centred international capstone project/internship programme offered to engineering, product design and business undergraduates, designed by Arvid Andersen [2]. EPS started in 1995 in Denmark and is currently offered by a group of 18 European engineering schools, from 12 countries, called the EPS Providers, as part of their student exchange programme portfolio. The goal of the programme is to prepare future engineers to think and act globally, by adopting project-based learning and teamwork methodologies, fostering the development of scientific, technical and soft skills. In particular, multidisciplinary and multicultural collaborative learning and sustainable and ethical development are pervasive concerns within EPS projects. The programme provides an integrated framework to undertake engineering capstone projects supported by a project-based learning methodology. Moreover, it focusses on teamwork and exposes students to cultural, scientific and technical diversity. The EPS package is organised around one central module – the EPS project – and a set of complementary supportive modules. The project proposals should refer to open multidisciplinary real world problems, empowering the teams for the conduction of their projects [3].

The EPS providers have discussed, agreed upon and posted on the EPS Providers site² the specification of the EPS framework – the so-called “10 Golden Rules of EPS” that an EPS provider must comply with: (i) English is the working language of EPS; (ii) 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; (iii) ideally, but not necessarily, an EPS project is multidisciplinary; (iv) an EPS semester is a 30 ECTU package, the duration of which is not less than 15 weeks; (v) 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; (vi) the main focus on EPS is on teamwork; (vii) the subjects included in the EPS must be project supportive; English and a basic crash course in the local language must be offered; (viii) the subjects must include Teambuilding in the very beginning and Project Management in the beginning of an EPS semester; (ix) project supervision/coaching must focus on the process as well as the product; and (x) EPS must have continuous assessment including an Interim Report and a Final Report. The different EPS programmes are not only compliant with this generic framework, but also with “diverse flavours”. There are programmes focused on engineering (most providers), business, product design or media and with different operational approaches. By default, EPS, as an engineering capstone programme framework, is intended for the final year of the engineering programme. There are programmes offered to 3rd year students (all providers), to 3rd and 4th year students (Polytechnic Institute of Porto) and 3rd, 4th and 5th year students.

Bearing these ideas in mind, Section 2 describes the EPS@ISEP programme. Next, Section 3 identifies the problems and strengths of this implementation and Section 4 proposes a set of improvement suggestions for near future implementation. Finally, Section 5, draws the main conclusions.

1 EPS@ISEP

The School of Engineering of the Porto Polytechnic (ISEP/PPorto) became an EPS provider in 2011 and has since welcomed 3rd and 4th year mobility students during

² <http://www.europeanprojectsemester.eu>

the spring semester. EPS@ISEP – the EPS programme provided by ISEP/PPorto – targets engineering, business and product design students and aims to prepare them for their professional life by fostering the autonomous development of scientific, technical, personal and social skills

The EPS@ISEP programme is a 30 European Credit Transfer Units (ECTU) package structured in six modules: 20 ECTU assigned for the project module and 10 ECTU for complementary modules: Project Management and Team Work (2 ECTU), Marketing and Communication (2 ECTU), Foreign Language (2 ECTU), Energy and Sustainable Development (2 ECTU) and Ethics and Deontology (2 ECTU). The latter are project supportive seminars, oriented towards the specificities of each project, focussed on the development of the soft skills essential in the training of twenty-first century engineers: communication (including technical-scientific 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 ecological footprint; ethics and deontology analyses the ethical and deontological concerns; and marketing tackles the market analysis, segmentation and positioning of the prototype [4]. Furthermore, there is also an Arduino crash course to provide students with basic knowledge about this simple control platform. Figure 1 presents the EPS@ISEP schedule and illustrates the concretization of golden rules *viii* and *x*.

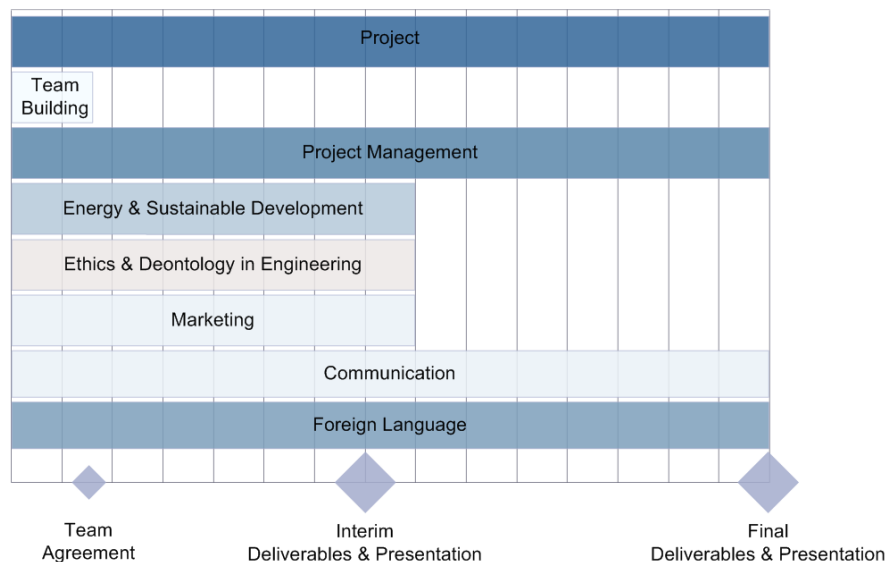


Fig. 1. EPS@ISEP schedule

Before the beginning of the semester, a set of project proposals regarding real world problems are collected, each one with a specific client, with a strong focus on sustainability, to raise the student's awareness to the problem, and in multidisciplinary topics, so each team member can contribute to the project with his/her previous knowledge and background experience. The origin of proposals ranges from industry, services, R&D institutions or the school itself. The proposals tend to be multidisciplinary problems, i.e., require the integration of multiple technical and scientific competences. A proposal defines the problem/challenge to tackle, the minimal set of requirements, mostly mandatory directives and standards, and the maximum budget. This type of proposal directs the team towards the design thinking stages and, then, towards the development and operation stages of the capstone project/internship. As all proposed projects are open ended, team discussions about the possible solutions provide an opportunity for the students to expose their different

beliefs and values, in a multicultural setting. Depending on the complexity of the projects, the average cost of an EPS@ISEP project is approximately 200 €.

Before the start of the semester, each student is asked to fill a Belbin questionnaire, which will be used to identify the individual teamwork profile and design of teams according to rule *ii*. According to the EPS rules, not only the teams must incorporate students from different fields of expertise and nationalities, but team building activities must be offered to allow team members to discover and perceive the existing cultural, scientific and personality differences. One of the first tasks team members are faced with during team building activities (rule *viii*), is to define their own set of conflict resolution rules – Team Work Agreement – using the mechanism proposed by Hansen [5]. The resulting document is signed by all team members and archived in the team folder. Next, the teams select the project of their choice from the list of project proposals available and start their learning journey by conducting studies on marketing, ethics, deontology and sustainability together with scientific research (a state of the art analysis of the problem domain) to decide on the structure design & materials, as well as on the system design & control system.

EPS@ISEP adopts a unique supervision model where a panel of multidisciplinary experts, consisting of teachers from various study fields, acts as a consulting committee (Figure 2). Every week, this panel meets with each team for about 40 min.

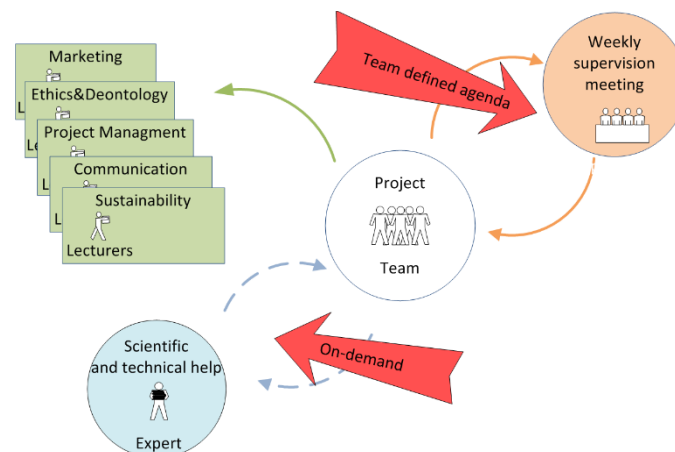


Fig. 2. EPS@ISEP model of student supervision

In the meeting with the panel, the teams conduct the meeting, and only the topics previously specified by the team in the wiki agenda are discussed. In this meeting, the teams are challenged to explain and justify any decisions taken during the previous week (shared in advance on the project wiki) and motivated to explore further. In order to be effective, the coaching panel is aware that it is interacting with students from diverse scientific and cultural backgrounds as well as that it must provide prompt feedback. In addition, the teams hold weekly meetings with their direct project supervisor(s) to promote further brainstorming, debugging, assembling and testing of the project. The teams can take the initiative to propose additional coaching meetings.

Assessment drives learning and hence a good assessment design is the key to effective student development [6]. EPS@ISEP uses the assessment scheme proposed by Hansen [5]. Assessment occurs twice during the semester and contemplates self and peer (S&P) and supervisor assessment (SA). The S&P assessment considers the quality and quantity of the technical contribution, openness to others ideas, teamwork performance, leadership, attitude and initiative shown [7]. The SA assessment reflects both team performance as well as the

individual performance of each student. 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 supervisors use the assessment to monitor team working and to give constructive feedback and advice where needed [7].

The teams must produce several deliverables, including the project wiki, report, video, paper, manual, brochure and a proof of concept prototype. The report structure (provided beforehand) includes as mandatory sections the introduction, state of the art, marketing, sustainability, ethical concerns, project development and conclusions. Some chapters are produced and refined within the corresponding complementary modules. The structure and presentation of the deliverables are addressed in the communication seminar. The wiki is a key tool to the EPS process since it acts as a collaborative work platform and as the project show case.

2 REFLECTION ON EPS@ISEP

Since 2011, EPS@ISEP has welcomed 138 students from 18 countries, as depicted in Figure 3. These participants successfully conducted 28 projects.

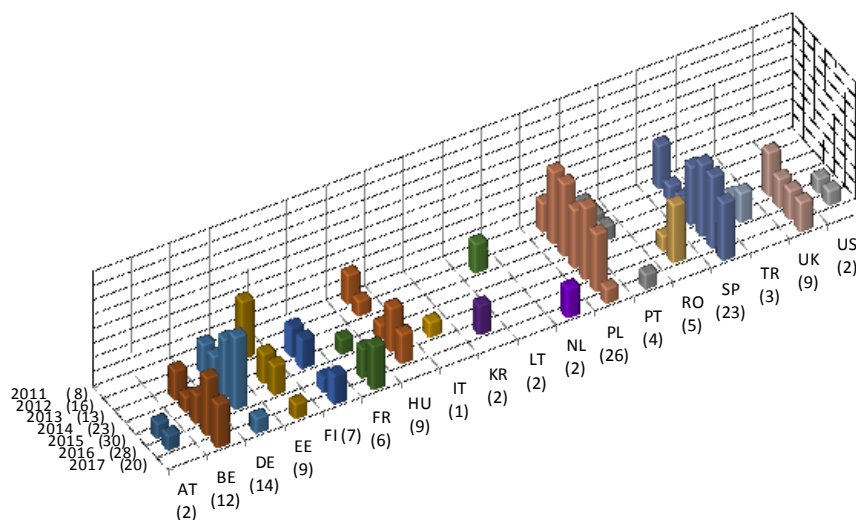


Fig. 3. EPS@ISEP: Number and nationality of students

The scheduled classroom activities involve thirteen teachers from seven ISEP departments and account for a total of 472 h/semester. Dislocated EU students are supported by EU Erasmus+ mobility grants, typically covering one round trip and the accommodation costs. These figures allowed the identification of several strengths, but also weaknesses related with the programme management and costs, the students profile and their motivation and the teaching and support staff.

2.1 Programme Management

Concerning the managerial aspects, the programme involves a 470 h of teaching and a dedicated room is allocated to all activities during the entire semester. However, since this programme implements hands-on practical training, there is the need to use different laboratories, mainly related to the development and construction of the prototypes. Typically, due to the wide range of the problem domains, there is the need to use several laboratories from different departments, e.g., the mechanical, electrical, electronics and chemistry laboratories. This dependency presents problems related with the authorisation and availability.

Another aspect related to this topic is the financing of the projects. While initially the projects were financed by ISEP, nowadays they are financed by sponsors, clients, prizes, organisation of events and the fees of international (non-EU) and free mover students. The materials and components acquisition is a cumbersome process, due to the requirements for public procurement of goods and services in Portugal. The teams participating in the EPS@ISEP provide the supervisors with their list of materials and suppliers. These lists must be thoroughly inspected, to check if the suppliers fulfil the existing acquisition rules, and submitted to the financial department for approval. After authorisation, orders are placed and, typically within a week, the materials are received and delivered to the teams. During this process, teams often suggest suppliers which do not fulfil ISEP's acquisition rules, typically companies operating on the Internet, such as Amazon, eBay or Alibaba, and despite repeated warnings, make non-authorised purchases.

There is also a problem with the grading system. The EPS grading system privileges the process instead of the product, but this presents some drawbacks, since it tends to penalize good, hard-working, students who belong to weak groups, and favour weak, non-working students, participating in strong groups. This aspect has led to situations on which hard-working students feel wronged and lazy students feel lucky. These students, after returning to their home institutions, advertise against and in favour of the programme, respectively, preventing the application of students from these institutions with the desirable profile in subsequent years.

2.2 Student Issues

Regarding the students, there are four main drawbacks: insufficient mastery of the English language, insufficient technical-scientific background knowledge, pending academic activities at home school and wrong motivation for participating in an exchange programme. Although applicants must provide a B2 Common European Framework of Reference for Languages (CEFR) level of English, in some cases their actual level of English is below. The second aspect is related to the fact that some students enrol without sufficient technical-scientific background knowledge. In other cases, they have not yet accomplished the necessary 150 ECTU to enrol in a capstone/internship module and still have pending academic at their home schools. Such activities, *e.g.*, exams, are highly disruptive and involve returning for a few days. This is particularly inconvenient when it occurs in the last months of the semester, a period of heavy workload involving the assembly and test of the prototype and the subsequent preparation of the final deliverables. Finally, there are still students with the wrong motivation to participate in an exchange programme, *i.e.*, focussed on travelling and recreational activities rather than on the personal growth and international multidisciplinary teamwork offered by EPS@ISEP.

To minimise the first problem, all students are asked to send a B2 CEFR level English certificate as part of the application documentation. Regarding the second and third issues, the acceptance letter, sent to the accepted applicants and their home institutions, specifies the programme acceptance rules, stating that students must not have pending activities at their home schools during the spring semester, nor have less than 150 ECTU accomplished at the moment of their arrival. Unfortunately, there are still students and partner schools disregarding these rules.

2.3 Staff Issues

Although the programme involves, on average, around 20 students, thirteen teachers and account for a total of 472 h each semester, there is no support staff to help manage the programme activities. This implies that all bureaucracies inherent to the

programme, as well as student problems must be solved, mainly, by the team of supervisors, which is a time-consuming activity. The only exception is the mobility documentation processed by the International Office.

Concerning the seven project supervisors, it should be mentioned that coaching EPS students is an additional activity involving large amounts of unaccounted time and effort. However, despite this, the team of supervisors has worked together with most teams to publish a project paper on reputed international conferences and, in some cases, even in international journals with peer-reviewing.

Finally, the six project supportive module teachers are from distinct departments and it is, sometimes, difficult to keep the same teachers between editions. Also, some of these teachers are not fully aware of the particularities of the programme and of its objectives, and have some difficulty in organizing and teaching their modules in a way that is fully supportive of the project that the students are developing.

3 IMPROVEMENT SUGGESTIONS

The first improvement suggestion is to allocate a laboratory/room equipped with basic consumption materials, tools (mechanical and electrical/electronic) and equipment. This laboratory should also be equipped with basic machines for wood working since several project prototypes have been developed in wood. Finally, this space should include a technician to support the students during the development of their project prototypes and conduct, whenever necessary, the purchase process.

Regarding the use of the budget allocated to the project, an effort should be made to have most of the project proposals sponsored by companies / institutions outside of ISEP. In these cases, what has been negotiated with the companies is that the acquisitions are performed directly by the team of supervisors, the receipts have the data from the companies, and the expenses are latter directly reimbursed to the people that acquired the materials (teachers or students), without the inherent bureaucracy.

In relation to the EPS grading system, the problem is difficult to tackle since a decision should be made among the providers to change it. Anyway, the supervisors should have the possibility to “bypass” the “regular” grading system under justified circumstances, *i.e.*, whenever they believe any student has been unfairly assessed.

Concerning the problems related to students, it is impossible to assess their motivation, English and technical knowledge before they arrive. This can only be solved with the cooperation of the partner schools. In particular, it is easy to ensure that applicants have accomplished at least 150 ECTU and do not have pending exams. In addition, this should be discussed and agreed among the providers.

Finally, internally, an effort should be made to consider the actual number of teaching hours involved in the coaching of EPS students and the departments should assign teachers motivated to foster multidisciplinary project-based learning.

The authors recognize that some of these ideas are difficult to implement, but must be considered if the programme is to be improved.

4 SUMMARY AND ACKNOWLEDGEMENTS

The EPS student-centred learning process is based on promoting the autonomy and responsibility in the teams, adopting technical and scientific coaching and offering project supportive and soft skills complementary modules. This process drives the teams to design and develop a concrete prototype and produce multiple deliverables,

while learning to manage the project, to study the state of the art in the different fields of the project, to create a marketing plan, to work together and to justify all design, materials and development decisions based on the analysis of the sustainability, ethics, scientific and technological aspects. However, the objective of this programme is more ambitious than just expecting the students to implement prototypes – it is also to make them contribute with their distinct visions of the problem to a common consensual solution. This process is not always easy, since at this educational level the students are not used to collaborate with peers from different nationalities (implying distinct cultural backgrounds) and from different study backgrounds (engineering students tend to think differently from business and product design students). Given these ideas, this paper described the EPS program, reflects on its implementation at ISEP and proposes improvement suggestions regarding the EPS@ISEP implementation.

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