

Boosting professional competences and IT companies' innovation in a Master Degree in Informatics Engineering

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Abstract—This Innovative Practice Category Work In Progress presents a singular experience of a cooperative education program in a Master Degree in Informatics Engineering in Spain, which is so far unique in the country at master level. This Master provides the students with the competences, attitudes and skills necessary to direct and carry out innovating projects in the area of information technology and communication in national and international companies. The usage of Problem Based Learning methodologies in different courses infers a decidedly practical-oriented nature to the program. This character has been reinforced introducing the co-op model, which involves companies in the overall learning process. The program started in 2015 and the first results are showing very encouraging in terms of students' satisfaction with their education and the high competence level of these students from the companies' perspective.

Index Terms—Cooperative education, Work integrated learning, Employability, Professional competences

I. WORK DESCRIPTION

Since Herman Schneider launched the first cooperative education program [1] for engineering at the University of Cincinnati in 1906, the number of programs offered in this model have been growing worldwide but not in a uniform way. While it is well extended in countries like the USA, Canada, Australia or New Zealand, it is less common in many European countries with some remarkable exceptions like the *alternance model* in France [2] or the case of the DHBW¹ in the state of Baden-Württemberg in Germany [3]. The interest for co-op education in Europe has been growing during the last two decades and new experiences have emerged in different countries. In Spain, there are only isolated experiences in co-op programs like the one of the Machine Tool Institute in the Basque Country [4], at bachelor level. The interest for starting new co-op programs is growing and other experiences are now starting. This work presents a singular experience of a co-op master degree in informatics engineering in Spain.

Co-op education has become a strategic model for improving the acquisition of skills and competences, as well as the employability of the graduates [5], [6]. Starting from the

very basic concept of co-op education model where work experience is integrated into the curriculum for a significant experiential learning, the implementation was preceded by an effort for adapting this idea to the idiosyncrasy of our environment, that is, to our legal framework, labor legislation, corporate culture and students' culture. At the same time, there has been an adaptation of the academic staff for a proper implementation of the model. For instance, the evaluation of the students has been redesigned to a competencies based assessment.

One of the mainstays of the model lies on defining proper training projects and work periods for students [7] in companies so that they can guarantee the achievement of the competencies of the degree. The tutor in the company is responsible for the students education and monitoring within the company, providing appropriate support to their work and taking part in the assessment of the competencies achieved. This work is done in close collaboration between the company and the academic tutor.

Among other difficulties, we had to overcome the lack of culture in our environment for hiring as a worker somebody who is still in a learning process. After three years of close collaboration, the perception of the companies at this point has completely changed and the advantages are worth the efforts invested in the project. In particular, co-op students are helping companies in their innovation processes and in some cases the work of the student in the company has evolved towards an industrial PhD project.

The aim of this work-in-progress paper is presenting the development of the implementation of the cooperative education system in the master, as well as report first results from the feedback provided by students and tutors, based on their experience.

II. CO-OP METHODOLOGY IN THE MASTER DEGREE: PLANIFICATION, IMPLEMENTATION AND CHALLENGES

II-A. Program description

Spanish legislation on higher education establishes particular regulations for those programs directly related with the access to the professional practice. The Master Degree in Informatics is designed following these regulations [8], which fix specific competences and workload. Although

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these aspects limit any possible implementation, the program has been properly designed in order to allow coexistence among ordinary and co-op based systems.

This is a three-semester Master Degree program that is structured in 90 ECTS², from which 54 ECTS cover compulsory courses in Management and Information Technologies and 24 ECTS are taken from specialization modules: *Big Data Analytics and Video-game Development*.

As pedagogical approach, the program is focused on the Project Based Learning paradigm [9], centered on design and development of real-world projects. As a step further in this direction, in 2015 a new specialization module was included in the program, named *Enterprise Integrated Projects*, devoted to drive the co-op program.

The overall design and implementation of this master program has been accredited with the "Seal of Excellence" by the national Quality Agency³ and it has also been awarded with the Euro-Inf Quality Label, which identifies high quality informatics and computer science degree programmes in Europe and abroad.

II-B. Implementation and organization

The life-cycle of the co-op methodology [10] covers two main stages: seeking appropriate job positions and assignment to candidates and, secondly, properly planning guidance and evaluation steps during the learning period in the company.

Procedure for Searching and Assigning New Job Positions: The proposed procedure is composed of the following six different stages:

1. *Collection of vacancies (February-March):* Companies define their job vacancies, including an enterprise description, tasks to develop, student profile, work timetable and annual gross remuneration. The offers are reviewed from an ad-hoc commission, to validate its adaption to the program competences and skills.
2. *Promotion of the vacancies (April):* Selected offers are published on the web page of the master program and sent to our international partner universities to attract the attention of their potentially interested students.
3. *Collection of the students' applications (May):* Students send to the coordinator a priority list of their preferences. When the given deadline has expired, each company receives those applications addressed to them.
4. *Selection of the candidates by companies (June-July):* The companies analyze the received applications and conducts the selection process. In case that one student was selected for more than one company, he/she chooses the vacancy that best suits his/her preferences.
5. *Global meeting between Academic Tutors and Company Tutors (September):* Two different tutors are assigned to each student: Academic Tutor (AT) at the university and Company Tutor (CT) at the company.

All the academic and enterprise tutors involved in the program attend the kick-off meeting, in order to get to know each other and clarify the overall procedure.

6. *Definition and beginning of the training period for each student (September-October):* Students begin their training plan usually during the last two weeks of September. During these two weeks, a first meeting with the student and his/her both tutors is arranged, in order to define skills and activities to be carried out during the first semester.

Procedure for Student Guidance: The student guidance and monitoring is carried out by means of a portfolio, which is integrated in the Virtual Campus. This tool has been designed using as a basis the portfolio described in a previous work [11].

The portfolio establishes a minimum number of meetings to be held throughout the three semesters involving the different actors (AT: Academic Tutor, CT: Company Tutor and ST: Student), as described in Table I. As we can see, there are a minimum of two planned meetings for each semester, the first one to define the competences and activities to develop throughout the semester and the second one to assess the work carried out during the semester. In addition, there is a meeting during the second semester, named *MEINF Dual Meeting*, where each student shares his/her experience with their classmates, so they gain a global vision of the IT sector.

In the last meeting, there is a global assessment of the learning period. This assessment reflects the acquisition of the program competencies as well as achievement of professional skills (pro-activity participation, motivation, efficiency, responsibility and communication).

II-C. Challenges for the companies

Beyond the academic design of the co-op methodology, several external difficulties have arisen. These challenges cover those aspects that companies have to deal with in order to achieve a successful incorporation of the apprentice in their projects. After three years of experience in this model, companies have been able to adjust their internal procedures to accomplish a suitable fitting. The main issues to be faced are sketched below.

Economic aspects:

- The tutors of the companies must invest a part of their time to supervise and tutorize students.
- Companies hire co-op students as full-time workers, although they are half of the workday at the company and the second half they attend lectures at university. However, his/her remuneration will be for a full-time job.

Legal aspects:

- Within the Spanish legislative framework, there is not a particular type of contract specifically designed for co-op students. This problem is especially important for international students because they do not have a work visa and they require a special authorization from the administration, which sometimes may be denied.

²ECTS: European Credit Transfer System

³AQU Catalunya, <http://www.aqu.cat>

TABLE I
MEETINGS SCHEDULED THROUGHOUT THE LEARNING PERIOD

Meeting	Actors	Aims	Dates
1st Meeting	CT/AT/ST	- Discuss about integration of the student in the company - Define the competences and skills and the related activities to develop during the first semester.	October
2nd Meeting	CT/AT/ST	- Review the activities developed during the first semester. - Assess the achievement level of each competence/skill.	February
3rd Meeting	CT/AT/ST	- Define the competences and skills and the related activities to develop during the second semester.	March
MEINF Dual Meeting	ATs/STs	- Share the experiences of students involved in the co-op program. - Show the co-op program to students at the last year of bachelor .	May
4th Meeting	CT/AT/ST	- Review the activities developed during the second semester - Assess the achievement level of each competence/skill.	July
5th Meeting	CT/AT/ST	- Define the competences and skills and the related activities to develop during the third semester.	October
Final Assessment Meeting	CT/AT/ST	- Review the activities developed during the third semester. - Assess the learning level of each competence/skill during the semester. - Global assessment taking into account the overall learning period.	February

TABLE II
STUDENTS SURVEY AND PERCENTAGE OF ANSWERS

Questions	1	2	3	4	5
Related to the Academic Tutor					
The academic tutor shows interest in the tutorial action	0 %	0 %	14 %	43 %	43 %
Creates a climate of dialogue, trust and work	0 %	0 %	0 %	51 %	39 %
The follow-up of my experiences by the academic tutor has been adequate	0 %	0 %	8 %	53 %	39 %
I consider that the academic tutor is a good tutor	0 %	0 %	0 %	47 %	53 %
Related to the Company Tutor					
The Company Tutor has been concerned about the objectives of the training program	0 %	7 %	23 %	31 %	39 %
The Company Tutor has created the most favorable conditions to practice the most relevant skills in the professional environment	0 %	0 %	16 %	38 %	46 %
Related to the Organization					
There is coordination between the academic and company tutor	0 %	0 %	31 %	23 %	46 %
The work plan agreed upon at the beginning has been followed completely	0 %	0 %	39 %	46 %	15 %
The evaluation procedure is appropriate	0 %	0 %	15 %	70 %	15 %
Related to the Company					
The activity is related to my training	0 %	8 %	46 %	30 %	16 %
The welcome to the company was correct	0 %	0 %	0 %	54 %	46 %
Related to Learning					
I have been able to practice professional skills in real situations	0 %	0 %	8 %	61 %	31 %
I have acquired the competences provided in the co-op education program	0 %	15 %	15 %	55 %	15 %
I have been able to respond to the actions that have been proposed to me	0 %	0 %	15 %	45 %	40 %

1: Strongly Disagree; 2: Disagree; 3: Neither Agree/Nor Disagree; 4: Agree; 5: Strongly Agree

TABLE III
COMPANY TUTOR SURVEY AND PERCENTAGE OF ANSWERS

Questions	1	2	3	4	5
Related to the Co-op Education Program					
The contacts with the university have been sufficient for the organization of the co-op education in the company	0 %	0 %	0 %	60 %	40 %
The design of the training program (skills, objectives, activities) is adequate and realistic	0 %	0 %	20 %	60 %	20 %
The evaluation procedure is appropriate	0 %	0 %	20 %	60 %	20 %
The periods and time distribution between university and company is adequate	0 %	0 %	0 %	60 %	40 %
Related to Students					
The presence of the student in the workplace is positive for the development of the professional activity of the company	0 %	0 %	0 %	20 %	80 %
I consider that the way these practices are organized, offer a good chance of professional learning to students	0 %	0 %	0 %	40 %	60 %
Previous student training has been adequate for the development of the training program	0 %	0 %	20 %	40 %	40 %
Students have shown availability for learning	0 %	0 %	0 %	0 %	100 %
The students have achieved the objectives that are posed in the training program	0 %	0 %	0 %	0 %	100 %

1: Strongly Disagree; 2: Disagree; 3: Neither Agree/Nor Disagree; 4: Agree; 5: Strongly Agree

- The intellectual property of the results that may arise during the co-op training will be shared among the company and the student. A specific agreement establishes general rules concerning these aspects in order to avoid possible conflicts.
- Companies provide confidential information to the university as evidence of the student's learning process. The custody of this information generates concerns to the companies, so the university must offer guarantees through confidentiality agreements, which might be as exhaustive as possible.

Organizational aspects:

- Timing and deadlines of the selection process driven by the company's human resources area are conditioned by the academic calendar.
- The company must incorporate the dual student as any other worker, although he/she will have several advantages over the rest of the workforce. This advantages can generate tensions and comparative grievances to others workers of the company.
- The co-op education students participate in project development tasks which, in certain cases, forces the company to redefine their work organization processes.

Environmental aspects:

- Companies are reluctant to allow people outside the organization (such as Academic Tutors) to access to detailed information on their products, production processes, personnel policy or quality.
- Companies are used to consider the technical aspects of training but feel insecure when they have to handle with pedagogical aspects. They are not accustomed to planning in terms of competences, academic monitoring or numerical qualification. In this sense, the role of the academic tutor is crucial in order to plan the learning process of the student in the company.
- Some companies have the perception that universities are excessively theoretical and are far from their reality. This, in some cases, generates barriers of communication between companies to the university, and vice-versa.

III. RESULTS AND DISCUSSION

The experimental approach is based on evaluative research as a case study focused on the students enrolled to the master during the last three years [12], [13]. Two surveys have been designed and conducted in order to obtain feedback from students and company tutors (see tables II and III), and have been completed by 25 students and 10 tutors.

The analysis of results reveals that majority of students has a very good perception of the co-op program (Figure 1). On average, the most positive aspect is related to the academic tutor and the student's feelings in relation to their learning experience. Besides, the two worst aspects refer to the accomplishment of the working plan and also the fitting between the company activity with his/her academic training. In addition, it is worth pointing out that none of the questions

was assessed with a negative answer (Strongly Disagree or Disagree). The second survey reveals that Company Tutors' opinion (Figure 2) is more favorable than the students' one, highlighting the achievement of 100 % of *Strongly Agrees* to the questions related to the availability of the students and the accomplishment of the aims during the training period.

The MEINF Dual Meeting and the Final Assessment Meeting (Table I) provide valuable feedback both from students and tutors. In terms of satisfaction of students, most of them claim that they would have studied again under the co-op model, even though it implies a greater workload for them. All the students that have finished the degree have received a job offer in the same company. Besides, companies perceive how the progression throughout the training process enhances students' competences and skills. At the same time, co-op students boost companies in their innovation processes. Finally, confidence between companies and the university has improved and both feel part of a common project.

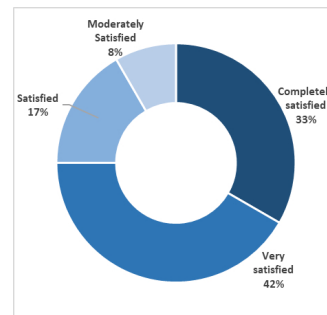


Fig. 1. ST Global Satisfaction

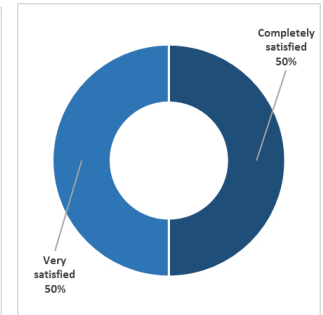


Fig. 2. CT Global Satisfaction

IV. CONCLUDING REMARKS AND FUTURE WORK

During the last three years a co-op education system has been deployed in a Master Degree in Information Engineering. Implementation and organization aspects have been tuned over this period in order to achieve an efficient and manageable procedure fitting the needs and rhythms of students, companies and academia.

Students acquire a comprehensive education, not solely based on technical aspects but also acquiring professional expertise, cross-skills development and personal growth. Companies highlight the learning capacity of students, whose activity is highly aligned with the enterprise objectives and their contributions to their workplace are positively perceived. From the academia point of view, the co-op program enriches students' education, strengthens the relationships with companies and boosts knowledge transfer.

Although many challenges must be overcome to deploy the co-op educational methodology [14] the benefits are many and worthy from all perspectives. In fact, this experience can be easily extended to other engineering studies, both at bachelor and master level. Indeed, we are currently working on applying this model to a master program in Industrial Engineering and also to a bachelor in Building Engineering.

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