Author(s): Kakko, Anneli

Title: Smart collaboration for skills and competitiveness in engineering education

Please cite the original version:

Kakko, A. (2019). Smart collaboration for skills and competitiveness in engineering education. In V.N. Balázs, M. Murphy, H-M. Järvinen & A. Kálmán (Eds.), Varietas delectat… Complexity is the new normality. SEFI 47th Annual Conference, Proceedings, 16-20 September 2019, Budabest, Hungary, 594-603.

URL: https://www.sefi.be/wp-content/uploads/2019/10/SEFI2019_Proceedings.pdf

Smart collaboration for skills and competitiveness in Engineering Education

A Kakko[1]
JAMK University of Applied Sciences
Jyväskylä, Finland

Conference Key Areas: New notions of interdisciplinarity in engineering education, Diversity in Engineering Education

Keywords: Internationality, innovation, multidisciplinary, flexible mentoring

ABSTRACT

Smart HEI-Business collaboration for skills and competitiveness (HEIBus) is Erasmus + Knowledge Alliances 2 project. Its duration is 36 months (January 2017 – December 2019) and it aims to develop and test smart and innovative new methods including virtual implementations for High Education Institution (HEI)-company cooperation for mutual benefit. With a budget of about one million euros, the project brings together HEIs and companies from five European countries with strong expertise and experience in different engineering fields.

HEIs have many challenges to meet future needs and to develop teaching methods in constantly changing world. Focus must be in matching the needs of working life with the provided education which can only be reached with good and efficient HEI-company cooperation.

Competent and motivated personnel is one key factor for the success of the companies. One way to achieve this is deeper cooperation between companies and HEIs offering companies a good recruiting tool.

The project focuses on strengthening the collaboration between HEIs and companies by creating new innovative cooperation models and teaching methods. These models and methods facilitate the involvement of HEI students and teachers and company experts in international and multidisciplinary R&D&I projects proposed by companies.

1 BACKGROUND AND BASIC INFORMATION OF THE HEIBUS PROJECT

1.1 Background of the HEIBus project

Europe is trailing behind the USA, Japan and Canada with regard to building a smarter economy. Competitiveness and rising levels of productivity are a crucial force behind sustained levels of economic progress and the wellbeing of citizens. In short, Europe needs improvements. To tackle the problems, Europe has launched

A Kakko
anneli.kakko@jamk.fi

the Europe 2020 strategy with objectives on employment, innovation, education, social inclusion and climate/energy. The Europe 2020 strategy identifies actions to boost growth and jobs.

The schooling system in Europe is on a very good level, but we still need to improve the velocity of innovation, productisation and commercialisation. At Higher Education Institutions (HEIs), both students and personnel are frequently handling innovations that could be the basis of improved business in small- and medium-sized companies (SMEs) or create new business possibilities for larger enterprises.

Economic success demands that the company is innovative, which in turn requires different kinds of multidisciplinary know-how. The purpose of the Smart HEI-Business collaboration for skills and competitiveness (HEIBus, www.heibus.eu) project is to increase, improve, widen and deepen HEI-company cooperation at the student and expert levels, promoting entrepreneurial thinking and innovations. The feedback of earlier research projects, such as RePCI (www.repci.eu), showed a clear need for deeper and wider HEI-company cooperation, such as multidisciplinary study area and HEI-company expert level cooperation.

HEIs have many challenges, such as meeting future needs set by working life and developing teaching methods, which motivate students to learn and carry out their studies successfully in time. The labour market is constantly evolving, with the necessary skills, competences and qualifications changing over time. Traditional education does not always answer the needs of the field, and new teaching and learning methods for new skills are needed. It is important that the needs of working life is matched with the education provided. This is an ongoing process and can only be reached with HEI-company cooperation.

One key factor for the success of the companies is competent and motivated personnel. One way to achieve this is through deeper integration of the company with the student groups throughout the studies, which provides companies a good recruiting tool.

1.2 Research of HEI-company cooperation models

Currently, HEIs and companies around the world are experiencing a renewed interest in strengthening their forms of cooperation. It has been proved that bridging the gap between HEIs and companies benefits both parties. Cooperation between HEIs and companies is not a new concept. There are cooperation programmes, which date back to the first decade of the 20th century [1] or are well-known internationally that have served as a reference model [2]. However, the idea of integrating working life with the learning process has its detractors. They place strong emphasis on exploitative internships and non-enriching jobs in which students are just observing instead of being engaged in productive work. To tackle this problem, there are associations such as the Canadian Association for Co-operative Education (CAFCE) [3], the Cooperative Education & Internship Association (CEIA) [4] and the German Central Evaluation and Accreditation Agency (ZEvA) [5] that guarantee the quality of cooperation agreements.

The mechanisms offered by HEIs to provide students with the opportunity to gain work experience in their career fields are included in the generic concept of Work-Integrated Learning (WIL) [6]. According to the definition adopted by the Higher Education Quality Council of Ontario [7], work-integrated learning is the process through which students come to learn from experiences in educational and practice settings. It includes the kinds of curriculum and pedagogic practices that can assist, provide and effectively integrate learning experiences in both settings. Depending on the context, the term WIL is often used interchangeably with other similar terms such as "work-based learning," "practice-based learning," "work-related learning," "vocational learning," "experiential learning," "co-operative education," "clinical education," "internship," "practicum" and "field education" [8]. However, many of these terms are also used to describe specific types of work-integrated learning. The most widespread types of WIL are cooperative education, internship, apprenticeship, field experience, mandatory professional practice, applied research learning and service learning.

1.3 Partners

The HEIBus project consists of five university partners and seven company partners from five different European countries (Finland, Germany, Hungary, Romania and Spain) taking part in the project as full partners:

- JAMK University of Applied Sciences (JAMK, main partner, www.jamk.fi/en/) and ITAB Finland Oy (www.itab.fi/en/) from Finland
- Technical University of Cluj-Napoca (TUCLUJ, www.utcluj.ro/en/), SC PRO Tehnic (www.pro-tehnic.ro) and Automates ACM SRL (www.automatesacm.ro) from Romania
- University of Miskolc (ME, www.uni-miskolc.hu/en/), Electrolux (www.electrolux.com) and Robert Bosch Power Tool (www.bosch-garden.com/gb/en) from Hungary
- University of Applied Sciences Esslingen (HE, www.hs-esslingen.de/en/) and Stoebich (www.stoebich.com) from Germany
- University of Jaen (UJA, www.ujaen.es/serv/vicint/home/index) and Valeo Lighting Systems (www.valeo.com/en) from Spain.

The group of company partners consists of SMEs as well as some large companies. Three HEI partners are academic universities while two are universities of applied sciences. The partnership comprises a perfect variety of different types of organisations and professionals. This provides very interesting and fruitful cooperation with different perspectives on each aspect of the project. There are also 17 associated partner companies and institutions and several external partners around Europe who have followed the progress, utilised the results or taken part in some of the project activities.

The project focuses on strengthening the collaboration between HEIs and companies by creating new innovative cooperation models. These models facilitate the involvement of students and staff from HEIs in international Research & Development & Innovation (R&D&I) projects proposed by companies.

1.4 Work packages

The HEIBus project consists of eight work packages, which are shown in Fig. 1 and include Management (WP1), Best practices of HEI-company cooperation (WP2), Multidisciplinary student level real life problem solving (WP3), Expert level real life problem solving (WP4), Flexible student mentoring by companies (WP5), Quality assurance (WP6), Evaluation (WP7) and Dissemination & exploitation (WP8). Four of them (WP2, WP3, WP4 and WP5) are implementation work packages which will be explained deeper in the following chapters.

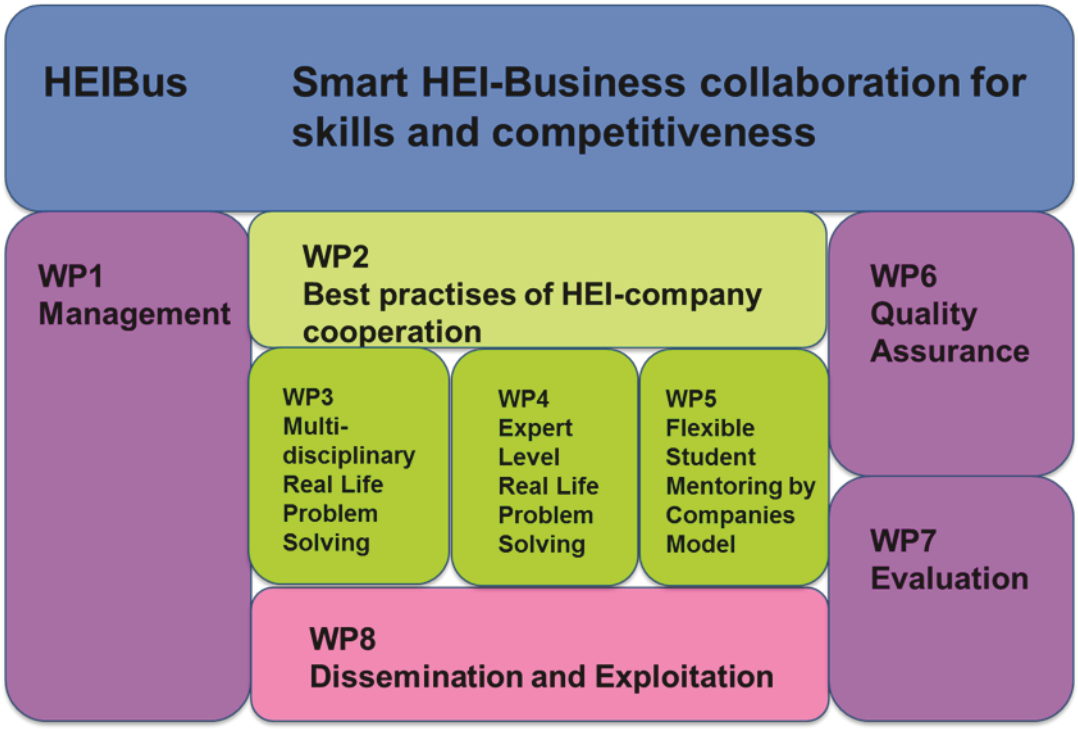

Fig. 1. Work packages of HEIBus project.

The project addresses the flagship initiatives of innovation union, youth on the move and an agenda for new skills and jobs. The HEIBus project carries out several tasks where students, HEI experts and company experts are involved in solving real-life problems of companies. This boosts the new innovative ideas that can be quickly taken into use in companies.

2 BEST PRACTICES OF HEI-COMPANY COOPERATION

The aim of the Best practices of HEI-company cooperation work package (WP2) was to analyse the existing cooperation models providing real-life experiences between HEIs and companies in the following issues:

- the state-of-the-art HEI student-company cooperation models
- the state-of-the-art HEI expert-company cooperation models
- different platforms and forums used in HEI-company communication
- the best practices on company involvement in HEI education.

In the beginning of the HEIBus project, all work package leaders searched existing methods and models for HEI-company cooperation, which the leader of WP2 then collected. During April - May 2017 the best models for deeper analysis were selected. Regarding the outcomes of this work package, the best and most

comprehensive ideas and models for HEI-company cooperation were expected to be found. These models have formed a good background for the other implementation work packages, WP3-WP5.

3 MULTIDISCIPLINARY STUDENT LEVEL REAL LIFE PROBLEM SOLVING

The Multidisciplinary student level real life problem solving (RLPS, WP3) work package focused on bringing students, HEI staff and companies together. The idea was that students from different study programmes and nationalities form mixed groups in order to solve a real life problem that has been given to them by a company, as shown in *Fig. 2.* The aim of the RLPS was to create a new model on how to spread the real life problem solving method to a new multidisciplinary cooperation level and to build a virtual implementation of the RLPS method. Virtual implementation frees the RLPS method from the confines of space and makes it more accessible to students unable to travel. It also makes the method easy to use anywhere in Europe.

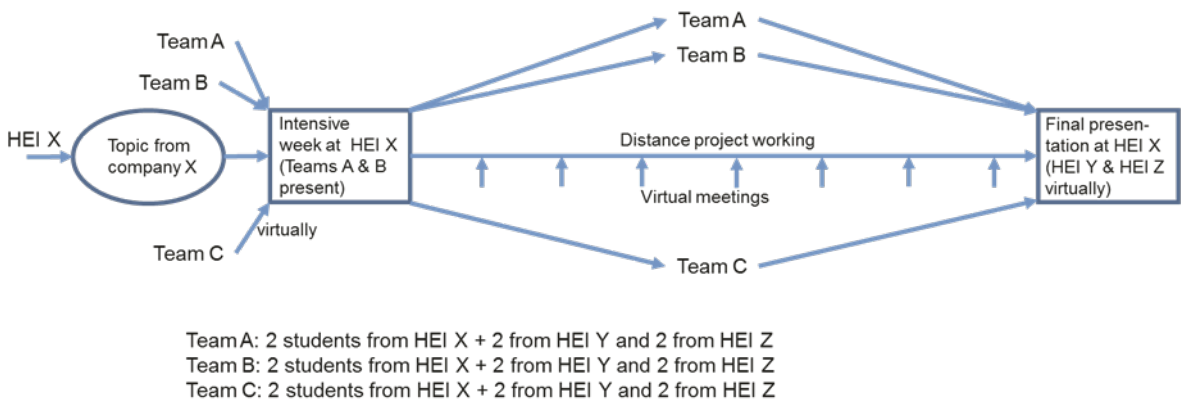

Fig. 2. Pilot Projects of WP3.

In every pilot project, three multidisciplinary and international student groups solved the proposed topic during one academic semester and competed with each other. At the end of the semester, the company tutors selected a winning solution and HEI supervisors gave grades. This work package was expected to produce motivated students with good teamwork, project management, cultural and language skills.

Pilot projects were carried out in two rounds, first three in autumn 2017 and the second three in autumn 2018. Preparations of these pilot projects started in previous spring including meetings with partner companies, finding topics, planning of tailored lectures, creating information material and having information sessions for suitable student groups. The list of chosen companies for the first round pilot projects, real life problems and HEI partners can be seen in *Table 1* and the second round pilot projects in *Table 2.*

Table 1. List of chosen companies, real life problems and HEI partners for the first round multidisciplinary student level pilot projects

Chosen company	Country	Real life problem	Host HEI	Other HEI partners
ITAB Finland	Finland	New concept for self service station in order to enhance customer experience	JAMK	HE and UJA

SC AutoMates ACM SRL	Romania	Design a fully pneumatic slicing machine for use in food industry to portion hard and semi-hard cheese	TUCLUJ	ME and HE
Centro Tecnologico del Plastico, Andaltec	Spain	Reducing the environmental footprint through the development of new and biodegradable plastic products	UJA	JAMK and ME

Table 2. List of chosen companies, real life problems and HEI partners for the second round multidisciplinary student level pilot projects

Chosen company	**Country**	**Real life problem**	**Host HEI**	**Other HEI partners**
FESTOOL GmbH	Germany	Create New Product Ideas for the FESTOOL Product Range by using a very agile Innovation Process	HE	ME and UJA
Robert Bosch Power Tool	Hungary	Connected power tool development for hobby and home decoration	ME	JAMK and TUCLUJ
Sensor Integration & Robotics (ISR)	Spain	Construction of a Prototype for the automatic control of a horizontal centrifuge machine	TUCLUJ	JAMK and TUCLUJ

In every student group there were two students from every three HEIs, so together six students. In the beginning of the implementations, two student groups had an intensive week in the home country of the company giving the topic and the third student group took part virtually in this intensive week. After the intensive week, all students worked at their own HEIs and student groups cooperated virtually until the end of the implementation. After the pilot projects, feedback from students, HEI supervisors and company tutors was collected and generally, it was quite positive. Here under some important observations for projects:

- Enough time for group work is needed during the intensive week.
- Well tested communication tools are necessary and important for the virtual meetings.
- Working with people from different countries and different study programs is very fruitful and important also for the future.

The HEI supervisors wrote an evaluation report of the results of the implementation for each team. This evaluation report was based on an evaluation criteria table created by HEI supervisors. The evaluation criteria table contained the project management
(planning, implementation and schedule), the results compared with the objectives, social skills (team work, communication), reports and presentations. The importance of different parts of the criteria might vary in different projects. The grade for individual student was the same as the team grade. However, if a student performed clearly better or worse than the rest of the team, the grade of that student could be higher or lower than the grades of the rest of the team.

As interesting summary of the RLPS projects it was found out that:

- In all implementations of the first round, the winner group was the group, which took part in face-to-face intensive week, but all implementations of the second round the winner group was the virtual group. Based on this we could say that there is no difference if the implementation is partly or totally virtual.
- All student groups worked hard and tried their best.
- Motivation of students was mainly high during the whole project.
- Not only professional, but also international and language skills of every student improved.

In autumn 2019 the partner HEIs will write a step-by-step guide of the RLPS model. The model will consist of three different levels of RLPS: original implementation, partly virtual implementation and totally virtual implementation.

4 EXPERT LEVEL REAL LIFE PROBLEM SOLVING

The Expert level real life problem solving (EXPERT, WP4) work package aims to develop and pilot a new cooperation model between HEIs and companies. This enables companies to bring more complex problems to be solved by international and multidisciplinary experts. This promotes innovation and knowledge transfer between HEIs and companies as well as increases the skills of HEI experts and the working life relevance of education.

In the beginning, a step-by-step process model was built and pilot projects for testing the model was planned, as shown in *Fig. 3.* The EXPERT pilot projects in two rounds were implemented in Finland, Hungary and Romania in spring 2018 and 2019. In order to search for companies and their topics for the first and the second round pilot projects, an information sheet about expert level real life problem solving was created. Each HEI involved (JAMK, ME and TUCLUJ) contacted companies and asked potential project topics. The topics of the first round pilot projects are described in *Table 3* and of the second round pilot projects in *Table 4*.

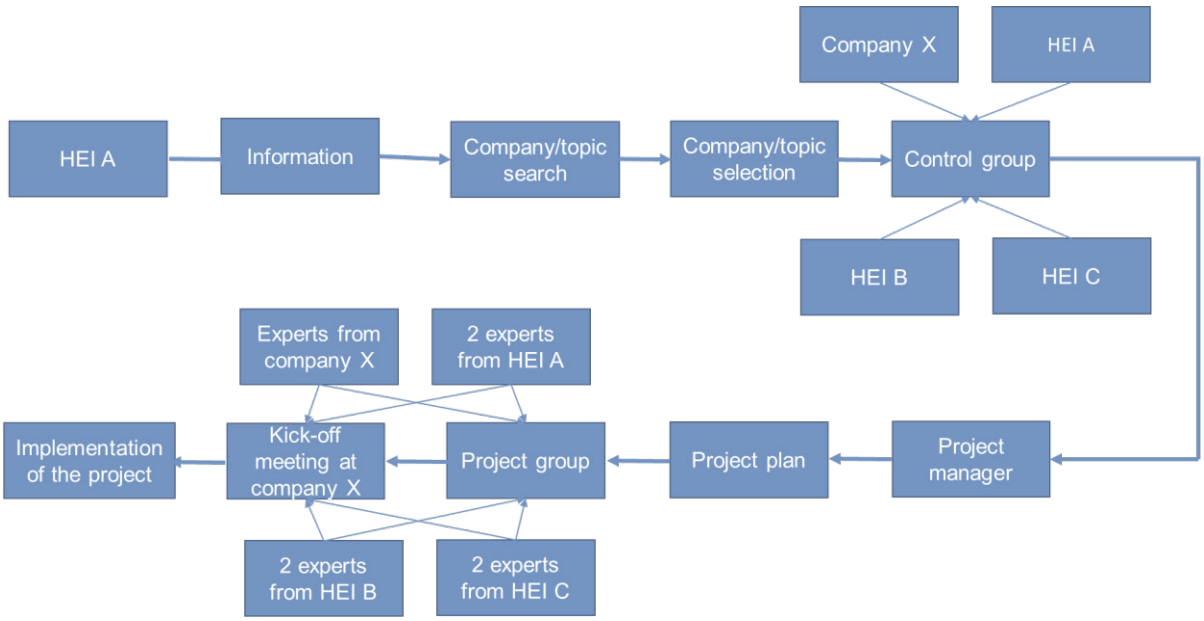

Fig. 3. Pilot Projects of WP4.

Table 3. List of chosen companies, real life problems, HEI partners and needed expert areas for the first round expert level pilot projects.

Host HEI	Company	Topic	HEI experts	Expertise areas
JAMK, Finland	ITAB Finland	Inventory management by smart fittings	2 from JAMK 2 from ME 2 from UJA	Machine vision, Mechanical engineering, Electronics, Data collection
ME, Hungary	Electrolux Lehel	Developing a pipe air flow resistance measuring device for vacuum cleaner pipes	2 from JAMK 2 from ME 2 from TUCLUJ	Mechanical engineering, Electronics, Aerodynamics (fluid dynamics), Data collection
TUCLUJ, Romania	SC ProTehnic	Implementing IoT and lifecycle management in photovoltaic area	2 from JAMK 2 from ME 2 from TUCLUJ	Electronics, Sensors, Data acquisition/ Measurement systems, Microcontrollers, Actuators/control systems, Programming for embedded systems

Table 4. List of chosen companies, real life problems, HEI partners and needed expert areas for the second round expert level pilot projects.

Host HEI	Company	Topic	HEI experts	Expertise areas
JAMK, Finland	Valtra	Benefits of audio feedback enhancing user experience in an agricultural tractor	2 from JAMK 2 from TUCLUJ 2 from UJA	Usability and ergonomics, Product development, Automation, Electronics
ME, Hungary	Bosch Power Tool	Perceivable noise reduction of power tools	2 from ME 2 from TUCLUJ 2 from UJA	Mechanical engineering, Vibration technology, Ergonomics
TUCLUJ, Romania	Bosch Jucu plant	Elimination of the air bubbles during the conformal coating process of PCB's	2 from JAMK 2 from TUCLUJ 2 from UJA	Conformal coating of PCBs, Fluid mechanics, Material science (fluid coating materials), Mechatronics (automated machines/robots)

In every pilot project a project plan was made by the project manager who was a representative of the company. The schedule of each pilot project depended on the needs of the company and the problem to be solved. The HEI partners found and selected the best experts for the problem to be solved, and these experts formed the project team. One team included six experts from three different HEIs (three different countries) and experts from the company whose problem the team was solving.

In the beginning of each project, a kick-off meeting in the company was arranged where the whole project team was present. Other project meetings and the final meeting at the end of the project were arranged by video conferences (virtually). The project team agreed on the best ways of working together, including virtual meetings, individual work, forming smaller teams inside the project team, etc. The project team worked on solving the real life problem of the company and proposed a solution. With

the help of the project team, the project manager reported the results of the project to the company.

After the pilot projects, a feedback was collected. The feedback was very positive and it seemed that there were not many issues which need to be changed for the next similar projects. The biggest challenge was to find suitable experts and to have an equal workload for the experts. In addition, it is important to pay attention for planning of the project meetings from the kick-off meeting until the final meeting as well as to select the proper communication ways for those meetings. It seemed that it is important that the kick-off meeting is a face-to-face meeting but for the other meetings virtual methods can be used.

Based on the process model and experiences of the pilot projects an action plan to widen the international expert cooperation model outside the HEIBus-project will be created.

In addition, the Expert level real life problem solving work package included the building of a virtual Expert Support Service (ESS) with easy and quick access for all companies looking for expert services by HEIs. The ESS offers direct expert contacts for starting an expert level RLPS, and a possibility to ask quick support for smaller problems.

The developing work of ESS started with finding out and analyzing the existing models. The website was developed using WordPress software and the ESS database platform is available at www.heibus.eu/experts. The platform was designed to be fully responsive, being able to work also on mobile devices. The main functionality of the website is to return a result from an expert database after a "Search" operation. The search results may consist of the personal and professional data of an expert, or a list of experts meeting the search criteria.

5 FLEXIBLE STUDENT MENTORING BY COMPANIES

The Flexible student mentoring by companies (Flex Mentoring, WP5) cooperation model aims to find and test flexible ways to involve companies in the education process of students. Flexibility comes from different levels of involvement. Virtual reality, which is not dependent on time or place, is present in many activities, such as expert lectures and info sessions for a wider audience that makes it possible for students from international HEI partners, among others, to join by video conference, etc. The cooperation model also seeks to find out if Flex Mentoring could be a feasible solution for improving students' post-graduation employment and helping students lagging behind in their studies or at risk of dropping out completely.

The Flex Mentoring implementations started in autumn 2017 and they will continue until the end of the HEIBus project or longer in every partner HEI. In every HEI one or more companies walk hand-in-hand with one study group from the beginning until the end of the studies. Each HEI partner has selected two suitable student groups: one group consisting of students at the beginning of their studies and another group in which the students are at a more advanced level.

Flex Mentoring work package contains the following tasks:

- making plans on how the Flex Mentoring programme is implemented
- selecting the most suitable involvement methods and making detailed plans for the execution for each study year
- reviewing the plans after every study year and modifying if needed
- creating info materials of Flex Mentoring
- introducing the materials to selected companies and student groups.

Each HEI and company have chosen the involvement level and methods best suited to them, in a flexible way. Used methods have been for example workshops with company representatives, tailored lectures and project supervision by company representatives and job fairs.

The main outcomes of this work package will be increased motivation and study success for students, easy recruitment and a good labour force for companies and good knowledge transfer between HEIs and companies.

REFERENCES

[1] Houshmand, A, Papadakis, C (2007), One Century of Cooperative Education in the United States 1906-2006, Drexel University.

[2] Linn, P, Howard, A, Miller, E (2004), Handbook for research in cooperative education and internship. NJ: Lawrence Erlbaum.

[3] CAFCE: Canadian association for co-operative education CAFCE [online] http://www.cafce.ca/coop-defined.html.

[4] Cooperative Education & Internship Association (CEIA) [online] http://www.ceiainc.org/, last access in February 2017.

[5] German Central Evaluation and Accreditation Agency (ZEvA) [online] http://www.zeva.org/english-version/.

[6] Association for Cooperative Education (ACE) [on line] http://www.co-op.bc.ca.

[7] Higher Education Quality Council of Ontario [online] http://www.heqco.ca/enca/Pages/Home.aspx.

[8] Academica group. Taking a pulse of work-integrated learning in Canada. Business higher education roundtable [online] http://bher.ca/wpcontent/uploads/2016/10/BHER-Academica-report-full.pdf.