

# AN INTEGRATED LEARNING MODEL IN COLLABORATION WITH INDUSTRIAL PARTNERS

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## ABSTRACT

We present a recently developed learning model of work integrated learning in the Bachelor programs in Mechanical Engineering as well as Electronic and Computer Engineering at Umeå University, Sweden. The model is based on an organized collaboration with our industrial partners in the surrounding geographic region. As a part of the collaboration, each participating student is guaranteed internships at a chosen company over the summer period. In the model, company based projects are integrated with some of the study program courses. Moreover, the participating students are given a possibility to perform their final thesis at the chosen company. We consider this collaboration as a "win-win situation" for the three parties involved in the learning model: the students, the University/faculty and the industrial partners. A number of positive effects have been observed and documented as follows:

- i) The integrated learning improves the learning process for the students, where learning, knowledge and practice are integrated into the engineering curricula.
- ii) The general quality of the study programs in the faculty has been developed and improved based on the professional skills as required by modern industrial companies.
- iii) The obtained advantage for the industrial partners has been to establish professional contacts with the students as well as the possibility to be acquainted with potential future employees.

We will discuss the experiences of this learning model in relation to CDIO standard 7 (Integrated Learning Experiences) and 8 (Active Learning). It has been found that the company based projects promote interdisciplinary learning as well as fostering system building skills and personal communication skills. Moreover, the developed learning model supports the expected learning outcomes, especially with regard to interpersonal skills, teamwork and communication. Finally, we will investigate the learning theories that support the developed learning model from a pedagogical point of view.

## KEYWORDS

Work Integrated Learning, Integrated Learning Experiences (CDIO Standard 7), Active Learning (CDIO Standard 8).

## INTRODUCTION

Work integrated education or "cooperative education" (co-op) is a form of collaboration that aims to integrate practical work experience as learning objects during an on-going education. By including extended work periods in the curricula at the partner company with supervised training, the students increase their understanding of the personal and professional skills, as well as their ability to relate the underlying disciplinary knowledge to practical work. This concept forms a good basis to developing engineering and professional skills.

A number of authors investigated this type of education. Haddara and Skanesa (2007) reviewed the development of cooperative education in North America over the last 100 years. Sovilla and Varty (2004) performed a similar study to reach practical conclusions with respect to the local pedagogical systems. Arslan and Kuş (2008) presented a model of cooperative education "group leader training program" for industry employees. These studies confirm that cooperative education programs can actually help to bridge the gap between theory and practice in engineering education. With respect to the professional development of University students, the studies of Riggio et al. (1994) and Gardner et al. (1992) indicate that participation in cooperative education programs will provide the student with an advantage when it comes to the job negotiation after graduation (e.g., in terms of starting salary) since the students in this case can show that they have already acquired a certain level of job experience. This article extends the previous works of these authors in the sense that it investigates the cooperative education considering a new perspective.

In this study, a learning model for Work Integrated Learning (WIL) is presented and discussed. The model, which is under development, is included in two undergraduate engineering programs at Umeå University. Moreover, we discuss the pedagogical foundations of the learning model in relation to contemporary learning theories and also in relation to the CDIO standards 7 and 8, Integrated Learning Experiences and Active Learning, respectively.

## THE INTEGRATED LEARNING MODEL

### ***Short description of the background***

The initiative for the development of the model was taken in 2012 by a group of industrial companies in Örnsköldsvik, Sweden, in the field of mechanical-, electronic- and computer engineering. Discussions between the University and the companies resulted in an agreement to introduce an educational Work Integrated Model. The discussions continued during 2013, whereby some additional companies in the Umeå area joined the collaboration. In the beginning of 2013, a limited number of first year engineering students were offered a co-op study position. Out of 12 applicants, 9 students were accepted (7 male and 2 female students). Presently, the cooperation involves the following companies: BAE Systems, Bosch Rexroth, Sanmina-SCI, Knightec, Ålö AB, GE Healthcare, Komatsu Forest, located in the Örnsköldsvik-Umeå area in northern Sweden. We are actively working to extend the cooperation to include even more companies.

### ***Description of the learning model***

The agreement between the University and the industrial companies (formalized in a "letter of intent") means that a number of students yearly are offered a co-op study position. The

exact number of positions depends on the availability and supervisory resources at the companies. All accepted students are guaranteed two internships at their company. These internships take place during the summer period between the first and the second, and the second and the third study year, respectively. The other activities included in the agreement are integrated short projects in some of the program courses, a study-trip in the beginning of the first year and also the final project at the last semester during the third study year.

An overview of the learning model is shown in Table 1 below. The very first activity is the study-trip to the partner companies, which occurs early at the first study semester. The trip is, in fact, carried out as a part of the first regular course of the study programs. That is, all students are invited to participate in the trip. The purpose of the trip is to introduce the learning model to all first-year students and provide the opportunity for the companies to present their activities to the students. Two days are scheduled for the trip.

The next activity is the application procedure. Interested students are given the opportunity to apply for a co-op position at one or several of the partner companies. Prior to the application process, the students are taught how to write a CV and an application letter. Application letters should be written in the same way as an application to an ordinary job position.

Table 1. Overview of the learning model

<b>Study year</b>	<b>Period of time</b>	<b>Activity</b>
1	Sept./ two days	Study trip
1	Nov.-Dec.	Application for a co-op position
1	Jan.	Application interview
1	Febr.- March/1-2 days	Introduction at the company, meeting with the supervisor
1	June-Aug./ 6-10 weeks	Industrial internship No. 1
2	fall semester/ 1-2 weeks	Projects within regular course (short project)
2	spring semester/ 1-2 weeks	Projects within regular course (short project)
2	June-Aug./ 6-10 weeks	Industrial internship No. 2
3	fall semester/ 1-2 weeks	Projects within regular course (short project)
3	spring semester/ 10 weeks	Final degree project

After the submission of applications an interview session with the candidates is arranged. Representatives from the companies (normally from HR departments) perform the interviews. Allocation of the positions takes place in dialogue with the University, after the companies have made a proposal. After the positions have been allocated in the beginning of the spring semester the first study year, the accepted co-op students are given the opportunity during 1-2 days to meet the contact person/supervisor at the company. The student is responsible for taking this contact and plan for this introductory meeting.

The first practical work period is the internship during the summer period between the first and second year of study. The agreement states that each co-op student should be offered

6-10 weeks of paid internship. This also includes that the company allocates resources to supervise the student. The internship is not coupled to any specific part of examination; however the student is expected to submit a written document with his/her description and reflection of the activities during the internship.

During the fall semester, the 2<sup>nd</sup> study year, integrated projects in partnership with the companies are performed. The projects are integrated in one or several of the regular program courses and the each project correspond to about one week of study. Typically, four or five students participate in each project. The industrial partners are responsible to come up with project proposals. The project and associated documentation are reviewed and examined at the University. Recently (fall semester 2013), three company-related projects that involved 15 students on the Bachelor of Science program in Mechanical Engineering, have been performed within two of the regular engineering courses (Production technology and Hydraulics). Also students without a co-op position are welcome to participate in the projects. This shows that the learning concept is beneficial for all the students, not only those who have got a co-op position, which is a positive effect. New company-related projects are introduced in other courses the following semester.

During the summer period between the second and third study year, the second internship is performed. The purpose of the industrial practice, in addition to learn how things are working at the company, is also to provide some kind of learning progression. Therefore, the first internship period consist of simpler tasks (practical engineering work in a workshop or similar) whereas the second internship is focused on somewhat more advanced tasks (such as production planning/ construction/design). After the second internship, the students are expected to have more experience and gained a clearer insight into their future profession.

The collaboration continues during the third study year with company-related projects in the fall semester and the final degree project in the spring semester. The student performs their final degree projects at the same company as they performed their summer internships. After the final project is completed, the formal cooperation with the company is finished. Perhaps some students will get their first real job position at their co-op company, and in that way cooperation continues.

In a broader sense, an advantage with this learning model is that there is no difference in total study time (three years for a Bachelor degree) between a student who has a co-op position and one that does not have a position. The cooperative periods occur within the time frame for the program. A Work Integrated Learning (WIL) model that is organized in that way is commonly referred to as the “parallel model”.

## **THE PRESENT LEARNING MODEL IN RELATION TO LEARNING THEORIES AND CDIO STANDARDS**

In order to align a suitable learning theory with the presented model for cooperative education, it is worthwhile to introduce the co-op education as a structured way of learning that combines in-class learning with periods of practical work. With this working experience, the student will have the possibility to be involved with network with employers, gain valuable work experience in the engineering field, and earn academic credits that count toward engineering degree.

Learning is commonly defined as a process that combines cognitive, emotional, and environmental influences and experiences for acquiring, enhancing, or making changes in individual's knowledge, skills, values, and world views (Illeris, 2004; Ormorod, 2012). In order to describe the complex process of learning, a learning theory is established. In general, there are four schools of education that are methodologically established, which treats the learning process. These are behaviourism; cognitivism/constructivism; cultural-historical; socio-cultural.

In brief, behaviourism as advanced by Skinner (Hassan, 2011) focuses only on the objectively observable aspects of learning and considers the student as learning machine without considering the environmental effects or cognitive aspects. Cognitive theories look beyond behaviour to explain brain-based learning (cognitive forces) as a process in which the learner actively constructs or builds new ideas or concepts. The cultural-historical school is based on the ideas of the Russian psychologist Vygotsky (Vygotskij, 2001), as discussed below. The socio-cultural perspective of learning is basically the same as that of Vygotsky but without the philosophy of dialectical materialism. In this educational perspective, the learning focus is not on a passive student who is exposed to stimuli, as in behaviourism, nor is the focus on a student with innate characteristics who received learning a determined way under the influence of traditional instruction, as in cognitive/ constructivism school of learning. Instead, the starting point is the accumulated knowledge of the societal community and the interaction between the individual and society (Hassan, 2011). A student will develop his/her learning within a framework of interaction with other people. An essential part of learning is that the student learns to deal with the mediating tools in the frame of institutionalised practices (see e.g. Säljö 2000). Learning occurs primarily through participation in activities, not by teaching. This learning framework may be traced back to the educational ideas of John Dewey (Dewey, 1997). Moreover, learning is dependent on the ability to take these tools and to use them; it is thus a process whereby people acquire the knowledge, skills and values that have shaped society for hundreds of years (Hassan, 2011). The engineering learning may be viewed from a socio-cultural perspective as being an interaction process between students with each other in the University environment and the practical place such as company. This interaction bears responsibility for providing students with the opportunity to use tools (e.g. machines, experimental equipment, laboratory demonstrations, running projects in a company etc.). Learning and development are a shared responsibility and they occur in real learning environments as represented by University (theory) and practice (company).

The cooperation between engineering education and engineering companies communicates not only subjective knowledge but also knowledge about how students will tackle the cultural toolbox (teaching materials, films, computers, machines, test materials, etc.) and develop it in the long term. Consequently, the socio- cultural learning theory can be clearly linked to the present WIL model of integrated learning. In this respect, learning occurs primarily through participation in activities, and not through traditional teaching. WIL can thus create opportunities for engineering students to acquire practical experience through interaction, practice and activities, and to give them an opportunity to reflect on the work itself. The resulting knowledge can be seen both as a tool for solving problems and to deal with real work situations in a company.

Schön (1987) describes a model called "*the reflected practitioner*". It is based on a professional person who obtains professional experience in a systematic way and uses it to further enhance the knowledge she/he acquires from previous situation. Dewey (2004) describes the didactic principle of "learning by doing", in which the individual acquires

knowledge through practical experience. Hassan (2011) describes a pedagogical model in which cognitive levels, social factors and teamwork and behaviouristic elements are integrated to optimise the learning process on an engineering course.

The presented WIL model should therefore give students the opportunity to bridge the gap between theory and practice. Further, it can provide students with opportunities to examine and observe the new practical experience. The academic knowledge will consequently be deepened as a result of the combination between theory and practice. Obviously, there are many different ways to learn in this context, but a combination of both theory and practice in a real company can be particularly suitable to support engineering students' learning as well as enhancing the quality of engineering education.

Furthermore, the WIL model can be closely related to the CDIO standard 7 (Integrated Learning Experiences) and CDIO standard 8 (Active Learning). The CDIO standard 7 is developed as pedagogical approaches that foster the learning of disciplinary knowledge simultaneously with personal, interpersonal, and product and system building skills (Crawley et al., 2007). For example, students might consider the analysis of a product, the design of the product, and the social responsibility of the designer of the product, all in one exercise. In the present developed WIL-model the industrial partners are helpful in providing examples of such exercises, in particularly the integrated projects where the partners are responsible to provide the project ideas. The CDIO standard 8, Active Learning, also supports our concept (Crawley et al., 2007). In active learning, students engage directly in thinking and problem solving activities. It can easily be argued that the industrial internships and integrated project work are forms of experimental active learning, as students are given the opportunity to work with real practical engineering problem in collaboration with companies. The integrated projects together with the companies can be carried out as case studies, which support the students to reach the learning outcomes, particular those related to personal and professional skills, teamwork and communication.

As a last observation, by promoting the presented model for cooperative education, students, employers and educators will be connected in a network to create dynamic synergies of talent, experience and education in the workforce, which in turn will improve the courses syllabus, as occurred in the present case.

## **DISCUSSION AND CONCLUSION**

We have described the development of an adapted model for Work Integrated Learning (WIL). The model, which we call cooperative learning (co-op) has recently (2013) been introduced in the Bachelor programs in mechanical-, electronic and computer engineering at Umeå University. We have discussed the relation between the model and conventional learning theories, with focus on the socio-cultural theory. The industrial collaboration companies have agreed to support the co-op students with internships during the summer periods, and to support us with project proposals to be incorporated in some of the regular courses on the program. The evaluation of the concept is done continuously; however since we recently started evaluation is so far somewhat limited. Some documentation and reflections from the internships 2013 are though available, both from the students and their supervisors at the companies. Below follows some opinions from internship supervisors:

"The difference with these student trainees from other summer trainees is that they generally are older and more mature."

"I think the approach to do the first internship in the production department, that last one in the production line before delivery to the customer, is right. This provides insight into the problems we experience when the functions earlier in the process did not have time to deliver on time. This creates a greater understanding of the challenges when the student comes, for example, to the construction department. "

"In summary, I think this is the right approach. You could certainly do the opposite but I think that if you first create a network out in the workshop, it is easier to communicate with the production people, something one must do as a production engineer. "

We believe that this learning model is favorable and gives a number of positive effects that were discussed in the Introduction. The fact that not only those students who have a co-op position can participate in industrial project-based courses is advantageous for the entire education. The feedback we received so far from our industrial partners has been positive. A detailed evaluation will be made at a later stage when more information is available. It should also be mentioned that the number of applicants for a co-op position was relatively modest in relation to the total number of enrolled students at the programs. Of the 12 applicants who applied to this type of learning (in a group of about 40 students), 9 students were offered internship positions.

Moreover, a network is formed consisting of representatives from the partner companies and program managers in order to develop the cooperation model further. Letters of intent have been signed between the companies and the faculty of technical and natural sciences at Umeå University. This formalizes the agreement and conditions for the cooperation model. More companies are expected to join the cooperation during 2014, and we thus plan to increase the number of available co-op positions. Moreover, a careful assessment of the placement will be conducted based on the respective company management and students feedback in order to maximize the learning process and also to make the best of the student internship periods at the company. The developed learning model can be related to the CDIO standards 7 and 8 from several aspects. The internships and industrial-related projects promote integrated learning experiences. Also, active learning can be applied successfully in the project-based courses.

Finally, cooperative education is a flexible model of practical-academic learning that bridges the University life and the working world as well as meeting the new developments in industrial needs, which will subsequently contribute to make University education available to the growing number of students.

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