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BRIDGING THE GAP BETWEEN HIGHER EDUCATION INSTITUTIONS AND COMPANIES. THE HEIBUS COOPERATION MODELS

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Abstract

Currently, Higher Education Institutions (HEIs) and companies around the world are experiencing a renewed interest in strengthening their forms of cooperation. There are many benefits to be gained by boosting this partnership. Employment opportunities, exchange of knowledge and the development of new teaching and learning methodologies are direct advantages for all those involved in this cooperation. This paper presents an overview of the existing cooperation models between different actors: HEIs student-company and HEIs expert-company. In addition, models where companies are directly involved in HEI education are also searched and analysed. It is to be noted that this work is framed within the context of the Smart HEI-Business collaboration for skills and competitiveness (HEIBus) project. The HEIBus is an Erasmus + Knowledge Alliances 2 (KA2) project with a budget of about one million euros and a duration of 36 months. Five European universities and seven companies with strong expertise and experience in different fields are taking part in this project. HEIBus focuses on strengthening the collaboration between HEIs and companies by creating new innovative cooperation models. These models are also detailed in this work.

Keywords: University-Business cooperation, innovation, multidisciplinary.

1 INTRODUCTION

Many forms of cooperation are possible between Higher Education Institutions (HEIs) and companies. At HEIs both the students and the university staff (HEI expert) may interact with companies at different levels of involvement. Companies may also be involved in HEIs education. It is therefore logical to assume that the quality and efficiency of education improves by matching the learned skills with the requirements of working life [1]. On the basis of the above and considering the interaction between the different actors, three ways of cooperation can be defined as follows: HEIs students-company, HEIs expert-company and company involvement in education.

The first way of cooperation includes those mechanisms offered by HEIs to provide students with the opportunity to gain work experience in their field before completing their studies. These forms of cooperation are included in the generic concept of Work Integrated Learning (WIL) [2]. According to the definition adopted by the Higher Education Quality Council of Ontario [3], WIL is the process through which students come to learn from experiences in educational and practice settings. The most widespread types of WIL are: cooperative education (also known as Dual System), internship, apprenticeship, field experience, mandatory professional practice, applied research learning and service learning [4].

The second way of cooperation include all types of direct and indirect, personal and non-personal interaction between employees from both the company and the university, with the aim of exchanging knowledge within innovation processes [5]. Scharfetter et al. in [6] define them as “knowledge interaction”, identifying the following four categories: joint research, contract research, mobility, and training. Cohen et al. consider them the “channels” that contribute to improving industrial innovation in [7] and Perkmann & Walsh in [8] treat them as “links”.

The third way of cooperation deals with the involvement of companies in the education at HEIs. Important concepts such as Early Organizational Involvement (EOI), Recognition of Prior Learning (RPL), Work Related Learning (WRL) are frequently mentioned in the literature [9], [10]. EOI and RPL are similar terms that encourage higher education and industry to collaborate and become involved in the early stages of the student’s professional development to best prepare students for the transition

from classroom to the work environment [11], [12]. WRL programmes prepare students and manage their expectations for the workplace [13].

There are also new approaches that contribute to new teaching, learning and mentoring models in the previously described ways of cooperation. One example is the Smart HEI-Business collaboration for skills and competitiveness (HEIBus) project [14]. Basically, the HEIBus project develops and implements new ways of cooperation, including virtual implementations, for the mutual benefit of HEIs and companies [15]. The HEIBus provides innovative models for each of the previous ways of cooperation. For the first way of cooperation a particular type of Project Based Learning (PBL) has been developed. It is known as multidisciplinary Real Life Solving Problem (RLSP). In the case of the second way of cooperation a similar model as RLSP is implemented but on this occasion the problem is solved by HEIs expert. That is why this second model has been termed as EXPERT level real life solving problem (EXPERT). Finally, for the third way of cooperation a set of methods to involve companies in the education at HEIs is being implemented. These methods are divided at different levels, depending on the amount of involvement needed from the company and known as Flexible student Mentoring by companies (Flex Mentoring).

The rest of the paper is organised as follows. Section 2 details the methodology followed for the selection of the best models in each of the three cooperation ways considered. Section 3 presents an analysis of the models of cooperation, including a description of the HEIBus models. Finally, the conclusions are drawn in Section 4.

2 METHODOLOGY

The methodology shown in Figure 1 was implemented with the aim to identify and analyze the existing cooperation models providing real life experiences between HEIs and companies. As can be seen, the analysis of HEIs and companies cooperation models follow the same procedure (Figure 1a) with the exception of the analysis of company involvement in HEI education (Figure 1b). For the first two analyses, an intensive review of existing models where students were directly involved in cooperation with companies, first case, and HEI experts and companies cooperate together, second case, was done. Then at least ten good models were found and the best five were selected for a deeper analysis. For the third analysis, different levels of company involvement in education at HEIs were searched and detailed. The following sub sections describe these methodologies.

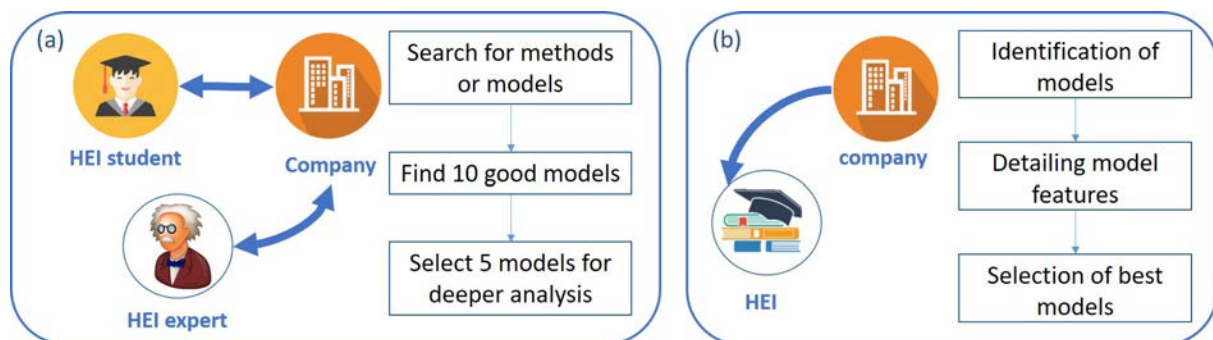


Figure 1. Methodologies to identify the best existing models of HEI-company cooperation. (a) Interaction between HEI student and HEI expert with company; (b) Company involvement in HEI education.

2.1 Analysis of HEIs Student-Company cooperation models

In the endeavour to find ten successful cooperation models, four categories are defined. These categories are based on two of the most widespread types of WIL: cooperative education and internship. In a nutshell, cooperative education (co-op) is a structured method of combining classroom-based education with practical work experience while internship is an experience involving student's working in their expected career field.

Hence, models where cooperation follows a cooperative education and the students have the possibility of working in several companies, fall into the first category, *basic co-op educational models*. The second category, *company specific co-op educational model*, comprises co-op models in which the student does the training in one company. The third category, *internship company model*, includes those models in which students are hired by the university and acquire work experience in one or

several companies. In addition, models within this category solve problems demanded by the company that will be utilized in the short term, or work in a specific task.

Finally, the fourth category, *internship research model*, comprises cooperation models considered as an internship, but the result of this cooperation will be applied in the long term. Here, students are hired by a HEI research group, or a university spin-off and take part in a project, which outcomes will be utilized by the company in the long-term.

Table 1 summarizes the main features of these models and where are they applied. In order to select the five best good models (highlighted in the Table 1) two main features has been considered: internationalization and accreditation. Internationalization is when the model has any type of interaction with institutions or companies located in different countries and accreditation assures the quality of the model.

Table 1. Models and main features.

Model	Category	Followed by	Main features
M1	Basic co-op	European universities whose programs have been certified by an agency of association	<p>Educational purpose: integration of theory and practice; career exploration and development; progressive skill acquisition; professional socialization; workplace literacy; workforce readiness</p> <p>Duration: Work terms are normally one semester (4 months) but may be consecutive; minimum 3-6 work terms required for co-op designation</p> <p>Compulsory/Optional: Both</p> <p>Paid /no Paid: Companies paid student a salary/scholarship</p> <p>Role of student: Full-time employee engaged in productive work</p> <p>Role of employer: Supervision, evaluation</p> <p>Role of institution: Set learning objectives and approve host site; assist with student selection; monitoring and assessment</p>
M2	Basic co-op	European universities whose programs have not been certified	
M3	Basic co-op	Canadian or USA universities whose programs have not been certified	
M4	Basic co-op	USA or Canadians universities whose programs have been certified by an agency of association	
M5	Company Specific co-op	European or Canadian or USA universities with cooperation programs with companies located in their geographical region	
M6	Company Specific co-op	European companies with a certified cooperation program with universities from another geographical region	
M7	Company Specific co-op	USA or Canadian companies with cooperation programs with European universities	
M8	Internship Company	HEIs with internships with companies located in the same geographical region.	
M9	Internship Company	HEIs with internships with companies located in different geographical regions.	
M10	Internship Research	HEIs with internships in which students cooperate in research projects.	

2.2 Analysis of HEIs Expert-Company cooperation models

Based on an intensive review of models where HEIs experts and companies cooperate together [5]-[8], the ten models shown in Table 2 have been chosen as good models. The selection has been

based on how easy is to quantify the effect of the cooperation. The potential indicators that have led the quantitative assessment of the models are also presented in Table 2.

Table 2. HEI expert-company cooperation models with potential indicators.

Model	Description	HEI expert indicators	Company indicators
M1 Research collaborative projects	Short-term and Long-term R&D collaborative projects, considering regional, national, or international research projects, financed by public or private funds		
M2. Innovation collaborative contracts	Research contracts that aim at developing innovative activities in companies	<ul style="list-style-type: none"> • Number of patents • Number of papers conferences workshops 	
M3 Spin off - entrepreneurship	Companies founded by the university staff, developed because of the research, and teaching activities and partially financed with public funds, and whose exploitation has the university institution some rights recognized by the legal framework	<ul style="list-style-type: none"> • Number of new spin-off • Specific formation seminars • Novel techniques implemented in industry 	<ul style="list-style-type: none"> • Reduction of time in the engineering process
M4 Seminars and workshops taught by company members	Taught by company members, with the target of improving the expertise of academic staff	<ul style="list-style-type: none"> • Number of student enrolled in courses, internships and diploma projects related with the cooperation 	<ul style="list-style-type: none"> • Number of patents • Resignation rates • Growth rate • Seminars/courses
M5 Seminars and workshops taught by HEI experts	Taught by HEI experts, with the target of improving scientific knowledge of company members	<ul style="list-style-type: none"> • Number of R&D contracts • Application for joint company-HEI expert R&D projects 	<ul style="list-style-type: none"> • Application for joint company-HEI expert R&D projects
M6 Joint supervision of students	Ph.D., masters and graduate theses, internships, etc.	<ul style="list-style-type: none"> • Number of Royalties 	<ul style="list-style-type: none"> • Number of industrial PhDs
M7 Consultancy and engineering services	Product tests, projects review, projects management, and use of university facilities by companies	<ul style="list-style-type: none"> • Number of contracts regarding to: product tests, projects review, projects management, and use of university facilities by companies 	
M8 Personnel exchanges	Mobility of researchers between universities and companies		
M9 Joint spread of knowledge	Spread of knowledge either democratized (i.e. spread of knowledge amongst the common people) or privileged (i.e. spread of knowledge amongst elites such as academics)		
M10 Philanthropic contributions by companies to HEI experts	Grants offered to HEI Experts by private companies, which support academic staff research and training		

These pre-selected models should be classified in order to obtain the five best models. Due to several selection criteria have to be considered and also ten candidate models are available, a multi-criteria selection procedure should be applied. A well-known multi-criteria procedure, widely applied in different selection problems, is the Analytical Hierarchy Process (AHP) described by Satty [16]. Regarding to our ranking problem, the AHP has been applied considering three criteria: information availability, cooperation benefits and management issues. According to AHP the best five models (highlighted in Table 2) ordered by global weights are: research collaborative projects, consultancy

and engineering services, seminar and workshops (models 4 and 5 are blended in an unique model), collaborative innovation and joint spread of knowledge.

2.3 Analysis of how the companies are involved in HEIs education

Different involvement actions of companies in HEIs education were categorized and analysed. Table 3 shows the different categories, their features, the good models on each of the categories and the level of involvement for companies. In this case, an example of models with different level of involvement have been chosen for a deep analysis.

Table 3. Categories and models of how companies are involved in HEIs education.

Model	Category	Main Features	Involvement level for companies
M1. Industrial advisory boards (IAB)	C1. Development of new educational programs or the revision of existing ones	<p>Educational purposes. Curriculum development and strategies to promote industrial engagement; rational goals and open system; human relations; internal processes; accreditation; integration of theory and practice in a current work placement; progressive skill acquisition.</p> <p>Role of company. <u>Advisor</u> (new courses proposed; master thesis advice; companies provide definitions for students' research projects). <u>Supervisor</u> in work placements; board membership consisting of a strong base of experienced.</p> <p>Role of HEIs. To set learning objectives and approve host site; assist with student selection; monitoring and assessment.</p> <p>Company incentives. Opportunity for companies to access expertise in the HEIs</p> <p>HEIs incentives. Strong leadership by managers who believed in the advisory board process</p>	HIGH
M2. Dual vocational education training			HIGH
M3. Visiting professors	C2. Teaching and learning processes	<p>Educational purposes. Integration of theory and practice; personal development; career exploration and development; professional socialization.</p> <p>Role of company. Supervision, evaluation</p> <p>Role of HEIs. To set learning objectives and approve host site; assist with student selection; monitoring and assessment.</p> <p>Company incentives. To access to a highly skilled workforce and cutting-edge academic research.</p> <p>HEIs incentives. To establish long-term sustainable collaborations with business; to help build awareness of the added-value that university research can bring to industry and society at large; to help to improve recognition of the PhD qualification; to make sure doctoral students are well informed about all career opportunities</p>	MEDIUM
M4. Summer schools			LOW-MEDIUM
M5 PhD Programs (company oriented)			MEDIUM-HIGH
M6. Career fairs	C3. Transfer between studies and work life	<p>Educational purposes. To develop cross-cutting skills such as drawing-up CVs, one-to-one interview, good team-working skills and flexibility; to increase social skills; to increase capabilities to transfer know-how on practical knowledge to local partners.</p>	MEDIUM
M7. Industrial mentoring programs			HIGH

<p>M8 Competitions and awards</p>		<p>Role of company. Mentoring; supervision; evaluation. Role of HEIs. Set host site; assist with student selection; monitoring and assessment. Company incentives. To access to a skilled workforce. HEIs incentives. To establish short and medium-term sustainable collaborations with business; to help build awareness of the added-value that university research can bring to industry and society at large</p>	<p>MEDIUM-HIGH</p>
<p>M9. Students' grants/scholarships</p>	<p>C4. Sponsorship initiatives by companies</p>	<p>Educational purposes. Foster student's skills under the strategic lines of the companies and proximity approach between R&D lines of the HEI and companies. Role of company. Funders. Role of HEIs. Manager of the facilities. Company incentives. To access to a skilled workforce. HEIs incentives. Availability of funding resources.</p>	<p>LOW-MEDIUM</p>
<p>M10. Sponsorship of Joint Laboratories at HEI</p>			<p>MEDIUM-HIGH</p>

3 RESULTS

This section presents an in-depth analysis of the selected models (highlighted in Tables 1, 2 and 3) in each of the three cooperation ways studied in this work. Then, the HEIBus cooperation models are briefly described. A detailed analysis of HEIBus models can be found in [14], [15].

3.1 Best practices of HEI-company cooperation

The methodology described in Figure 1 served as basis to obtain five good models of best practices of HEI-company cooperation. Main features of these models are described in the next sub-sections.

3.1.1 HEIs student-company

The first two models (M1 and M4) were within the category basic co-op. The first one was followed by European universities while the second one was a common practice for USA and Canadian universities. Both models shared the following issues:

- Mainly followed by public universities.
- Several semesters of duration.
- Compulsory.
- Students receive a regular compensation.
- During the work placement, a company representative is responsible for the day-to-day supervision. There is a HEI tutor responsible for the general coordination of the work placements.
- The program has partner companies involved that offer work placement opportunities.
- The company is involved throughout the formative period.

Model 6 was within the category company specific co-op. It shares some of the former issues but with a few exceptions. For instance, public universities act as partners but the model is promoted by the private sector.

Finally, M9 and M10 were within the categories internship company and internship research, respectively. Common features in both models are:

- Mainly followed by public universities.

- The students receive a scholarship, so they are not directly paid by the companies. However, there is a possibility for the companies to compensate additional expenses incurred by the students.
- Several options for the internship duration but normally it ranges from 9 to 18 months, depending on the specific program.

The main difference between both models is that there is no company tutor in M10, all the coordination and supervision is performed by the HEI tutor.

3.1.2 *HEIs expert-company*

The best five models highlighted in Table 2 were: research collaborative projects, consultancy and engineering services, seminar and workshops, collaborative innovation and joint spread of knowledge. Main features of these models are detailed hereafter.

- Research collaborative projects. The main goal of this cooperation model is generating knowledge, sometimes even without a predefined thematic scope or any orientation. Most of these projects are publically funded through research grants (also through private sources), being their relevance one of the main characteristic features. As a consequence, these kinds of projects are conducted by young researchers with promising scientific paths, or research groups with a solid background. An important outcome of these collaborative projects may be the opportunities for joint publications, which constitute the most important channel for the dissemination of scientific knowledge.
- Consultancy and engineering services. This cooperation model is one of the most common and important instruments by which HEI experts can incorporate their academic knowledge and expertise to external organisations, such as private companies, public sector entities, or even the government. Often, this HEI expert-firm interaction is supported by the Technology Transfer Office (TTO), which is an organizational entity that most Universities incorporate to their organization.
- Seminar and workshops. Instruction tools, such as seminars and workshops, contribute to life-long education and to improve the scientific knowledge of company members and the expertise of academic staff. On the one hand, HEI experts should be up to date of the real engineering problems addressed by the companies. On the other hand, scientific knowledge can foster the innovation in companies. Seminars and workshops can be formal activities within the framework of an official agreement between university and company, or informal presentations and meetings.
- Collaborative innovation. This model involves a contract between a company and a HEI, in which a research group or expert belonging to a HEI are requested for the realization of a scientific or technical work in return for a specific financial consideration (managed by the TTO). The transfer of technology, technology or works involved are usually aimed at obtaining a commercial performance of the knowledge. These collaborative models present restrictions regarding the dissemination of results, regulated by non-disclosure agreements, which sometimes are protected as licensed patents. In addition, they constitute a major collaborative relationship in highly industrialized regions, thus, being an important source of incomes for the HEI.
- Joint spread of knowledge. This is a form of collaboration where at least one university researcher and one industrial researcher cooperate, and where it is assumed that there are strong bi-directional flows of knowledge over a limited period of time because it is based on close and face-to-face contacts. This collaboration is characterized by having some degree of formalisation (or some formal output).

3.1.3 *Company involvement in HEIs education*

Models having a different level of involvement for companies has been chosen in this way of cooperation. Hence, industrial advisory board, industrial mentoring and sponsorship of joint laboratories at HEIs are within a high or medium-high level of cooperation. Companies and HEIs incentives are expected to be higher with these models. It is easier to access expertise in the HEIs and skilled work force for companies. In the case of HEIs, they may establish agreements with relevant industrial sector companies.

Finally, with a medium or low-medium level of involvement two additional models have been chosen: visiting professors and summer schools. Here, mentoring students, running activities such as industrial visits or proposing and supervising undergraduate projects are included in these models of involvement.

3.2 The HEIBus models

The HEIBus project develops its own specific models for each of the former ways of cooperation. Following sub-sections present a brief overview of these models. A detailed description can be found in [14] and [15].

3.2.1 Real Life Problem Solving (RLSP)

The idea of this model is that students from different study programs and nationalities form three mixed groups in order to solve a real-life problem that is proposed by a company. Figure 2 shows a diagram of the RLSP model.

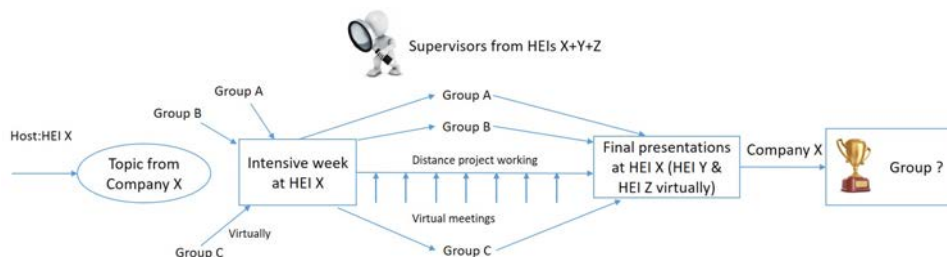


Figure 2. RLPS model.

The project starts with an intensive week, hosted by the university which company partner offered the topic. During this week, two of the groups have face-to-face meetings while the third group has them in a virtual way. Then, all of them work virtually and at the end of the semester, the company tutors select a winning solution.

3.2.2 EXPERT Level Real Life Problem Solving (EXPERT)

In the EXPERT model, a company bring a more complex problem than the proposed in the RLSP that has to be solved by a group of international and multidisciplinary experts. It also starts with an intensive week, hosted by the university which company partner offered the topic. Then, during several months, the experts work in a virtual way and develop a final prototype for the company. The feedback analysis of the implemented EXPERT projects show that this model promotes innovation and knowledge transfer between HEIs and companies as well as increases the skills of the HEI experts and the working life relevance of education.

3.2.3 Flex Mentoring

The HEIBus project tests flexible ways to involve companies in the education process of students. Flexibility comes from the different levels of involvement. The most common activities so far developed by the HEIs partners and companies have been: tailored lectures given by company representatives, dedicated courses by companies, company visits/practices activities, the development of bachelor projects, BSc, MSc, PhD students' supervision and workshops/seminars, where the students will meet with company representatives.

4 CONCLUSIONS

This work presents and analyses different ways of cooperation between HEIs and companies. It also describes the models of cooperation developed and implemented in the Smart HEI-Business collaboration for skills and competitiveness (HEIBus) project.

Once analysed best practices of HEIs and companies cooperation, it can be concluded that the HEIBus project follows innovative models for HEI student-company and HEI expert-company cooperation. Features such as: multilingual, multidisciplinary, virtual team work, performance evaluated by the company are included, all together, in the HEIBus models. The feedback for the first

implementations has been positive and also an effective way of strengthening the collaboration among all the partners (HEIs and companies) included in the project.

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