Work Placement in Higher Education – Bridging the Gap between Theory and Practice

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***Abstract*—During the engineering education, the focus is on theoretical knowledge and less on the practical competence to be a professional engineer. To lead higher education into the future, it is critical to develop models and methods to prepare students for working life. As a mobilizing instrument, work placement is a method to strengthen the flow of knowledge within the innovation systems. Developing knowledge and transversal skills are critical to prepare students for working life. This paper describes the course "Practical Engineering" integrated in the engineering bachelor programs at the University of South-Eastern Norway, Faculty of Technology, Natural Sciences, and Maritime Sciences (USN-TNM). The pilot project started up in 2015 in cooperation with The Research Council of Norway, regional government, industry and USN-TNM. From 2015 until 2018, 70 students have elected the course and more than 40 companies have offered a work placement. Data has been obtained through surveys and student reports from 2017-2018. The evaluation and feedback from both students and companies were satisfactory. In addition to fulfilling purpose and goals for the course, there are also several other positive side effects in the University-Business cooperation.**

Keywords—Learning, engineer, knowledge, innovation, work placement, University-Business cooperation,

I. INTRODUCTION

The government, the industry in general, The Norwegian Society of Engineers and Technologists (NITO) and students encourage engineering educations to provide students with work-life experience [1]. USN has a clear strategy to strengthen the collaboration between the university, the industry and the students [2]. The role of our educational institution is to provide students with a broad range of learning practicies and pedagogies to develop their knowledge base in becoming a professional engineer. The Norwegian engineering studies have been criticized for being too theoretical. The academies are to a large extent sceptical to integration of work-based learning, and its impact on academic achievement. Cooperative learning and learning within a community of practice is described in many ways. In recent times, sociocultural views on learning have got more focus in cooperative learning [3].

The students graduate with fundamental analytical engineering science and theory (know-why). Experience-based knowledge is developed by doing, using, reflecting and interacting (know-how), and are the core elements in the learning process [4]. The university provides students mostly with basic knowledge. The companies, in interaction with university, can provide students with a much stronger experience-based knowledge. A learning enviroment that can combine both STI (science, technology, innovation) and DUI (doing, using, interacting) will strenghten the total knowledge base for students. STI and DUI represent two ideal type modes of learning and innovation. The third ideal type of learning and innovation that combines elements from the STI and DUI modes is CCI (combined complex innovation) [5]. In designing a course like Engineering Practice based on work placement it is especially vital to implement formal procedures and methods that enhances the fulfillment of learning outcomes. What methods and procedures will encourage reflection and self assessment regarding students own learning? How can students be best aware of what they are learning, and why they are learning it? To be aware of what they are learning and why is in a learning outcome in the course. Important elements in reaching these outcomes are students' involvement in designing their own practice plan, writing status reports, and a final report assessing the work placement period. The final report will have mandatory reflection requirements as a vital part of the report. Work placement reports also provide a way for academic supervisors to assess and understand the students' learning story during the placement period [6].

Engineering students are eager to get an insight into the life of a professonal engineer. Practice learning in the context of a work placement gives the students opportunity and experience that educational institutions lack to provide. Learning and development are the core ideas, but collaborations and partnerships are important to create the context and the practice based learning environment.

Higher education in Norway is supposed to be based on both scientific and experienced knowledge. Apprenticeship arrangements and work placements should be accessable learning arenas for our students that will strengthen their educational pathways. To do so, a work placement course was designed and developed. The main goal and purpose for work placement learning is to give the students opportunity to bridge the gap between theory and practice and gain first hand knowledge, skills and attitudes required in working life. Furthermore to experience how theoretical knowledge is vital for solving real life practical tasks and process problems. An educational strategy with the purpose of creating a sustainable work placement course is to allow and encourage all participants to voice their concern and interest [7-8].

Two research questions were addressed:

- Does our model and its architecture enable and encourage learning?
- Do students strengthen their knowledge base through work placement and bridge the gap between theory and practice?

In this paper we argue that work placement in higher education is enhancing the students' knowledge base in their future role as a professional engineer. A theoretical framework for a dynamic educational learning is presented. Evaluation results and feedbacks from participating students and placement organizations are presented and discussed.

II. DESCRIPTION OF PRACTICAL ENGINEERING

The academic institutions have an important role in enabling university-industry interaction, and stimulate the flow of knowledge. The engineering education programs in Norway are mainly focusing on science and technical courses, not providing sufficient integration to industrial practice. Practical Engineering gives the students opportunity to gain confidence and practical experience in their field of study to become competent engineers.

Fig. 1 shows the framework and difference between Traditional learning and Dynamic educational learning.

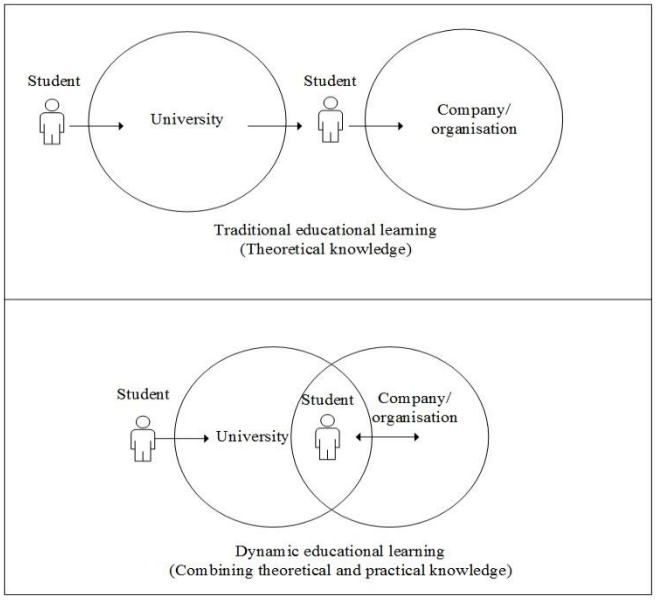


Fig. 1: From Traditional educational learning to Dynamic educational learning

Fig. 1 shows how the framework is organized in such a way that the student is in the middle of the integrated university/company learningsphere. Learning, guidance and work assessment come from both "institutions" through the course. In this framework the student will have possibilities of developing both practical and theoretical skills, receiving tutoring from both academia and business life. Work placement, in this context, is a socially contructed learning arena integrated in our educational programs. Our purpose and aim is to strengthen relevance, knowledge base and the intended learning outcomes for the students. Maximizing work-life learning experience depends very much on the educators, and how the learning process is designed and organized [9].

Practical Engineering is an optional(elective) 10 ECTS course in 3rd year. The course is designed to provide a learning environment by linking the learning and assessment to relevant companies and organizations. The length of the work placement is 30 days. The students must have passed study program courses comprising 100 ECTS in order to commence. The information and presentation of the course is in the beginning of semester 4 in the second year of study. Students have to obtain their own work placement and the deadline for obtaining workplace is end of June in 4th semester. The university must approve the work placement plans in order to ensure compliance with the study program. On approval a written agreement between the student, the company and the univerisity is signed. The company appoints a supervisor and the university appoints a placement tutor. Table I shows the main contents of the course.

Table I. Practical engineering - an overview

An overview of the course Practical Engineering
Work Placement Activities
Course startup at University The startup seminar presenting first-hand information about the course. The students, the companies and the university are participating. Academic supervisors are assigned from the specific study programs.
Practice plan The students take an active role in planning their work placement. The student must prepare a practice plan with a description of learning outcomes and goals, engineering tasks, schedule and milestones. This is done in partnership with the company during the first week of the work placement period. USN must approve the plan according to requirements for learning outcomes. If the plan is not approved an improved plan must be submitted.
The work placement status report (midterm) The students submit a short written status report regarding work placement progress according to the practice plan. Minor adjustments can be made (see below).
Guiding/Status meeting between business, university and student. Midterm meeting between the student, the university and the business. The meeting takes place in work placement arena. Required adjustments in the practice plan are discussed and implemented.
Work placement report The students must submit a final and formal report at the end of the semester. In the final report the students describe work carried out and what they gained from the placement. The report encourages students to reflect on learning outcomes and the work placement in general. These reports provide a way for the university to get an insight into the students' learning process and give inputs to quality improvements.
Oral presentations in a final evaluation session This session is a summary of the the work placement. Students, companies and the university participate in this session. Presentations, evaluation and feedback.

The students take an active role in the assignment of the practice plan. Together with the companies they discuss and

decide all aspects of the placement. The outcome of this process is the practice plan. The interaction and dialog between the students, the companies and the university during the placement period, is important for the quality in the placement. A midterm guidance meeting is held in the work place arena, often with guided tours. The students shall submit a final report thus ending the work placement. Writing work placement reports is also a method to encourage the students to reflect on learning outcomes. Finally the students present their work placement. The students, the companies, the placement tutors and the placement managers participate in this session. Reflection, evalution and feedback are important parts of this session.

III. METHODOLOGY

Our research approach is pragmatic and we are using mixed methods. Mixed methods are described in detail by Arbnor & Bjerke [10]. The data and analysis presented in this article are from years 2017 and 2018. Our research began with a preliminary study to identify key contents in work placement. We wanted to identify what the students had learned and their reflections on the work placement. The main data source is the practice plan and the work placement reports. The quality of work placement reports are affected by the students academic ability, writing ability and available time.

Through grouping of the content it was possible to generate a set of aggregate dimensions in the work placement context. See table II for an overview of research procedures. The companies and the organizations that participate are important for quality in the placement. Their opinion is important in several aspects. We conducted a survey to obtain data from the companies and work placement organizations. First, we wanted feedback on the structure and the content of the course, and degree of overall satisfaction. Secondly, we wanted to find out what the companies' views on the theoretical background of the students. To know whether there is a "match" between the students' perceptions and companies' perceptions on theoretical knowledge, is a very relevant issue.

Table II. Research procedures – an overview

Overview of the research procedure		
Research method	***Qualitative***	***Quantitative***
Data collection	*Document analysis:*	*Surveys and evaluation:*
	Student reports, practice plan, oral feedback	Students' course evaluations
	Oral presentations and evalution	Business feedback and evaluation on survey
	Observation and guidance:	
	Through guidance and role as supervisor	
Data analysis	Manual analysis to code the documents	
	Grouped the content - aggregated dimensions	
	Narrative strategy with focus on students' learning outcome and reflections	
Respondents	44 students	29 Companies

IV. RESULTS

Table III. The students' motivations for electing work placement

Reasons	**Number of students (44 respondents)**		
Gain work-life Experience	Yes: Partly:	42 2	(95%) (5%)
Want to combine theory and practice	Yes: Partly:	43 1	(98%) (2%)
Work with real challenges	Yes: Partly:	43 1	(98%) (2%)

As elements in table III shows, the reasons among students for choosing Practical Engineering may not be a surprise. Table IV indicates that students are quite satisfied with the course. Table V, qoutes from the students, also strengthens that.

Table IV. Elements from student survey

Elements	**Level of satisfaction [44 respondents]**	
Provide your own work-place	Positive: Negative: No comment*:	50 % 4 % 46 %
Work load in subject	Suitable: Excessive: No comment*:	43 % 7 % 50 %
Theoretical background for practice (From USN)	Very relevant: Partly relevant:	98 % 2 %
Overall evaluation of subject	Very Good: Good:	59 % 41 %

*"No comment" means that students did not address the issue.

Table V. The students quotes about the course

Student 1:	I would definitely recommend other students to choose engineering practice.
Student 2	Engineering practice has been an educational subject, and I have learned what an engineer is working with and gained insight into the everyday life of an engineering business.
Student 3	Engineering practice has given me motivation, security and is very educational.
Student 4	I have used theory as I have learned in the study, and gained better understanding of being an engineer.
Student 5	With lack of practical skills, I learned a lot from the connection between theory and practice.
Student 6	Practice as a learning arena has been in line with the expectations I had.
Student 7	The practice period has made this semester one of the best semesters of my engineering education at the USN.

Table VI. The Companies' view on the course

Degree of satisfaction: (29 respondents)	Not satisfied [%]	Some satisfied [%]	Satisfied [%]	Very satisfied [%]
Course information		10,3	37,9	51,7
The structure and organization of the course	3,4		31,0	65,5
Communication and dialog with the university	3,4		41,4	55,2
Work requirements in the course		10,3	37,9	51,7
Time allocated for follow-up and guidance		6,9	41,4	51,7
Total view on the course			41,4	58,6

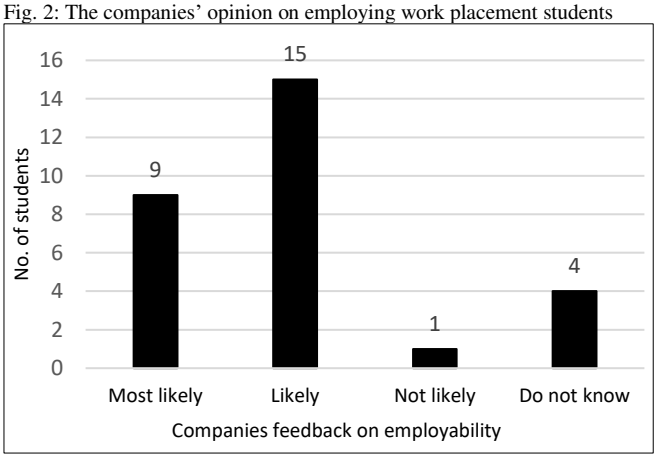
Table VI indicates that participating companies are quite satisfied with the course.
The companies had some remarks regarding students theoretical knowledge. Results are shown in table VII. We will discuss some of the results within a context analysis in the next session.

Table VII. Companies view on student's theoretical knowledge

Positive or no comments	18	62 %
Comments	11	38 %

Many students choose this course because of lack of work-life experience. They also want to become more employable, establish professional network and links to labour marked. The companies are quite positive to recruit the students from work placements (Fig.2)

Fig. 2: The companies' opinion on employing work placement students



V. Discussion

The goals of this study was to find out if our work placement model and its architecture enable and encourage learning. Many students choose this course because of lack of work-life experience. They also want to become more employable, establish professional networks and links to labour marked. Lack of work experience and industrial connectivity seems to be a vital factor that students miss during traditional eductional learning. It seem that during their education they struggle to see how to apply theory in practice. Bridging the gap between theory and practice by doing real engineering tasks is crucial for developing knowledge and deeper understanding. The students also seem to want a broader range of skills and perspectives that concern their profession. Such as social, environmental and economic issues.
Students' motivation and reasons for choosing work placement (table III) is a vital sign regarding how we teach engineering subjects. It seems to be a large potensial for improving traditional lecturing in scientific subjects by linking them much stronger to real problems in companies and business. Stronger student motivation can lead to more students acquiring their degree after 3 years of study. This will also be vital for university economy.

As mentioned earlier the students must provide their own work placement. Table IV shows overall that the students are positive to find their own company. Another possibilitiy would be that the University had "a pool" of workment places for the students. We considered several aspects of these different models and concluded that students should obtain their own work placement. Creating their own work placement is very similar to a job-seeking process and is considered to be a vital experience and learning process for the students. The students seem to be quite satisfied with the work load in the course. Still, some oral feedback indicates they wish more practice and less on writing reports.

Many students find it difficult to understand or translate theoretical theory into everyday, work-related practice. As shown in table III one of the main reasons for choosing work placement is to combine theory and practice. The students must have passed study program courses comprising 100 ECTS in order to commence. Basic theoretical skills are needed to be able to do engineering tasks and put theory into practice. Negative outcomes from the work placement may arise from weak integration of theory and practice Refeering to table IV nearly all students feel they have a theoretically relevant background for their work placement. This is reassuring from all points of view, and indicates that the quality in evaluation of the practice plan and engineering tasks are satisfactory. Some of the engineering tasks are quite challenging, so 100 ECTS seems necessary as a minimum total to take the course. The students' perceptions on their theoretical knowledge is within satisfaction. So it seems that the university is able to provide the right theoretical courses within our engineering study program. The quotes in table V verify the results and students view of the course from table IV. Overall, the students are satisfied with how the course is designed and their learning outcomes. Based on the students' evaluations the university has met their expectations on learning outcomes and relevance. As educational learners, we are satisfied with the results from the students and the framework quality. Table VI, sums up the view from companies on the course. The collaboration between the placement companies and the university is cruicial for quality in the work placement course. There is a high score on satisfaction from the companies. The feedback regarding the design and organization of the course is overall very good, with some minor comments. The results from both the students and the companies indicates that we have designed and implemented a solid framework.

The students' perceptions on connection between theory and practice are important. The students appreciate use of theoretical knowledge, gain confidence and practice in their field of study. Skills of how to use theoretical knowledge from higher education often have a tacit dimension, and work placement as a learning arena give the students' opportunity to bridge that gap. The companies' view on the students' theoretical skills is highly relevant. As table VII shows, companies are quite satisfied with students' theoretical knowledge. In the survey, they could also comment on this issue. The comments from our point of view were not critical, but important in further improvement of the course. Their comments were about use of software, lack of work-experience and knowledge about economics and business.

Fig. 2 illustrates that work placement is also beneficial for participating companies. The companies consider work placement as a trial arena for the students regarding job recruitment. Companies have different motives for participating in workplace cooperation, not suprisingly, recruitment is one important dimension. Companies are quite positive to employment of students and in fact, several of the companies have offered an employment after graduate.

Working with this paper has unveiled several aspects for improving results from such a study. The number of respondents are in some cases to small, and a larger population would give results with a higher degree of significance. A more specific question pool in surveys would improve extraction of results regarding both students' motivation and satisfaction. Additional interviews with students and company tutors would further enhance interpretation of learning outcomes for students.

VI. Conclusions

The objective of this study was to explore if our framework and course content quality was satisfying for both the students and the companies. The evaluation results from the companies and the student's surveys are to a large extent positive and the course is both needed and wanted. To meet the needs of society, business and public sector, our university must take steps to ensure that the employment market and society are accessible arenas of learning for our students in their educational pathways. This study gives clear signals that interaction between the students, the university and the industries must be improved and developed. The students' objectives for electing Practice Engineering are all within the main learning outcomes of the course.

A larger data collection will enable a more thorough evaluation of the framework and the fulfillment of learning outcomes for the course.

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