Tools and inspiration for engineering education development through stakeholder cooperation

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1 INTRODUCTION

This practice-based paper presents the motivation, model and results of national level stakeholder collaboration for the development of engineering education. In addition, it presents how the results have been utilised in a case university. Stakeholder collaboration has been successfully used in the development of engineering education in Finland. University management, teachers, education developers, students as well as partners outside the universities such as industry representatives and policy makers all share an interest and a role in the development of engineering education. The Academic Engineers and Architects in Finland TEK has been active in facilitating the collaboration between key stakeholders, creating networks and forums of cooperation as well as ways of distributing the know-how and best practices of education development.

One of the recent large-scale stakeholder forums for engineering education was organised together by TEK and The Federation of Finnish Technology Industries in December 2014. The bi-annual two-day event attracted almost 90 representatives of university management, teachers, educational developers, students, industry, research centres and policy makers. It can be considered as one of the main networking and development forums in the field of engineering education in Finland. In addition to the strategic development of universities, the focus was on the future working life competencies; *namely what they are and how university education can produce such skills and competencies needed*. The aim of the forum was to create tools and share best practices supporting competencies especially for the following

multidisciplinary areas: career planning, sustainable development, innovation, and entrepreneurship as well as sales and customer service.

The key findings of the stakeholder workshop indicate that more emphasis should be put on the development of students' self-esteem and confidence, communication and networking skills and in general to the type of "Yes, I can!"- attitude. Inspiring and systematic co-operation with industry and other stakeholders, such as visiting lecturers, traineeships, project work and case studies, as well as multidisciplinary team work and utilisation of modern teaching technologies and learning facilities are some of the tools to be implemented in engineering education.

In order for the tools to have an effect on education, they need to be put into practice. This paper examines how a case university, Aalto University School of Electrical Engineering, has been implementing new ideas and best practices gathered through collaboration with other universities and stakeholders.

2 A MODEL FOR STAKEHOLDER COOPERATION IN ENGINEERING EDUCATION DEVELOPMENT

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- To (still) strengthen the cooperation and collaborative learning of the key stakeholders of engineering education.
- To strenghten the strategic development of the higher education system as well as the universities of technology.
- To enhance the development of engineering education development to fullfill the competence needs of the future.

In addition to the strategic development of universities, the focus was on the future working life competencies; *namely what they are and how can university education produce the skills and competencies needed*. The target of the Future Skills and Competencies Work Shop was to create tools and share best practices supporting competencies especially for the following multidisciplinary areas: *career planning, sustainable development, innovation and entrepreneurship as well as sales and customer service.* These themes had been chosen based on previous work shops and long term collaboration with the key stakeholder groups, as well as the annual graduate feedback survey on engineering graduates [1, 2, 3]. Figure 1 presents feedback survey results from graduates of 2014. It pictures the assessment of various working life skills; their perceived importance and development within formal studies and through work experience gained prior to graduation. As can be seen, the

competencies related to entrepreneurial skills (skill number 8), ethical consciousness (11) and job applying skills (23) are regarded less important than many other skills and competencies. These skills are also less developed than many of the other skills. However, according to the stakeholder collaboration [1, 2] and discussions, the importance of these skills should on the contrary be emphasized much more in the engineering education.

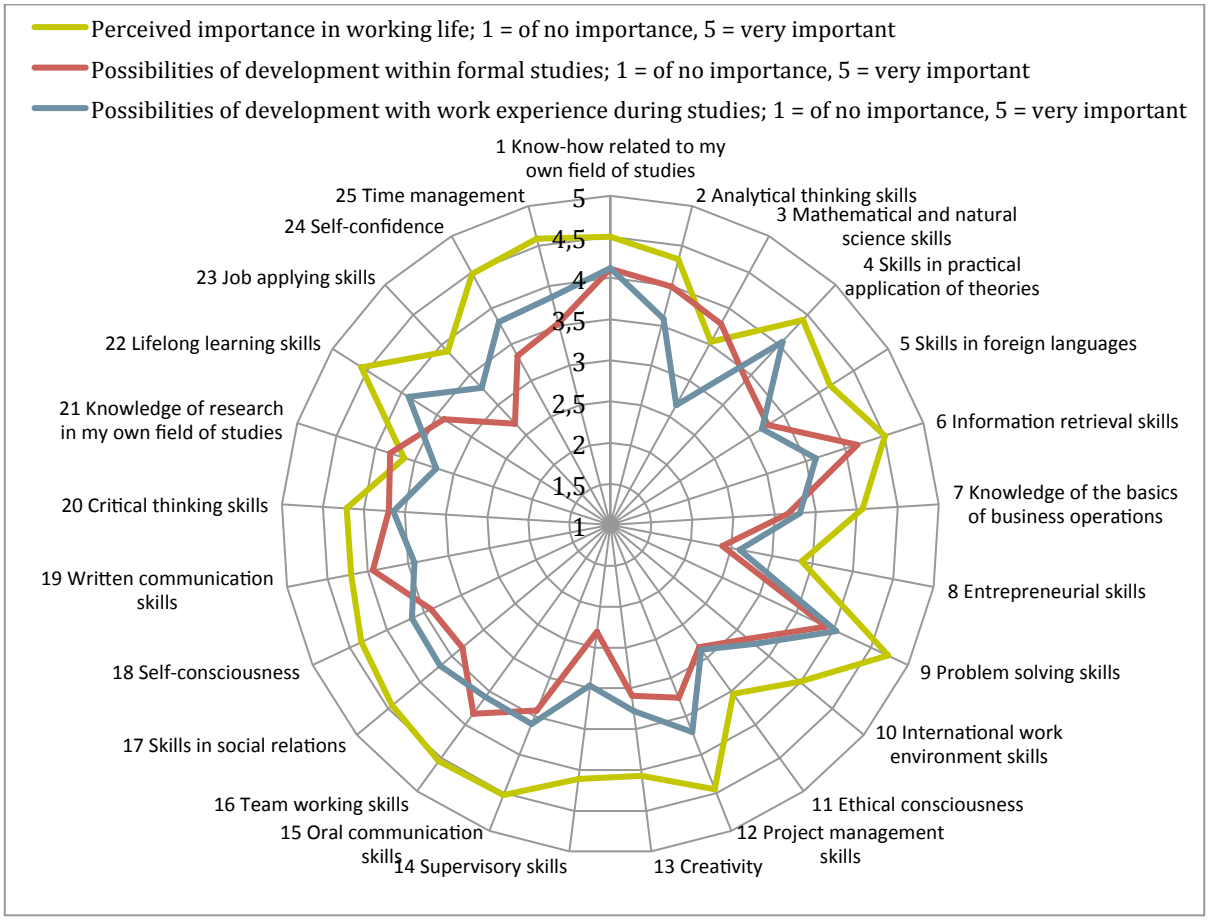

Figure 1. Annual feedback survey on engineering graduates: Importance and development of skills and competencies

3 THEMES OF "FUTURE SKILLS AND COMPETENCIES" WORKSHOP

3.1 Career Competencies

Changes in working life and re-structuration in many fields in the society bring about a new concept of a career. It can be stated that highly educated professionals, including engineers, need to be equipped for a new type of career development as well. Career specialists discuss a 'patchwork' career, meaning that an individual´s career may consist of a number of jobs and duties, even many separate careers. In other words, individuals have to seek jobs and may have to be ready to start again in a different area or a field of technology. Nowadays, even a Master's degree in engineering does not guarantee a steady employment and linear career path.

One of the global megatrends affecting careers and (working) life in general is digitalisation. Its effects are yet unknown to us. Ways of working and organisations

are in change. Therefore, the concepts for career and work will change as well. The essential question for the universities is that which career competencies are necessary for their graduates. In addition, how universities are able to foresight these competencies and implement them in engineering curricula in the future. [4, 5]

3.2 Competence on sustainable development

Engineers typically work in expert, managerial or leadership positions. Their work, decisions and attitudes have an impact on the entire society. It could be argued that engineers have a key role in creating as well as promoting and further implementing sustainable products, processes and technologies. Sustainable development should not only be regarded as a necessity or a question of responsibility, but also as a great opportunity. For instance, sustainable solutions for energy or materials production could create immense business opportunities. Sustainable development should also be seen as a chance to promote the positive role and effectiveness of engineers in the whole society.Technology and, thus, engineers have a relevant role in solving the challenges of sustainable development area. This is a great responsibility but an excessive opportunity for the entire profession as well. The question is what type of competencies engineers need in order to solve the challenges of a sustainable society and how universities can produce them.

3.3 Competence on entrepreneurship and innovation

The large companies are not the sole employers of engineers. Instead, the jobs are increasingly created by small and medium sized companies. Engineers should be educated to become job creators instead of job seekers. Entrepreneurship and innovation competencies have a key role in this. Entrepreneurial attitude should be emphasised in the engineering education in various ways. The theme has been increasingly on the agenda of universities, but there is still a long way to go.

3.4 Competence on sales and customer service

“The teaching of international marketing and sales are not fulfilling the needs of companies. These skills are clearly undervalued especially in the field of engineering education. The competence on sales and marketing should be included in the curricula on all levels of education. This calls for deeper cooperation between educational institutes, companies and international experts.”

- *The Federation of Finnish Technology Industries, 2014*

The changes in the operating field place new competence demands for the companies. There is a continuous need for personnel with adequate skills on international sales and marketing and international commerce in general. However, the lack of suitable personnel is hindering the internationalisation of (Finnish) companies.

The markets and ways of doing business are changing as well. The industrial internet and possibilities of digitalisation are still underutilised. The means of financing international commerce, as well as knowledge on international market operations are often not sufficiently known within small and medium sized companies.

The markets are highly specialized, scattered and difficult to identify. According to a study made by Confederation of Finnish Industries, 92 % of companies would like to invest in internationalisation, but the shortage of competent work force hinders them. The question is what kind of competencies best support international sales and marketing and how universities can produce competent work force for companies.

4 RESULTS OF THE "FUTURE SKILLS AND COMPETENCIES" WORKSHOP

4.1 Career competencies: Soft skills are hard work

The workshop team working on career competencies came to the conclusion that in addition to the engineering expertise, the so called soft skills play an important role in current and even more in tomorrow´s working life. Soft skills usually refer to communication, interaction, reflection and other social skills.

A good CV and an up-to-date LinkedIn profile are self-evident, but in order to create a good career an individual needs more. It is utmost important to be able to recognise and describe one´s skills and competencies to others, as well as the ability for lifelong learning. In addition to the marketing skills of one´s own prestige, social skills and networks are the key to survive in future working life as well. Also, the ability to retrieve, perceive and apply relevant information is regarded as fundamental career competencies.

According to the results of this workshop team, the career competencies of highly educated professionals are ideally developed through cooperation of the individual, university and companies. Although the individual has the responsibility for his/her personal development, the academic community (i.e. university) and the working life create the framework where to practice. The focus should not solely be on the curricula, let alone substance of individual courses, but instead on the teaching methods and environments supporting the development of interaction, self-esteem and multi-disciplinarity.

The cumulative development of self-esteem starts at the first year's studies and continues throughout them, creating a foundation for the career competencies. Group working, for instance, supports the important skills but it is not sufficient. Structured reflection and feedback are needed as well. The workshop team also listed some practical tools or exercises to support career competencies development:

- Simulation of recruitment situations in the courses (e.g. students themselves have to apply for a course, or students try to find a suitable candidate for an open job offer by looking at LinkedIn profiles, or by listing their own strengths for an open job.
- A learning diary / study journal from a (summer) traineeship or other work experience supports the analysis and description of competence development.

4.2 Competence on Sustainable development: It´s all about values and attitudes!

When talking about sustainable development, one often tends to think of the "pure" engineering competence aiming at saving energy, natural resources or improving the environment. We talk about recycling, renewable energy, measuring of CO_2-emissions and effective logistics. Nevertheless, sustainable development is a much broader concept than just the technology and the competence on how to use it. *Sustainable development should be regarded as a way of thinking, values and attitudes*. Creating a state of mind favourable for sustainable development could be seen as an educational challenge. However, this is not only on universities' account. When referring to sustainable development competence, we could talk about life cycle model; the development starts at birth and continues throughout the entire life of an individual.

How can sustainable development skills be taught? According to the results of this working group, real-life cases and hands-on experience have a significant role. It can be something that brings sustainability as a part of the actions and everyday life of an individual (a student). Values and attitudes are affected by good practices and examples. The workshop team also itemised some practical tools or exercises to support the development sustainability competencies:

- Solar panels and wind energy production at campus.
- Consumption of electricity and water at campus are seen on-line by everyone.
- These measures (used e.g. at Lappeenranta University of Technology, Finland) show students that one lives as one preaches.
- Another good example from Vaasa University, Finland: students of electrical engineering carried out a project aiming at diminishing the energy consumption of a local library. This real-life multidisciplinary case combined the different perspectives of the modern society: sustainability, technology, funds and human behaviour.
- More tools and practical examples on how to teach sustainable development competencies have been collected by TEK and experts of sustainable development (however currently only in Finnish): www.tek.fi/kestavayhteiskunta

4.3 Competence on entrepreneurship and innovation: Learning from experimenting and failure

According to the results of this working group, these are needed if the entrepreneurship and innovation competencies of university graduates are to be on adequate level. The knowledge related to creating and running a business is vital, but the mental capital is equally important for a career as an entrepreneur. Creativity, innovativeness and ability to stand the uncertainty are development in an environment supporting many types of experimenting. Success boosts student´s self-confidence, but failure may be even a better learning experience. Therefore, learning from failures should be encouraged and valued. A career as an entrepreneur is not a primary goal for every student, but the basic competencies should be included in everyone´s curricula in some way or the other.

In addition to integrating methods supporting the development of entrepreneurial attitude and competencies of graduates, the universities can promote entrepreneurship in many other ways. The universities can for example offer laboratories, equipment and other infrastructure to be used by start-up companies.

4.4 Competence on sales and customer service: the missing branch of science

Finland is highly dependent on export and international sales. However, the competencies and skills in interaction, multiculturalism and customer interface are not sufficiently emphasised in engineering education in universities. The Finnish students of technology are not as internationally minded as we like to think they are According to studies [3, 6], the amount of international experience of students varies substancially within degree programmes. In some cases almost 40 % of students do not plan to gain any intenational study or work experience. In addition to the competencies listed above, university education should also support the development of creativity, global value chain competence and the ability to collaborative learning. Like with many other competencies, also these can be developed by modern learning methods and environments and by enhancing the collaboration of teachers, researchers, students and companies. The development of skills and competencies should not be seen separately, but it should be integrated within the contents of substance courses. For instance, supporting the development of foreign language skills, interaction and presentation skills with group work and projects can be regarded as such. One only learns to communicate by communicating. The students should also be encouraged to study or gain work experience abroad. Universities should create co-ordinated, joint exchange programmes that fit well into the degrees. Good examples from international experiences should be actively communicated to the younger students. In other words, an international mind-set should be created within the students´ community.

5 IMPLEMENTING STAKEHOLDER COLLABORATION IN A CASE UNIVERSITY

At Aalto University School of Electrical Engineering (ELEC) a new Master's programmes will begin in autumn 2015. In order to receive data for the planning the curriculum and the courses, programmes have started stakeholder co-operation between various external actors. Workshops between industry and ELEC were organised in autumn 2014, in which programme management introduced the planning phase of each programme (e.g. majors, new courses). Company and industry participants could ask or suggest about new courses and their substance. In addition, workshop participants were discussing, for instance, which competencies are most needed in each field and what kind of engineers the industry partners would need in year 2020. New potential ways of stakeholder co-operation were also brainstormed. The data from the workshops were collected and documented, and it will be used in the planning and implementation of each new programme. The feedback from the industry partners was very positive, and the school's programme managers are committed to continue this process. These types of workshops will be re-organised biannually. In addition, the industry partners suggested that they would like to participate increasingly in students' actions and studies, for instance, project development and hands-on courses. According to the collected data, industrial partners appreciate good experts who still have gained soft skills and competencies in lifelong learning (e.g. can easily adapt new knowledge).

6 CONCLUSIONS

Systematic stakeholder cooperation has been used in Finland to create tools and inspiration for the engineering education development. One practical example of this is a bi-annual development forum for the universities of technology and the relevant stakeholders organised by Academic Engineers and Architects in Finland TEK and The Federation of Finnish Technology Industries. The most recent forum was organised in December 2014.

The bi-annual two-day event attracted almost 90 representatives of university management, teachers, educational developers, students, industry, research centres and policy makers. According to the feedback of the participants this kind of forum is seen as necessary and valuable. The creation of mutual trust and common goals are good bases not only for the development of current strategies, engineering programmes and degrees, but also for the sometimes inconvenient decisions of profiling of universities and distribution of national funds. The participants were asked a question: on the scale of 0 (definitely not) to 10 (definitely yes), would you recommend this forum to a colleaque or a peer? The average of responses was 9, 83 % of respondents giving 9 or 10. The participants valued the panel discussions of university management and other experts, group work with peers as well as the concrete tools and case examples on education development. In the next forums the participants would like to see more political desicion makers and stakeholders from other fields. It could be argued that the forum fullfilled the expectations and a third such event will most likely be organised again in 2016. However, the discussions and collaboration between the stakeholders of engineering education will be continued and cherished on national as well as on international level. This is seen for example in the case of Aalto University School of Electrical Engineering, where industry representatives are systematically involved with the development of the programmes content and learning environments.

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