KNOWLEDGE GAINED BY WORKING IN UNIVERSITY–INDUSTRY COLLABORATION PROJECTS

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ABSTRACT

Many surveys from recent years emphasize the interdisciplinary skills of job candidates, such as communication, organization, teamwork and social skills. Companies tend to value practical work experience that provides evidence of the applicant's capabilities and potential. The CDIO initiative also adduces the importance of interpersonal skills. The CDIO Standard 7, Integrated Learning Experiences, sets the focus on fostering the learning of disciplinary knowledge simultaneously with personal and interpersonal skills as well as product, process, and system building skills. Accordingly, the CDIO Standard 8, Active Learning, engages students in analytical thinking and problem-solving activities, strengthening also the students' motivation and reflection on what they have learned. Students ought to gain both disciplinary and interdisciplinary knowledge in order to become future engineering professionals. Usually, courses in higher education provide fundamental knowledge and skills during the studies. In addition, students should work in authentic contexts and environments to deepen their competences and thus, become more ready for working life. This case study analyzes a set of soft skills students have attained by working in "theFIRMA", a project-based learning environment at Turku University of Applied Sciences (TUAS), Finland. The analyze is done based on the survey done for the alumni of the learning environment. The results of the survey indicate that theFIRMA or its previous forms have had a great impact on the work possibilities and the skills students have attained while working in the learning environment. In addition, the most valued interpersonal skills of the alumni are the same skills that the companies recruiting value the most. Thus, it seems that the integration of project-based learning and interpersonal skills works smoothly.

KEYWORDS

Soft skills, university-industry collaboration, project-based learning, ICT, R&D learning environment, Standards: 7 and 8.

INTRODUCTION

Soft skills allude to an extensive set of skills, competencies, behaviors, attitudes, and personal qualities that enable people to effectively navigate their environment, work well with others, perform well, and achieve their goals (Lippman, Ryberg, Carney, Moore, 2015). Many surveys from recent years emphasize the interdisciplinary skills of job candidates, such as

communication, organization, teamwork and social skills and critical thinking (Berger, 2016; Morning Consult, 2019). Morning Consult conducted an online survey in September 2018 for Cengage. The companies found out that according to 502 hiring managers and 150 HR decision-makers, the top skills they're hunting for among new hires are: 1) The ability to listen (74%); 2) Attention to detail and attentiveness (70%); 3) Effective communication (69%); 4) Critical thinking (67%); 5) Strong interpersonal abilities (65%); and 6) Being able to keep learning (65%) (Morning Consult, 2019).

Jobs requiring high levels of social interaction grew by almost 12 percentage points between 1980 and 2012 while math intensive but less social jobs shrank by 3.3 percentage points. However, in jobs that require high levels of both math skills and social skills, employment and wage growth was particularly strong. Skills in social situations have evolved over thousands of years and for example, reading the minds of others and reacting on them is an unconscious process. There is a growing demand for social skills and one reason for this is that computers are still poor at simulating human interaction (Deming, 2015; 2017).

Thus, engineering degree programs are challenged to create different ways for students to learn not only core and technical subjects but also this kind of interdisciplinary or soft skills (Martins & Ferreira, 2016). However, there is a tension between the two main objectives in engineering education: the need to educate students as specialists in a range of technologies – while at the same time teaching students how to evolve as generalists in personal and interpersonal skills (Crawley, Malmqvist, Östlund & Brodeur, 2007). Project-based education is at the core of the CDIO-inspired programs, meaning that students ought to be trained in contexts complex enough to be prepared for the complexity of industry projects (Einarson & Saplacan, 2017). The CDIO Standard 7, Integrated Learning Experiences, sets the focus on fostering the learning of disciplinary knowledge simultaneously with personal and interpersonal skills as well as product, process, and system building skills. Accordingly, the CDIO Standard 8, Active Learning, engages students in analytical thinking and problem-solving activities, strengthening also the students' motivation and reflection on what they have learned (Crawley et al., 2007).

In this paper, the focus is set on studying the impact of theFIRMA project-learning environment (and its previous forms) for its alumni who have attained skills in university-industry collaboration projects. The main research questions are: 1) What kind of soft skills did the students attain while working in the project office?; 2). What kind of impact did it have on getting employed?; 3) How did the learning experiences affect the career path decisions? In addition, the skills students attained while working in theFIRMA are compared to the skills companies' value the most. First, the operations in theFIRMA are introduced. Thereafter, the survey done for the alumni is being described and compared to the results from the companies. Finally, the past and current activities are being discussed, and future development thoughts are presented.

theFIRMA PROJECT OFFICE

The project office theFIRMA provides ICT-focused development projects to small and medium-sized companies (SMEs) and third-sector organizations. All the projects are conceived based on the needs of a customer and typical assignments include web development, small-scale game prototypes, graphic design and end-user training. In addition, theFIRMA participates in several externally funded R&D projects. Project office theFIRMA was established in 2015 when the previous learning environments of TUAS' ICT unit were merged. Previously there were four

different learning environments: "Education Support Centre Finland", "Network Support Centre Finland", "ICT-portti" and "Citizen's Helpdesk". The main objective of combining the learning environments of TUAS' ICT unit was to increase the performance of the learning environment, standardize processes and expand the operation (Säisä, Määttä and Roslöf, 2017).

TheFIRMA operates like a real company: A student CEO leads the office and student project managers are responsible for leading the customer projects. Teachers and other staff members mentor the students. Multicultural and multidisciplinary teams work together in challenging assignments to meet the goals of the projects and their customers. Students attain relevant disciplinary and interdisciplinary skills by participating in the projects in different roles. Teamwork is very important to the development of an engineer's work because many projects involve several professionals in a multidisciplinary approach and aspects such as leadership and communication are essential to achieve goals successfully (Martins & Ferreira, 2016). For more detailed information about theFIRMA, see https://thefirma.fi/?page_id=1181.

ALUMNI SURVEY

Based on the earlier feedback of the alumni, there are three ways that theFIRMA has had an impact on the students: 1) Technical skills; 2) Soft skills; and 3) Networking with other students and local companies. This new survey was solely focused on the soft skills that students have attained while working in the project office. The reason for this point of view is that the learning activities have been done in many different development projects. Thus, analysis of the different technical skills attained would have been very complex. For example, the project assignments have included repairing computers and installing cybersecurity software, applying Microsoft products and services to different customer needs, and troubleshooting computer networks etc. That is, the main goal of the survey was to study the impacts of project-based learning for the alumni who have attained skills in these university-industry collaboration projects. The main questions were: 1) What kind of soft skills did the students attain while working in the project office?; 2) What kind of impact did it have on getting employed?; 3) How did the learning experiences affect the career path decisions?

The survey included 10 questions. The first four questions dealt with background data: The learning environment version that the respondent worked in, gender, age, and the graduation year of the respondent. Question five examined the respondents' current position in working life. Question six presented a set of 15 different social skills and asked which of these skills the respondent learned while working in theFIRMA or its previous forms. Questions seven and eight examined on a scale 1–5 how much these soft skills had an impact on getting employed. Question nine examined how much effect the working in the learning environment had on getting employed. Question 10 examined how the learning experiences affected the career path decisions of the respondents.

The survey was sent to the alumni via LinkedIn, Facebook and e-mail (N=100).

RESULTS OF THE SURVEY

The total amount of respondents was 33 (18 of the respondents had worked in theFIRMA, nine of the respondents had worked in ESC Finland, five of the respondents had worked in ICT-portti and one of the respondents had worked in Citizen's Microdesk). Age and gender of the

respondents is presented in Figure 1. The graduation year varied between 2005 and "not yet graduated".
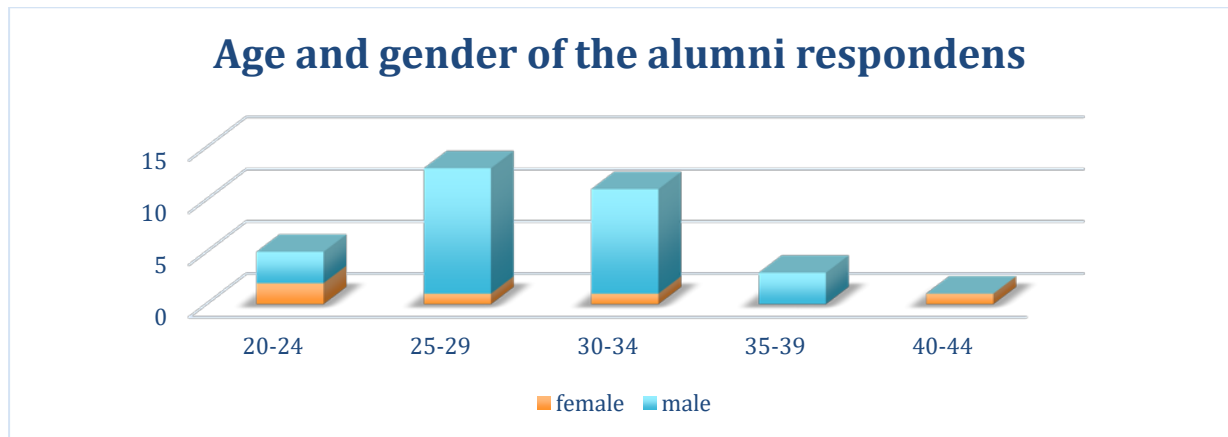
Age and gender of the alumni respondens

Figure 1: Age and gender of the alumni respondents

A bit less than one-tenth (9.4%) of the respondents work in an executive position in working life. 12.5% of the respondents work in middle management. The majority of the respondents (40.6%) work as senior-level specialists and a bit more than a third (34.4%) as junior-level specialists. One respondent (3.1%) works a clerk and one did not answer this question. The positions of the respondents are presented in Figure 2.
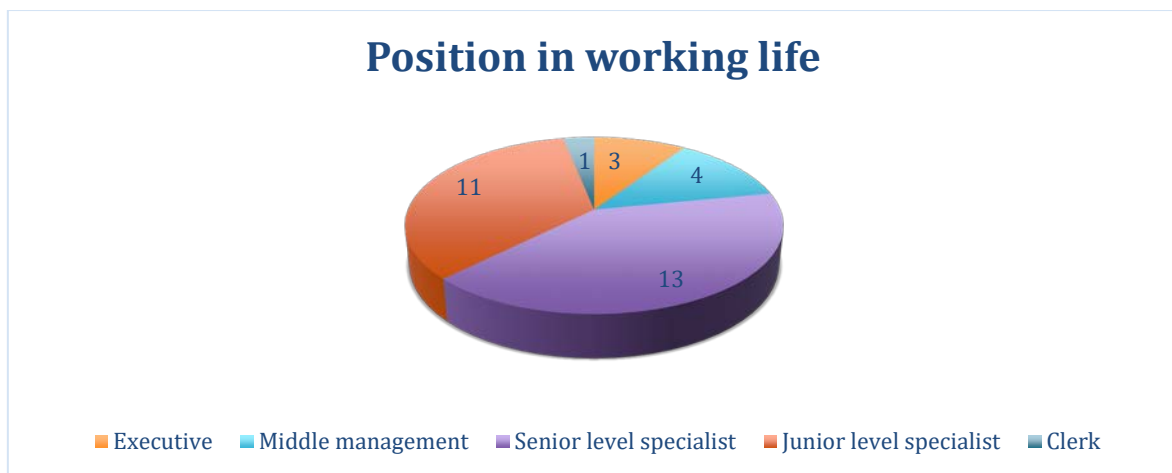
Position in working life

Figure 2: Position in working life of the alumni respondents

The first content question of the survey was to find out what kind of soft skills did the students attain while working in the project office. The soft skills that the respondents had experienced learning are presented in Figure 3. Communication, teamwork, problem-solving and leadership (n>20) were the skills that the respondents indicated the most. Time management, interpersonal skills, motivation and enthusiasm, organizational skills and presentation skills were also quite common answers (16<n<20). The soft skills that the respondents felt to have learned the least were flexibility, work ethics, creativity, negotiation, handling feedback and analytical skills (7<n<15).
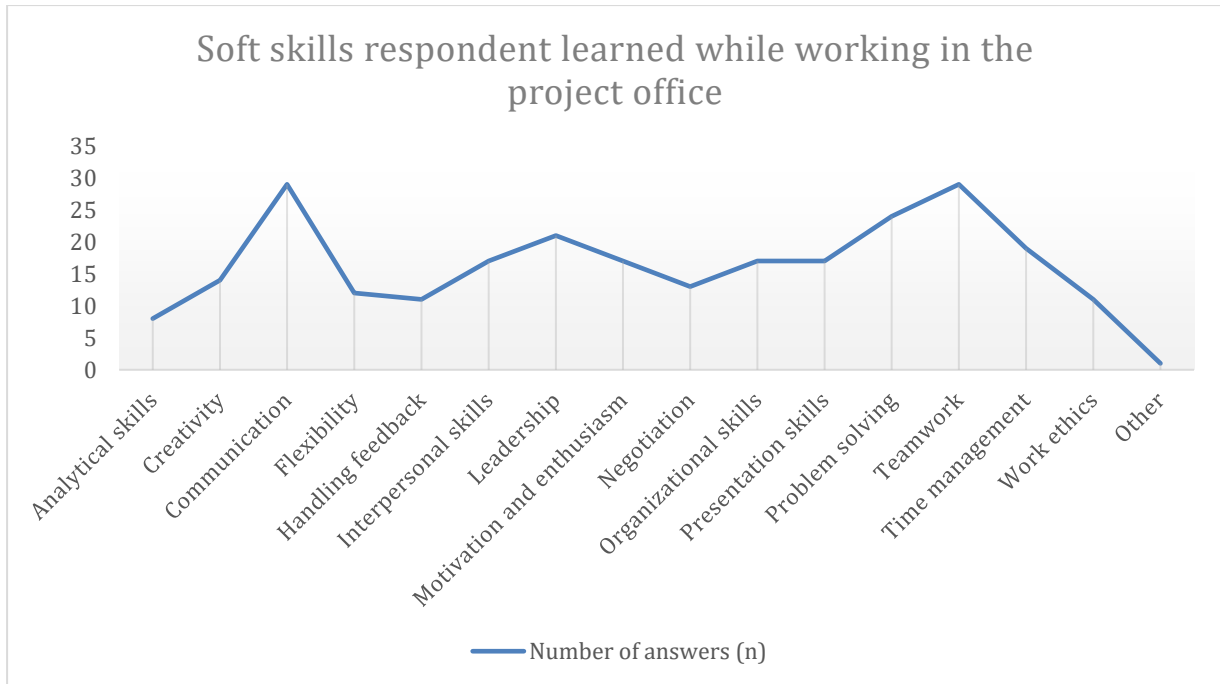
Figure 3: Soft skills learned while working in the learning environment

The second main question was to find out the impact of these skills and experiences had on employability. Communication, teamwork, problem solving, interpersonal skills, and motivation and enthusiasm were reported to have had the most impact on getting employed. For these, the percentage of replies between marks 4–5 was over 65%. Leadership, analytical, negotiation and time management skills had least impact. The impact scales of the different skills is presented in Figure 4.
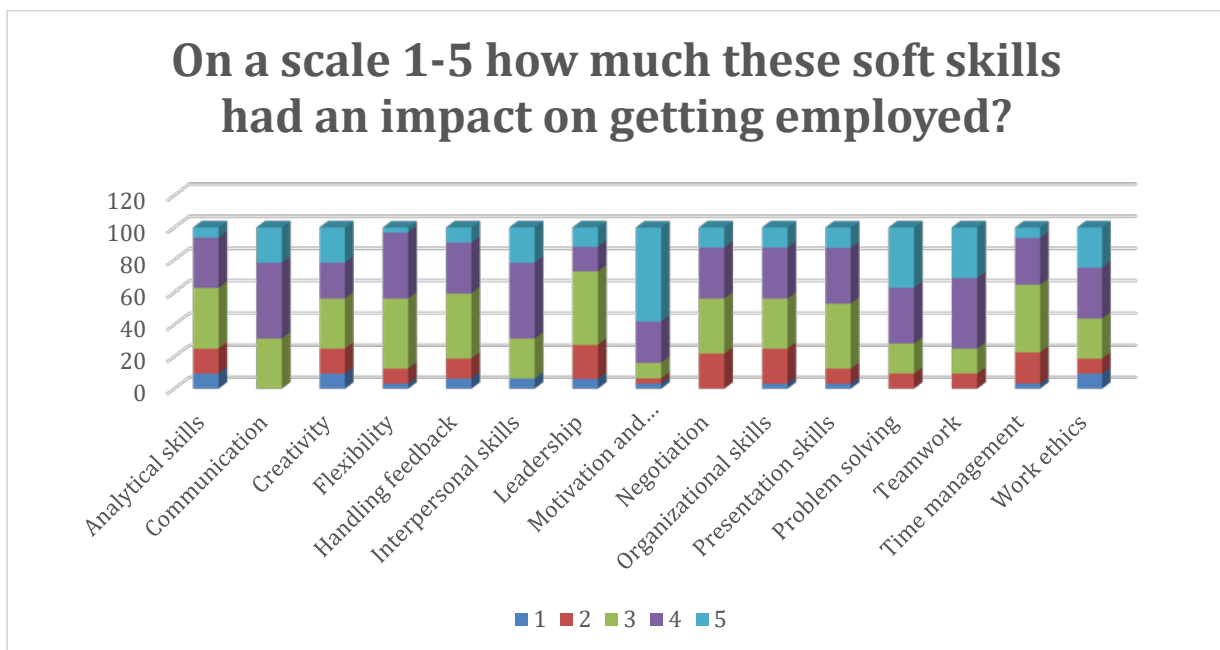

Figure 4: The impact scales of different skills (1 = lowest impact, 5 = highest impact)

When the respondents were asked to estimate on scale 1–10 how much their project-learning experiences affected getting employed, the answers varied mostly between 5–10 (average 7.8). The answers are presented in Figure 5. When comparing the answers between the learning environments, alumni from ESC Finland have had the biggest impact on getting employed with an average of 9. TheFIRMA learning environment had the second-best average 7.6. However, in theFIRMA, there was one answer with rating one and another answer with rating 4, which were the two lowest answers for the question. Also, the length of the professional career of the respondents may have an effect on this reflection. One of theFIRMA alumni respondents sent a message after completing the survey and told that this was a difficult question, since he has not yet found a job after graduation and, therefore, gave a really poor estimation. ICT-portti had an average of 6.8 and Citizen's Microdesk had an average of 5 with only one answer. In other words, it is not possible to find significant differences between the different development versions of the learning environments based on these results.

However, one of the differences between theFIRMA and ESC Finland is the amount of students that work in the learning environment. In the ESC, there were around 30–40 students working each year. Most of the students worked there for several months or even several years. In theFIRMA, some students study only a few credits whereas other students might study a major part of their degree there (Määttä, Roslöf & Säisä, 2017). Thus, it would have been a good idea to ask also, for how long the alumni worked in the environment. In this way, the correlation between the amounts of time the student worked in the environment and the impact on getting employed could have been analyzed.
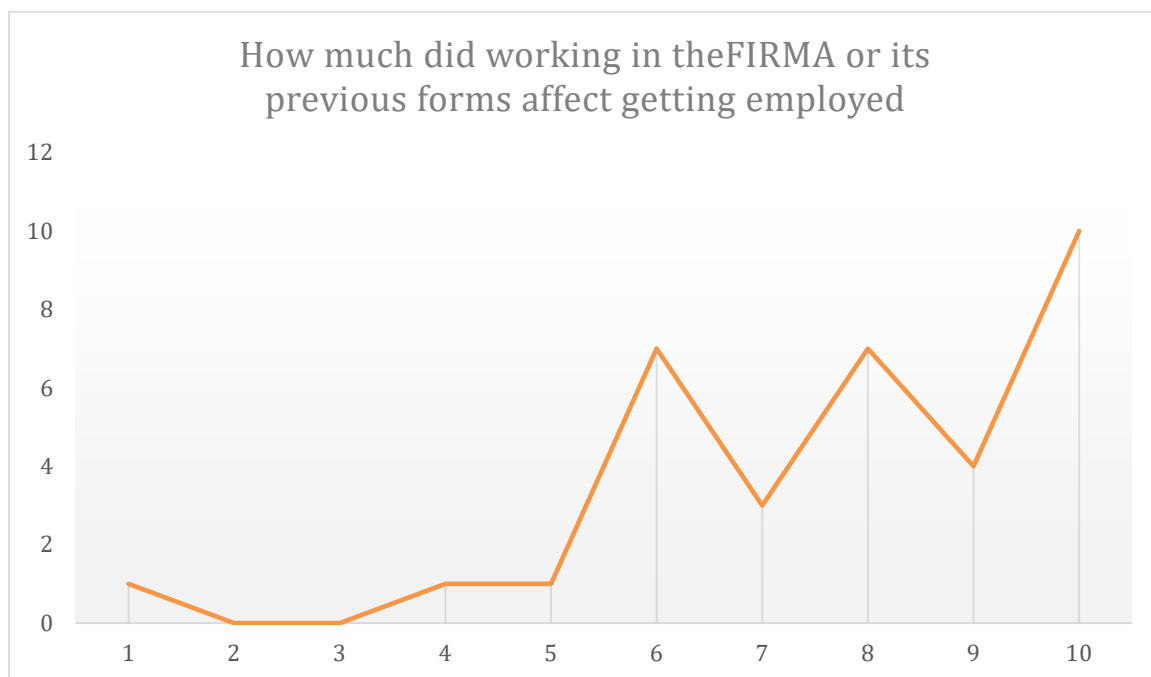

Figure 5: The impact on getting employed (1 = lowest impact, 10 = highest impact) (number of responses)

The last content question of the survey was to find out how the learning experiences affected career path decisions. The answers were given in free text form and 27 of the respondents

answered this question. Based on the answers, they can be categorized as follows: 1) Technical skills; 2) Soft skills; and 3) Networking – or a combination of these. Yet, one of the respondents felt that working in ESC did not affect getting employed in any way.

Most of the answers were related to technical skills. One of the main topics that arise from the answers was related to getting in touch with an interesting field of IT:

> "Working in ESC solidified the idea to work in a server environment and gave me valuable insight on what it might look like. Worked with anything Microsoft related from Windows Server and its basic features to OCS and Lync, SCCM, Virtualization and so on. Still work in the field doing the same stuff as a systems architect."

Quite often, the topics that students work within the project office are something that they get familiar with also after graduation:

> "The subjects in projects had topics on ERP software and invoicing software and a lot of web software development which brought experience on these topics. The job I got after theFirma used similar technologies and the business field was on a nearby domain with the projects. The experience in theFirma had a heavy effect on my career."

Quite many of the respondents felt like the work experience attained from the learning environment helped in soft skills as well:

> "In theFIRMA, I worked as a student CEO and student project manager in various projects. I learned a lot about working with different people and got the basic understanding on management tasks. Currently I work as a project manager in IT company, so all of the skills I learned in theFIRMA have been very useful. I doubt that I would be in my current position without the experience gained from theFIRMA. …"

The career path for many started already in the learning environment:

> "Worked in a manager role in ESC Finland. My responsibility was to share work tasks for teams and communicate with customers. And also did Windows servers administration on-premises and cloud. It had a huge benefit to my current position where I work nowadays. Keep up the good work!"

Networking is emphasized for the students. Moreover, when asked, many of the students say that the atmosphere and the people are the best things in the environment. It is not rare, that the students come across in working life after graduation. Thus, networking with other students is important already while studying. In addition, networking with alumni students and local companies is important for the future. One of the great networking stories were also presented in the answers:

> "I got my first IT summer job through the connections of ESC alumni and the manager later got me a job at a large IT company two years before graduating. This set me on a path where I spent 'a bit' of extra time to officially graduate but at that point, I already had a lot of real life experience from numerous projects and even an architect position under my belt. During my time in ESC, my colleagues and I actively participated in different events and hackathons and due to that I connected with some important people in the IT circles. I was mainly focused on web and mobile development and through a series of events; I ended up working as an IT consultant in another European

country eight months after graduating. There is no denying that working in ESC played an important role in my career path. I already had a long experience with programming but managed to meet the right people and built very important relationships throughout the years. To summarize, ESC gave me the confidence to aim higher than average, which resulted in seeking higher positions than what my actual work experience would suggest. The soft skills that I learned during that time gave me a head start and I've been building on top of those strong foundations ever since".

The skills students attained are comparable to the skills companies value the most. LinkedIn analyzed different soft skills of the job-hoppers that are members of their social media platform. Based on the analysis, the most important skills are communication, organization, teamwork, always punctual, critical thinking, social skills, creativity, interpersonal communication, adaptability and friendly personality. Based on the results of the alumni survey, communication, teamwork, problem-solving, interpersonal skills and motivation and enthusiasm have had the most impact on being employed. This goes hand in hand with the LinkedIn analysis.

CONCLUSIONS AND FUTURE WORK

Based on informal discussions with the alumni, the assumption was that theFIRMA or its previous forms have had a great impact on the work possibilities and the skills students have attained while working in the learning environment. The results of the survey indicate similar findings to the earlier assumptions. In addition, the most valued interpersonal skills of the alumni are the same skills that the companies recruiting value the most. Thus, it seems that the integration of project-based learning and interpersonal skills works smoothly.

From a statistical perspective, the survey was not ideal. For one, the exact number of alumni of all of the related learning environments is not known. Thus, the population of the survey included the alumni who we were able to reach. However, the main purpose of the survey was to find out the impacts of learning experiences for the alumni who have attained skills in university-industry collaboration projects. In that sense, the survey still fits its purpose.

In addition, this exercise made it clear that we ought to have better ways of communicating with our alumni. TUAS does systematical cooperation with its alumni in general, but this does not work very well for theFIRMAs purpose. We organize one or two mingling events each year for our current students and alumni, but the invitations reach only the active alumni that are part of theFIRMAs network. In the future, there should be a more standardized way to collect and maintain alumni contacts and communicate with them regularly. Currently, there is a mailing list and a Facebook group for the alumni. Since Facebook is not such a common social media among the young people anymore, the contacts were also made via LinkedIn. In the future, there will be a group for theFIRMA in LinkedIn, and when the students leave theFIRMA after a project or after graduation, they are advised to join the alumni group.

The benefit of project-based learning is dual-impact learning experiences: Students take on roles that simulate professional engineering practice and at the same time, responsibility for knowledge development transfers from the instructor to the learner. This methodology offers opportunities to use and develop higher-order learning and professional skills, such as critical thinking, teamwork and leadership (Meikleham, Hugo & Brennan, 2018). Dual learning is the key element of the project office at TUAS, too. Based on the survey results, the interpersonal and soft skills have been integrated well in the learning environment and they have an effect on getting employed and even for further future of the alumni.

There are other rather similar kinds of surveys done by the CDIO partner organizations, for example, the survey done for a BSc in Mechanical Engineering program in the Schulich School of Engineering. The survey measured twelve graduate attributes of which six were technical and six soft skills. The technical skills were: 1) A knowledge base for engineering; 2) Problem analysis & Professionalism; 3) Investigation; 4) Design; 5) Use of engineering tools; and 6) Economics & project management. The soft skills were: 7) Life-long learning; 8) Ethics and equity; 9) Communication skills; 10) Individual and teamwork; 11) Professionalism; and 12) Impact of engineering and society. The six-year study indicated that the top three self-efficacy attributes were design, life-long learning, and ethics and equity. The lowest three were knowledge base for engineering, problem analysis and use of engineering tools. (Brennan & Hugo, 2017)

The survey for theFIRMA alumni did not include technical skills, but when comparing the results of soft skills of the surveys, the respondents felt to have learned the least work ethics while, in the case of Schulich, the respondents estimated ethics and equity to be a top attribute. Then again, theFIRMA alumni respondents felt that they have learned communication, teamwork and problem solving the most while working in a project-based learning environment. In the future, work ethics is something that theFIRMA will focus more while also keeping the most learned soft skills on the top of the list.

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