ON THE EFFECT OF EMPLOYMENT DURING THE LAST YEAR OF STUDIES TO TIMELY GRADUATION AND DEEP LEARNING

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ABSTRACT

Engineering students in Finland have quite commonly been hired by the employers already before graduation. This happens particularly to the best engineering students. The students are quite keen on starting their engineering work life a bit early. One reason may be the lack of tuition fees; it is economically attractive to enjoy the benefits of being a hired engineer. This is not the only reason; the best engineers are enthusiastic about their engineering work and too impatient to wait for the final graduation if they get a chance for “real life” engineering work earlier.

The Ministry of Education and Culture in Finland is emphasizing the importance of cost effective universities where students graduate fast and become tax payers in the society. Timely graduation is one of the goals affecting the government financing of the universities. In order to reach this objective, the universities should push the students to limit their practical engineering working to minimum and concentrate on theoretical studies and fast graduation.

Working during the studies does delay graduation, but it also has its benefits. Working within one’s own engineering profession provides valuable experience on how to apply the theoretical knowledge learned in the university to practice. It may also boost the students’ motivation for deep learning of the subjects instead of just collecting the credits needed for graduation. Working in a non-engineering job does not provide perspective in engineering skills, but it is helpful in achieving important working life soft skills needed also in the engineering profession and thus improves the employability of the student.

CDIO capstone projects provide to the student similar advantages as working in an external engineering enterprise, but in a faster and better managed way. In this paper we analyze the effects of employment during studies to timely graduation and deep learning, and the capabilities of a CDIO based curriculum in filling up working life skill gaps. We present our method of reaching recent graduates of the department and the design of a survey for gathering the data on which this study is based. The study showed a clear correlation between the amount of study time working and the delay in graduation time. On the other hand, the study revealed clear benefits of study time employment to the students engineering way of thinking and problem solving abilities, to their professionalism in their current jobs, and to the application of learned skills and knowledge into practice.

KEYWORDS

Deep learning, timely graduation, capstone, employment, survey, CDIO Standards: 2, 3, 7

INTRODUCTION

In addition to traditional holiday time working, a majority of university students is taking jobs also during term time. The study by Mathei and Gilmore (2005) shows an average of 14 hours of weekly working during studies. According to Robotham (2008) some students spend more time in their job than in time-based classes, especially in a relatively narrow range of industrial sectors. In these cases the notion of full-time student could be considered as no longer applicable (Curtis and Shani, 2002).

The primary motivation for the students to take jobs is to finance their daily living expenses, and secondarily to enhance their CV's (Curtis, 2007). In a study by Curtis and Williams (2002) it was noted that almost half of the students worked for the reason of obtaining work experience; however, in another study Holmes (2008) found that only 9% of the students considered counting the job as work experience as an essential factor for the job selection. The most essential requirement in this study was flexible working hours (72%). This fits quite well with the findings made by Robotham (2008): in his study more than half of the students were working in retail, pubs, wine bars or restaurants.

Working has some negative effects on studying. Holmes (2008) found that half of the students felt working could have a negative impact on their degree classification. Watts and Pickering (2000) reported a conflict of interest and a sense of pulling students in two directions, leaving them feeling constantly overloaded and stressed. Mathei and Gilmore (2005) report on less time than desired for social activities, study and recreation. However, according to Robotham (2008) the students reported more positive than negative outcomes, such as enhanced time management and group working skills contributing to improved employability. These skills are more vocational than academic. A study by Tuononen et al. (2015) showed that work in connection with university studies is related to a deep approach to learning whereas other work was related to a surface approach and unorganized studying.

The majority of students in the study by Holmes (2008) felt they could balance work and study. Watts and Pickering (2000) talked about increasing employability by contributing students' personal growth. Curtis and Williams (2002) mention also that whatever skills the student gains during employment can be used as experience examples when faced with future job interviews.

Also engineering students in Finland need the salary to finance their studies and daily living. As shown in study presented in this paper, most of the engineering students at University of Turku are working massively, often in the area of their own studies. Same general benefits apply as in the studies presented earlier, like learning group working skills, understanding how businesses operate, or just getting to know how to act in an industrial enterprise. In addition to these, working does have also academic benefits improving one's ability to connect the theoretical studies to the real world and thus enhancing the deep learning of the skills and knowledge from the university classes. A high percentage of the students get their first job with Master level qualifications already before the actual graduation. The combination of almost full-time work and the lack of tuition fees delay the graduation.

A CDIO capstone project provides similar advantages to the student as working in an engineering enterprise outside the university. A pedagogically professional approach to the practical engineering work done in a capstone project may bring equivalent skills to the student with a faster and a better managed way as a part of the curriculum. University of

Turku joined CDIO in 2012, so we currently have both students that follow the new CDIO curriculum and older students who still follow the old non-CDIO curriculum.

27% of the graduates surveyed in this study are from countries outside of the European Union with a high motivation to graduate timely. The Finnish Immigration Service provides limited time residence permits for the studies allowing no more than 25 hours of employment weekly. The difference between Finnish and international students in timely graduation and working during studies is significant. This paper examines an analysis of the effects of employment during studies to timely graduation and deep learning. We present a method for reaching the graduates who have already started their working life and analyze how the knowledge and skills learned at the university fit to the requirements at their present jobs. We conducted a survey among engineering students who have graduated in 2014-2015. Some of the surveyed students were enrolled in our new CDIO curriculum with remarkable changes targeting practical engineering working life skills and also including a capstone project. In this research we analyze how much practical engineering work as an employee was done during the last year of studies, how much did working during studies delay graduation, and did working during studies help in deep understanding of engineering theories. We also compare the outcomes between students following the new CDIO curriculum including a capstone project and students following the previous non-CDIO curriculum.

THE SURVEY

The survey was targeted to students who graduated from a full 2-year MSc (Tech) degree program in University of Turku during 2014-2015. Most of the Finnish students had also their BSc (Tech) degree from the same university thus spending at least 5 years with these studies. The survey was made online using the Webropol service. One of the objectives of the survey was to analyze optimal ways to contact the graduates annually in the future in order to create a continuous feedback process. Most of the students were contacted using email (when address known) or via the LinkedIn service. A few students were contacted with conventional mail providing them with a shortened link to the survey and the student's survey ID code.

Related surveys

The Organization for Academic Engineers and Architects in Finland (TEK) conducts an annual survey for graduates. At the point of graduation University of Turku (in co-operation with TEK) sends a link to the survey to the student's still active university email account. The TEK survey 2015 had 22 replies of which 11 were from international students and 11 from Finnish students. All 7 students answering "My graduation was delayed by more than a year" were Finnish (63.6%). The answer "Delay was caused by working during the studies" was selected by 54.5% of Finnish students, none of the international students.

The Career Services of the University of Turku (Rekry) conducts a survey for all university graduates at one and five years after graduation. The survey is sent by conventional mail to addresses obtained from the Population Register Centre of Finland which has the official addresses of virtually all residents of the country. The response rate of the mail survey among 2013 engineering graduates was 30.6%. The results of the 2009-2013 survey were used as reference data on skill gaps from the earlier years.

Reaching the Graduated Students

Reaching the graduated engineers is somewhat complex as the university emails are deactivated shortly after the graduation. Several different methods were tested in order to find an optimal approach for an annual questionnaire for the forthcoming years. The students' union's alumni register at the university had the contact information for only a few most active graduates. Conventional mail option leads to heavy workload and high cost while likely yielding a poor response rate.

During the period from the beginning of January 2014 to the end of October 2015, 89 engineering students graduated from 2-year Master's programs in University of Turku. 30.3% of the graduates were international students and 69.7% Finnish. Five of the graduates were already connected to the author via the LinkedIn service. A LinkedIn contact request was sent to 44 graduates of whom 63.6% accepted it. Some of the LinkedIn accounts, especially among 2014 graduates, seemed to be passive without recent activity. There was a remarkable difference in the contact request accept rate between 2014 and 2015 graduates.

The response rate by conventional mail was poor. The survey was made during the Christmas holiday season and no conventional mail reminders were sent due to time issues. The big difference in the response rates shows clearly the benefits of contacting the graduates electronically. The highest response rate was achieved by direct email contacts. Of these 16 contacts 68.8% were employed by local universities thus not representing the target group well. Connection via the LinkedIn service provided almost the same response rate (66.7%) and can be ranked as the best way for connecting the graduates. Facebook was considered as well, but virtually all graduates identified in Facebook could be found also in the professionally more suitable LinkedIn service. The Alumni database included accurate contact information for only a few most active graduates, and they were found in the LinkedIn service as well. The best option for the future seems to be creating an active department Alumni group within the LinkedIn service.

Table 1. Reaching the students. Number of graduates,
LinkedIn contact request accept rate and response rates of the survey.
(a few responders did not answer on every questions)

	2014	2015	Total	
Graduates	49	40	89	
-Finnish	32	30	62	69,7 %
-International	17	10	27	30,3 %
eMail	7	9	16	
-responses	5	8	11	68,8 %
Conventional mail sent	18		18	
-responses	4		4	22,2 %
LinkedIn contact requests	24	20	44	
- accept rate	54,2 %	75,0 %	63,6 %	
LinkedIn contacts in total	16	17	33	
-responces	11	11	22	66,7 %
Total responses	22	21	43	**48,3 %**
-Finnish	17	15	32	51,6 %
-International	5	6	11	40,7 %

FINDINGS

According to the survey results, the majority of the respondents were working with salary especially during the final years of their studies. Finnish students participating in the full 3+2 year degree program studies (Bachelor's and Master's Degrees) (n=23) reported having worked on average 3.98 years during their studies. During the last year of the studies this group reported an average of 30.1 hours weekly working for pay of which 28.4 hours was directly connected to the topical area of their own studies. 86.7% of this group had been employed to a job with Master's level qualification requirements before graduation.

Students with a Bachelor's degree from a Finnish University of Applied Sciences (n=8) reported on average 1.95 years of working for pay during their 2-year studies and 31.3 hours of weekly work during the last year of their studies. Half of the students in this group had been completing their degree on the side of their daily full-time engineering job resulting in 5 years of study time in a 2-year program. Both of these two cases fit well with the conclusion made by Curtis and Shani (2002) that the notion of a full-time student can be considered as no longer applicable.

International students (n=10) reported an average of 9.9 months employment during their two years of Master's degree studies, and an average of 15.8 hours of weekly work for pay of which 8.75 hours directly connected to the topical area of their own studies. 56% of this group were employed to a job with Master's level qualification requirements before graduation. The number of responders among international students is very low, but the difference against Finnish students is remarkable.

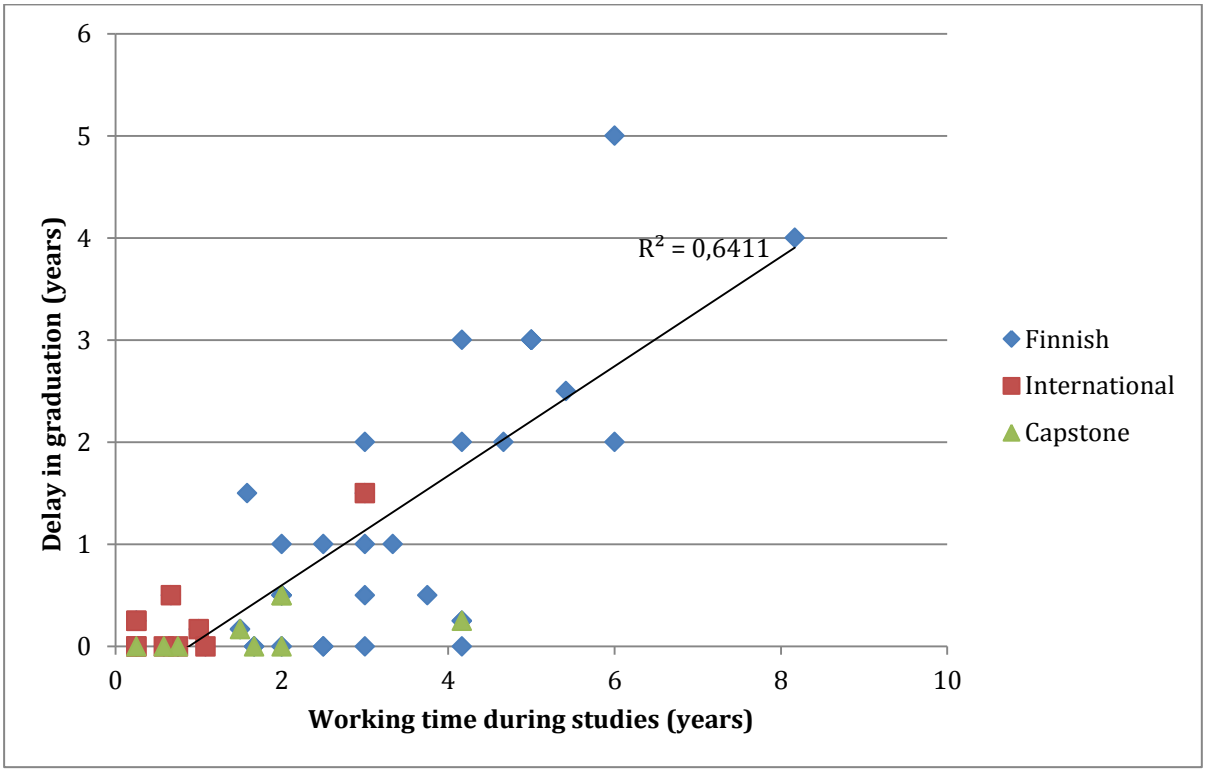

Figure 1. Delay in graduation versus the working time during the studies among Finnish (n=30) and International students (n=10) with a marking on the students who participated in a CDIO capstone project (n=9).

Delay in graduation

Figure 1 shows the delay in graduation versus the working for pay time during studies. The Finnish and International student groups are easy to spot from the diagram. Everyone reported at least 3 months of work. Only one Finn reported less than one year of employment during the studies. A remarkable share of Finnish students has no need to hurry with graduation due to being employed already and due to not having tuition fees. These students are full-time working and tax-paying citizens of the society, but show up in university statistics as students with often remarkable delays in graduation incorrectly indicating poor educational efficiency of the university.

Figure 1 has also a marking on the students who participated in a CDIO capstone project. These students seem to be graduating timely and working less for pay. However, capstone projects are quite new and they are obligatory only for students who started their studies in 2012 or later, thus having a maximum of one year delay in their graduation at the time of the survey. The possible effects on timely graduation are yet to be seen.

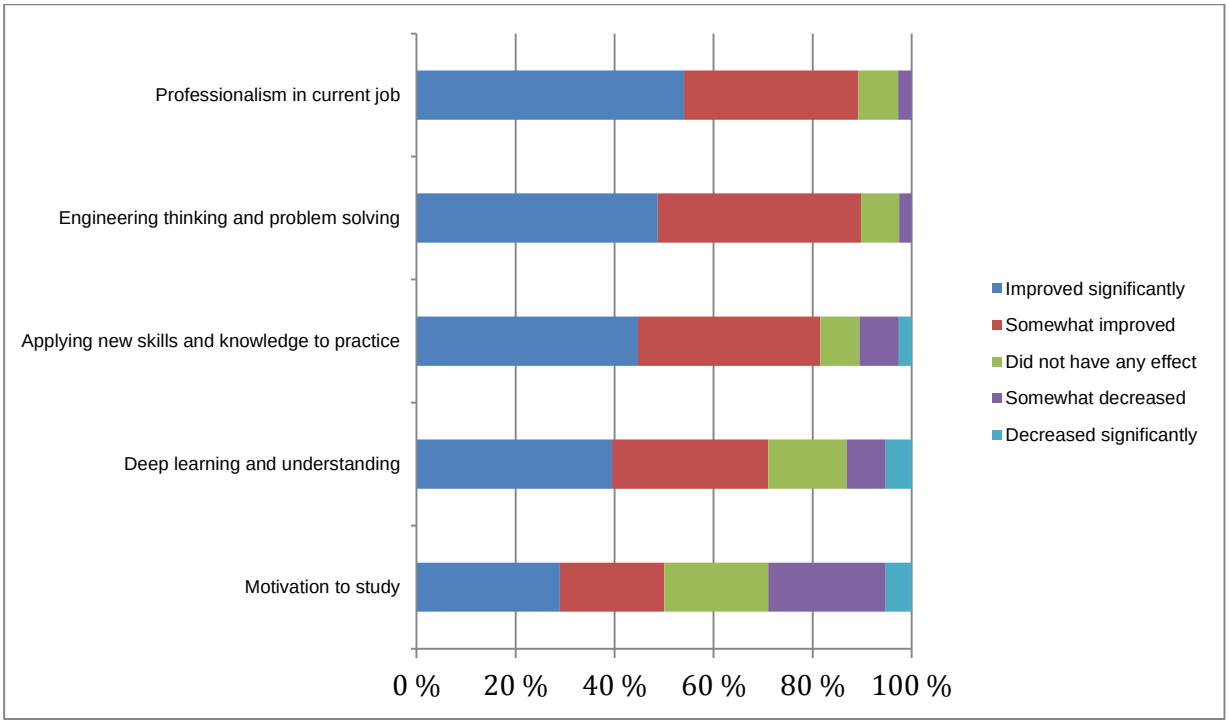

Figure 2. Answers from the graduates to the questions “How did the working for pay during your last year of studies affect on…” (n=38).

Effects of working for pay during studies

Additional questions were posed to the graduates on the effects of working for pay during the studies. Questions regarded effects on motivation to study, on deep learning and understanding of the new knowledge and skills, on the ability to apply new skills and knowledge to practice, on the engineering way of thinking and problem solving, and on graduates’ professionalism in their current job. 76.3% of all 190 answers were indicating a positive effect; the skill was either significantly or somewhat improved. 11.6% of all answers showed a negative effect where a particular skill was either somewhat or significantly

decreased due to working for pay during studies. Figure 2 shows results on these questions. Answers from the graduates who had participated in a CDIO capstone project (n=8) did not have significant differences to the rest of the group.

Figure 2 shows that the most common reported impacts of working during the last year of studies are improved professionalism in the current job and improved engineering thinking and problem solving skills. Decreased motivation to study is the main negative finding (29% of responders) in this study, however, 50% of responders reported on increased motivation to study.

A surprising finding was that these effects did not correlate (R^2 = 0.002 – 0.065) with the amount of weekly hours during the last year of studies. The survey data did not show a significant difference between students working 7.5 hours in a week or more than 30 hours a week and the rest of the group. Only three students responded “Skill decreased significantly” on any of the questions. Two of them were working more than 35 hours weekly. The low number of responses prevents the drawing of any conclusions on the negative effect when working over 35 hours weekly.

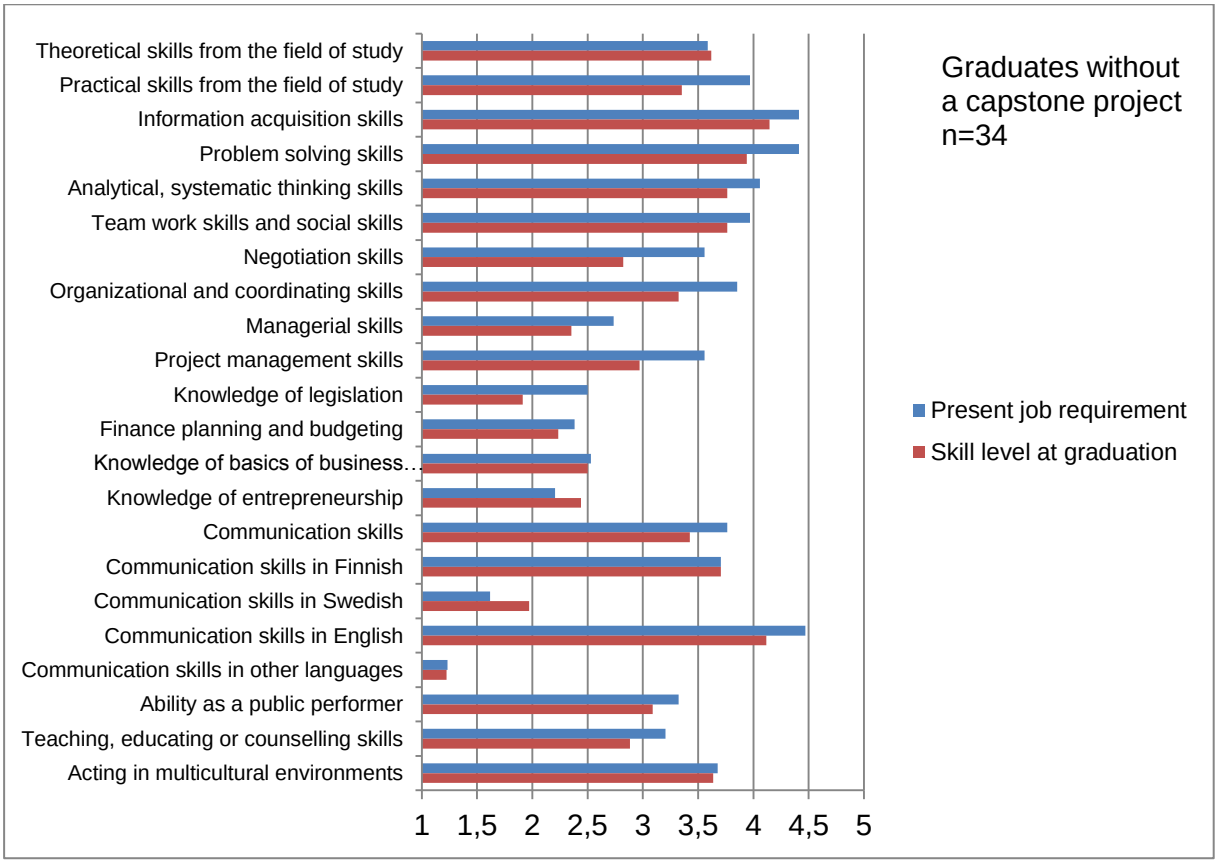

Figure 3. Present job requirements and self-estimated skill levels at the time of graduation in different working life skills among students who did not participate in a capstone project (n=34).

All findings indicate clearly more positive than negative impacts from working during the studies, virtually independent of the amount of weekly working hours. Earlier studies indicate negative effects on some students, like conflict of interest, a sense of pulling students in two directions and feeling constantly overloaded and stressed (Watts and Pickering, 2000), or

less time than desired for social activities, study and recreation (Mathei and Gilmore, 2005). These effects were not studied in this survey. Instead of working in their own topical area of studies, students studied in these surveys were working mainly in retail, pubs, wine bars and restaurants. Although similarities in working life soft skill requirements exist, employment among engineering students seems to be somewhat different.

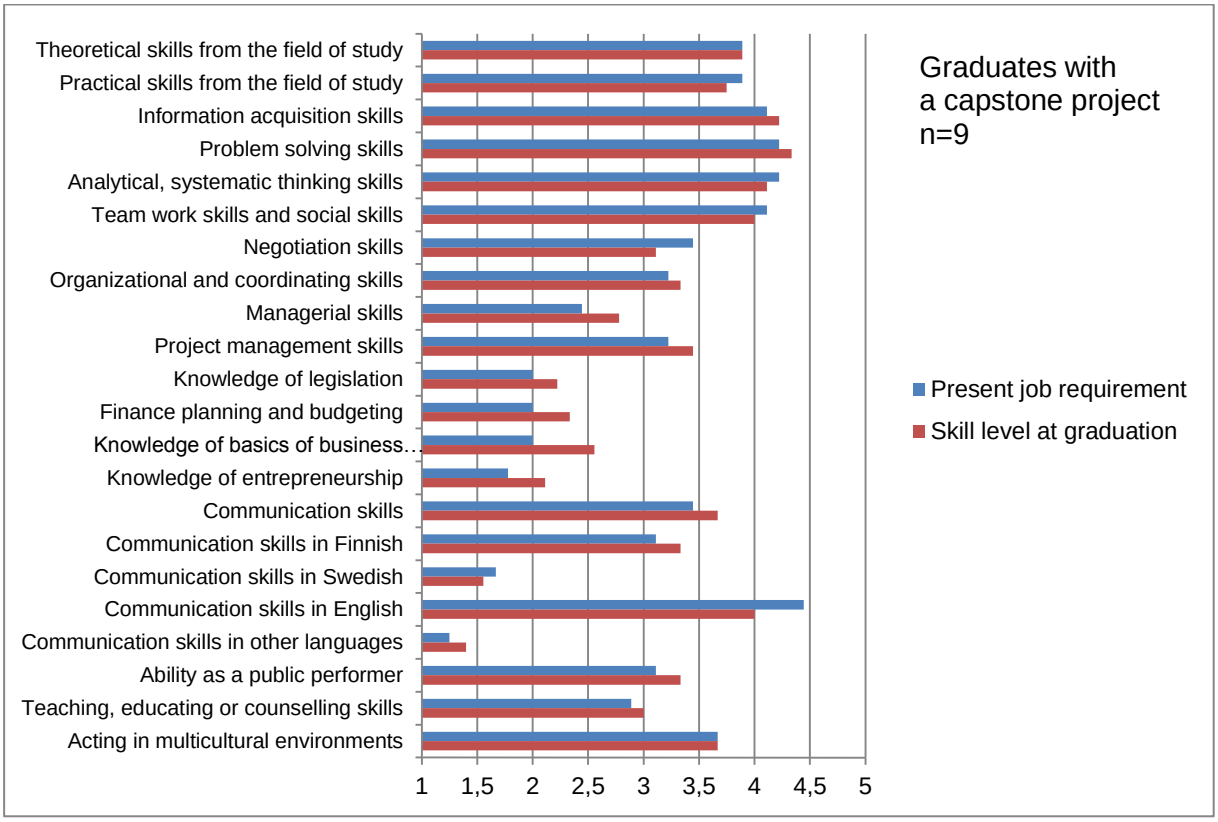

Figure 4. Present job requirements and self-estimated skill levels at the time of graduation in different working life skills among students who participated in a capstone project (n=9)

Working life skills at graduation and requirements in the present job

A list of 22 working life skills was presented in the survey with a double question: “How important are the following skills and knowledge in your current job and how well did you manage them when you graduated?” The results of these questions are presented in two groups: figure 3 shows the answers from graduates who did not join a capstone project (n=34) and figure 4 the answers from the graduates who participated in a capstone project (n=9). The main skill gaps (>0.2) are listed in tables 2 and 3. Despite the small number of responders, the results from the responders following the full CDIO curriculum and joining a capstone project show a clear improvement in filling the gaps in the skills required by the job.

Table 2. The self-estimated skill gaps among the graduates who joined a capstone project (n=9). (1=skill needed/managed not at all, 5=skill extremely important/managed skill very well)

	Present job requirement	Skill level at graduation	Difference
Communication skills in English	4,44	4,00	-0,44
Negotiation skills	3,44	3,11	-0,33

Theoretical skills from the field of study were well matched with job requirements also in the older surveys from Career Services of the University of Turku (2015) indicating a traditional strength on basic theories at the university.

Table 3. The self-estimated skill gaps from the group not joining in a capstone project (n=34) (1=skill managed/needed not at all, 5=skill extremely important/managed skill very well)

	Present job requirement	Skill level at graduation	Difference
Negotiation skills	3,56	2,82	-0,65
Practical skills from the field of study	3,97	3,35	-0,52
Knowledge of legislation	2,50	1,91	-0,42
Project management skills	3,56	2,97	-0,42
Organizational and coordinating skills	3,85	3,32	-0,40
Communication skills in English	4,47	4,12	-0,37
Problem solving skills	4,41	3,94	-0,35
Analytical, systematic thinking skills	4,06	3,76	-0,26
Managerial skills	2,74	2,35	-0,23
Teaching, educating or counselling skills	3,21	2,88	-0,23
Communication skills	3,76	3,42	-0,22

Career Services of the University of Turku has an annual survey for all its students one and five years after the graduation. The survey has a few similar questions with this study, and provides interesting reference material from earlier years. Table 4 indicates the skill gaps from students that graduated in 2009-2013 from the Department of Information Technology. The results are rescaled to match this study.

Table 4. The self-estimated skill gaps from a previous study on 2009-2013 graduates (Career Services of the University of Turku, 2015), rescaled to match this study

	Present job requirement	How well improved at the university	Difference
Practical skills from the field of study	4,42	2,50	-1,92
Negotiation skills	3,33	1,92	-1,42
Problem solving skills	4,67	3,58	-1,08
Communication skills in English	4,33	3,29	-1,04
Team work skills and social skills	4,17	3,17	-1,00
Organizational and coordinating skills	3,58	2,58	-1,00
Information acquisition skills	4,50	3,58	-0,92
Project management skills	3,50	2,67	-0,83
Communication skills in Finnish	4,21	3,42	-0,79
Ability as a public performer	3,75	3,00	-0,75
Analytical, systematic thinking skills	4,25	3,92	-0,33

The skills with largest gaps seem to be almost the same in the earlier study by the Career Services from the University of Turku. The study presented in this paper indicates that most of the skill gaps are presently remarkably smaller or fulfilled. The number of responders fully following the new CDIO curriculum is small, but it indicates further progress in matching the graduate skills to the job requirements. The engineering education in University of Turku has clearly been developing in the correct way.

CONCLUSION

The number of responders in this survey is quite small, especially in terms of students joining a CDIO capstone project, but it shows a clear improvement on the self-estimated skill gaps between students' competences at graduation and the requirements of their engineering jobs. Reference data on 2009-2013 graduates indicate the same trend as quite a large gap in for example practical skills in the students' own topical area of studies has almost disappeared. Other skills with a clear improvement include project management skills and negotiation skills. The new CDIO-style curriculum from 2012 as a whole is clearly working as planned.

The amount of work for pay the students do during the studies is very large especially during the final year. Many students are working full-time; studying seems to be more like a part-time activity. Employment indicates clear benefits in many topics, like the engineering way of thinking and problem solving (90%), professionalism in the current job (89%) and applying the learned skills and knowledge into practice (82%). These benefits do not correlate with the hours of weekly working for pay during the studies; one day per week would be enough.

This survey did not indicate the difference found by Tuononen et al.(2015) in deep learning between working on own topical area of study or in another job. Only a few of the students were working in areas not connected to their studies, making this result unreliable. Negative effects of the employment, such as additional stress and possible problems with passing the courses were not covered in this survey. Earlier studies have shown such effects reported by a minority of the students (Holmes, 2008; Watts and Pickering, 2000; Mathei & Gilmore, 2005; Robotham, 2008).

The study shows a clear correlation between the amount of working during the studies and the delay in graduation among engineering students at University of Turku. Most of the students are employed before graduation. Additional motivation for the graduation would be needed, either a bonus for timely graduation or a tuition fee or equivalent for extra years. On the other hand, the students employed before graduation are already working and tax paying citizens of the community and one can question what the benefit of timely graduation is in these cases. Moreover, Tuononen et al. (2015) showed that the deep learning approach has a negative relation to study pace.

The graduation delay of international students in this survey was small; motivation for timely graduation is provided by the immigration office in the form of limited-duration residence permits for foreign students.

This study will continue towards developing an annual feedback survey with a direct connection to curriculum design. The best way to reach the graduates seems to be the LinkedIn service, taken further with a possible LinkedIn Alumni group for graduates of the department. Some Alumni reached in this survey are already participating as visiting lecturers in a course called Engineering Working Life Skills.

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