

Professional knowledge, skills and competencies of the new graduates and the engineering professionals – comparison of the importance in working-life

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1. INTRODUCTION

The aim of this paper is to present an insight into how the knowledge, skills and competencies of the newly graduated engineers have developed through the engineering education and due to working experience gained during studies. Secondly, the paper compares the importance of the knowledge, skills and competencies of the new graduates with those of the engineering professionals who have a minimum of 5 years of post-graduate working experience.

This practice-based paper aims at presenting the important working-life skills and competencies in the field of engineering as well as the skills and competencies that should be emphasized in engineering education and further professional development.

This listing of competencies according to their importance in working life seems to be very similar across all the other age groups presented in this paper. It could be argued that it resembles the competence values of a typical engineer. The competencies are fairly similarly rated by the young, middle aged and senior engineers.

2. PARTICIPATING ORGANIZATIONS

2.1 TEK EDUCATION AND EMPLOYMENT POLICY

Academic Engineers and Architects in Finland - TEK is a service and labour market organization for highly educated professionals in the area of engineering and technology. The 73 000 members of TEK mostly hold a M.Sc. degree in engineering, technology, architecture or natural sciences. In addition to labour market issues, TEK actively participates in the development of engineering education and further professional development. This is done in close collaboration with higher education institutions, political authorities, representatives of working life and other relevant stakeholders.

One of the practical tools used for monitoring the quality of engineering education is a graduate feedback survey on the newly graduated M.Sc. engineers and architects. TEK and the Finnish universities of higher engineering education have conducted a joint feedback survey on a national scale for graduates since 2011. The main purpose of the feedback survey is to gather comparable information on the quality of the Finnish engineering M.Sc. degrees, the competencies gained by the graduates and their employment after graduation. This graduate feedback survey covers over 95 per cent of the Finnish M.Sc. engineering graduates. In 2013 60 per cent of the 2433 graduates participated in the survey.

Another tool in gathering up-to-date information on engineering education is the survey on Continuing Professional Development. The objective of the survey is to monitor the possibilities, forms and attitudes towards continuing professional development of the Finnish M.Sc. engineers. The latest survey was made in early 2014. To bring about generational differences the target group was defined to 4 groups according to year of birth: 1955, 1963, 1973 and 1981. Altogether 693 respondents took part in the survey and the response rate was 17,3 per cent.

2.2 THE ROLE OF THE STUDENT UNIONS IN DEVELOPING ENGINEERING EDUCATION IN FINLAND

Influencing and developing higher engineering education is a vast and complex process in a society. In addition to the actual higher education institutions, this involves a lot of other stakeholders. One of the relevant stakeholder groups is the student body. In Finland individual students are collectively represented by student unions. According to the Finnish University Act each university must have a student union to represent the students. The most influential administrative organs of the universities must have representatives of these three groups: professors, other staff members and students. Generally in Finnish universities, students are an integral part of the university community and the interaction between students and staff is very straightforward and non-formal.

The Student Union of Tampere University of Technology is an organization of around 7 600 members. In addition to the formal organization, the student union involves hundreds of students as volunteers helping with the supervision of students' interests, providing services for the members and working in cooperation with the university.

3. CORE COMPETENCIES AND SKILLS OF AN ENGINEER

As a part of the National Strategy Project for Finnish Engineering Education a national collaboration group coordinated by TEK published a list of competence requirements ¹ for an engineer in 2009. (Figure 1). In addition to technical core competencies, an engineer needs to master cross-disciplinary competencies and general skills. These form the basis for degree education as well as continuing education and professional development. Every engineer does not have to master all these skills and competencies, since sharing knowledge and networking are ways to deepen and widen personal knowledge into a competent team or network. However, this emphasizes the importance of collaborative learning skills and attitude. According to a recent study ² this was found to be one of the skills not being satisfactorily developed in a modern engineering education curriculum.

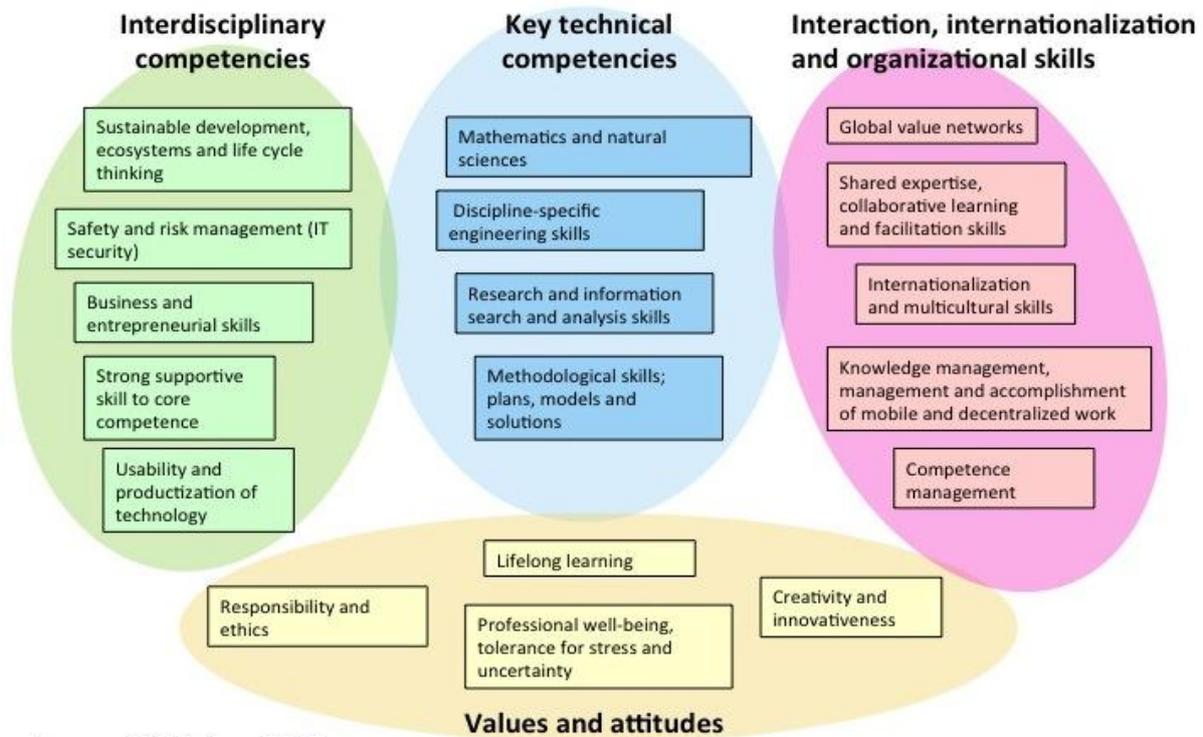
The map of competencies and skills presented in Figure 1 has been the framework which was used in the Feedback Survey of the New-graduates as well as in the Survey on Continuing Professional Development. In this paper as well as in the surveys the knowledge, skills and competencies in working-life (referred to as skills further in this paper) have been used according to table 1.

Key Technical Competencies
* Problem solving skills * Information retrieval skills * Know-how related to my own field of studies* Skills in practical application of theories* Analytical thinking skills * Critical thinking skills* Knowledge of research in my own field* Mathematical and natural science skills
Interaction, internationalization and organizational skills
* Oral communication skills * Team working skills* Project management skills * Skills in social relations * Self-consciousness * Skills in foreign languages * Written communication skills * Skills related to international work environment * Supervisory skills
Interdisciplinary competencies
• Entrepreneurial skills,* Knowledge of the basics of business operations
Values and attitudes
* Creativity, Self-confidence * Ethical consciousness

Table 1 List of knowledge skills and competencies in working-life

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Source: Mielityinen 2009

Figure 1. Skills and competencies of an engineer

4. RESULTS

4.1 CLASSICAL ENGINEERING EXPERTS - AGE GROUP BORN IN 1955

The respondents who are born in 1955 consider the key technical competencies among the three most important skill in working life. However this group does not regard interaction or communication skills generally as important as the other groups. Where the group born in 1981 consider 6 interaction/communication skills among the top ten of most important skills in working life, the group born in 1955 consider only four interaction and communication skills among the ten most important skills in working life and none of those are in the group of five most important. However this group considers self-confidence as very important. Of all the age groups in this survey this group ranked skills in practical application of theories highest in fifth.

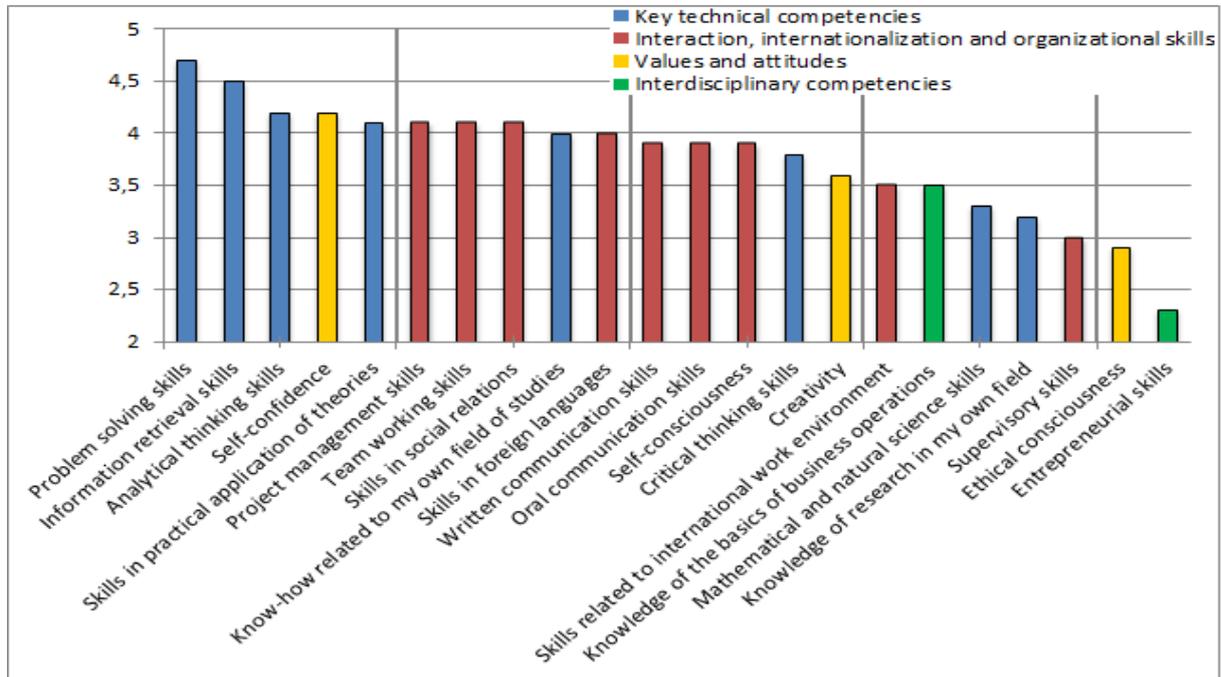


Figure 2. Importance of knowledge, skills and competencies of those born in 1955

4.2 CAREER ORIENTED ENGINEERS - AGE GROUP BORN IN 1963

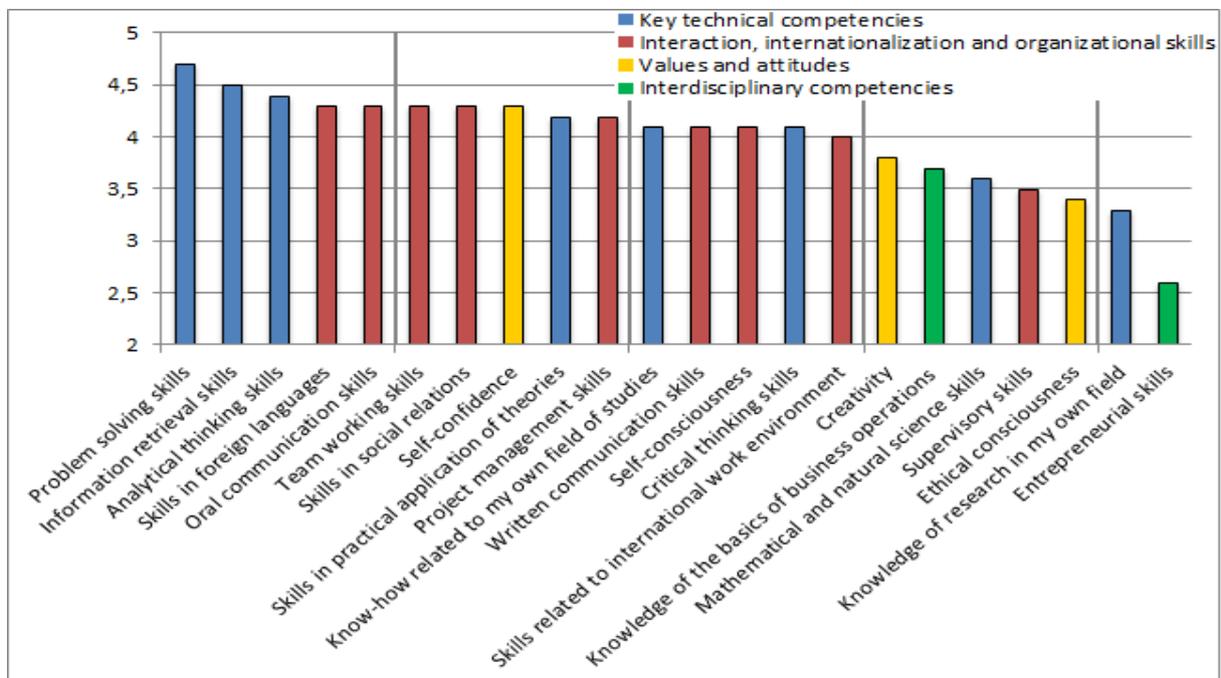


Figure 3. Importance of knowledge, skills and competencies of those born in 1963

The group born 1963 did not consider any skill from the category of interaction, internationalization or organizational skill among the three most important skills in working life. For this group the three most important skills are all linked to key technical competencies. Technical and mathematic-scientific competence is more important than to the groups born in 1981 and 1973. This group regards skills in

social relations as the 7th most important skill in working life where as the groups born in 1981 and in 1973 see skills in social relations as the third most important skill in working life. The 1963 generation emphasizes skills in foreign languages, oral communication skills and team working skills over the skills in social relations.

4.3 TECHNICALLY ORIENTED SUPERVISORS- AGE GROUP BORN IN 1973

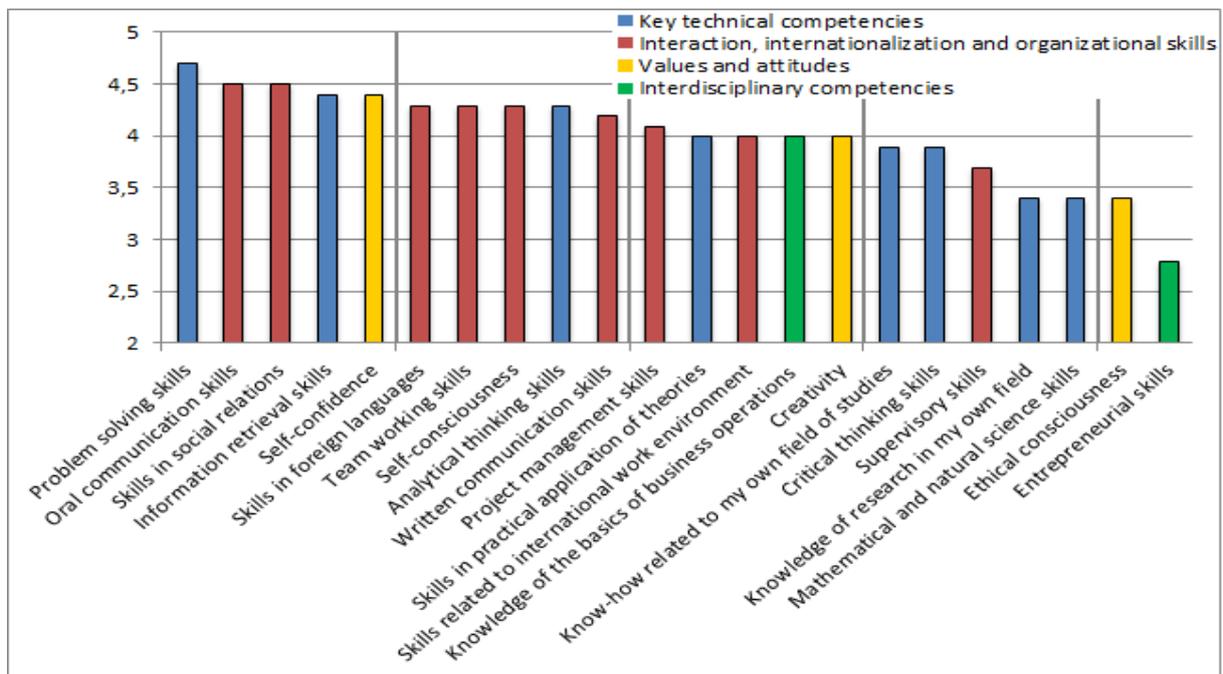


Figure 4. Importance of knowledge, skills and competencies for those born in 1973

For the age group born in 1973 problem solving skills is the most important skill in working life. This age groups considers oral communication skills as the second most important skill in working life. This generation also considers skills in social relations in the top three most important knowledge, skills and competencies in working life. Although according to the Survey on the Continuing Professional Development 33 percent of the respondents in this age group are in a supervisor position, supervisory skills are only considered as fifth least important skills among the listed 22 knowledge, skills and competence they were asked to evaluate.

4.4 COMMUNICATIVE EXPERTS - AGE GROUP BORN IN 1981

The generation born in 1981 considers problem solving skills, information retrieval skills and skills in social relations as three most important skills in working life. This age group also considers oral communication skills and team working skills as very important.

Among the listed 22 skills this age group considers knowledge related to their own field of science as sixteenth most important, whereas new-graduates consider knowledge related to their own field of science as the sixth most important. According to the survey results, the importance of ethical consciousness is generally considered very low among engineers. It seems the age group of 1981 values ethics more than the other groups, listed as 5th least important skill. The other groups place this among the three least important skills. This group really considers interaction, internationalization and organizational skills in general very important in working life.

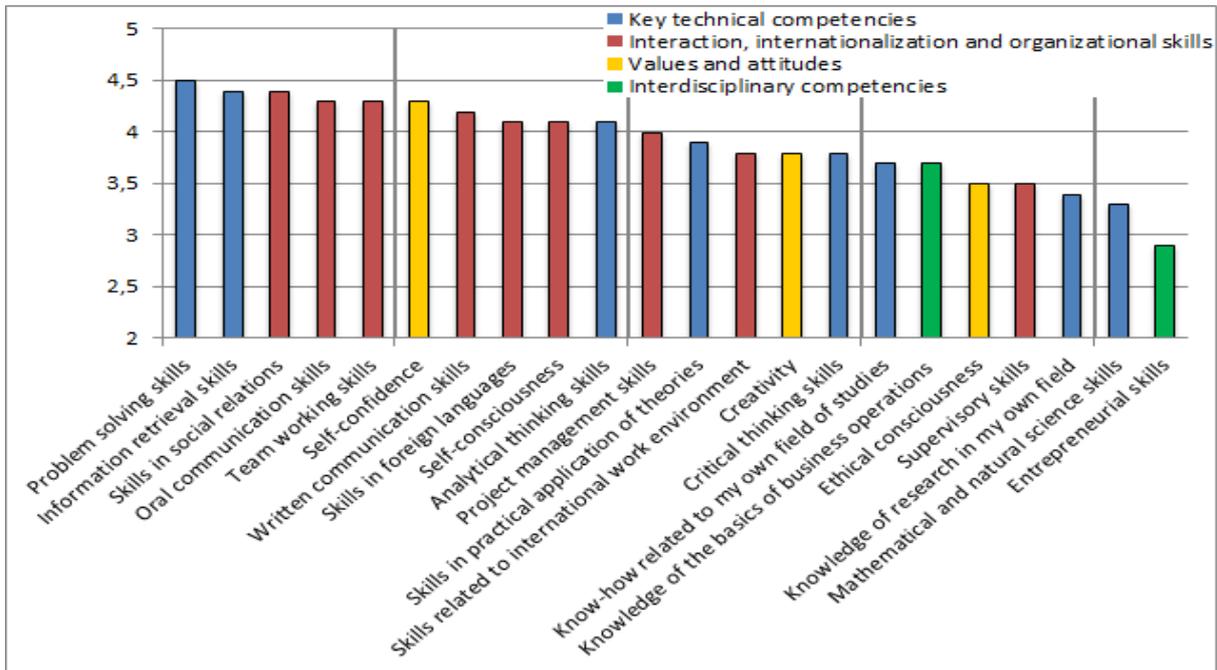


Figure 5. Importance of knowledge, skills and competencies of those born in 1981

4.5 NEW-GRADUATES - GENERATION Y

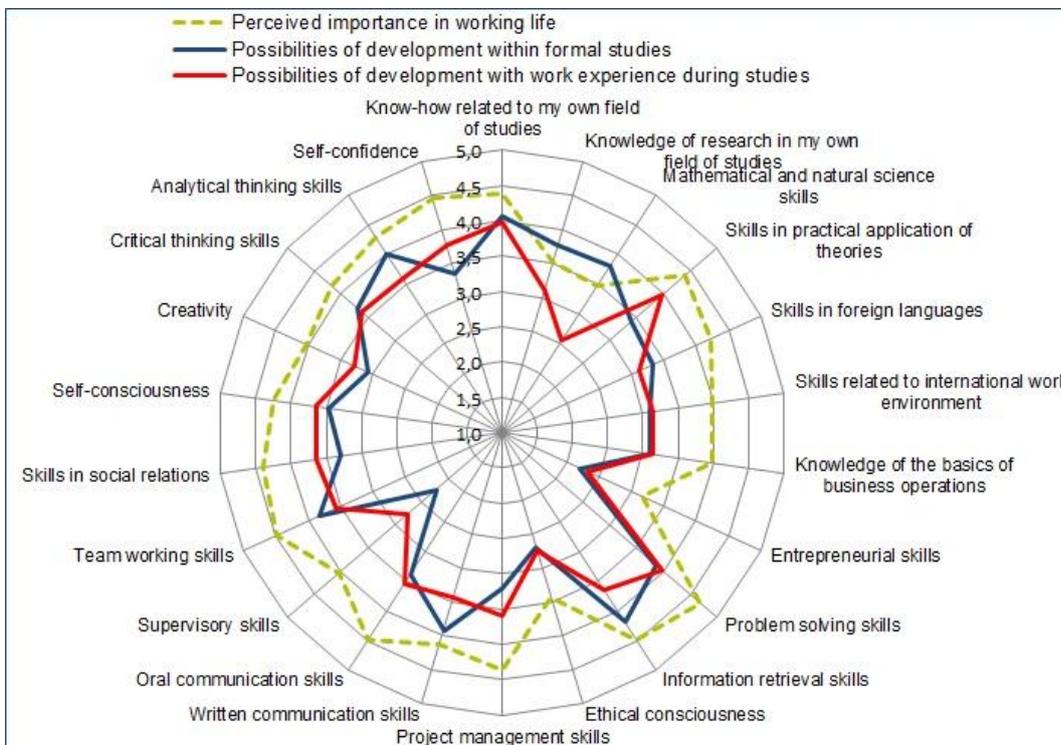


Figure 6. Importance of knowledge, skills and competencies of New-graduates

The recently graduated M.Sc. engineers consider problem solving skills clearly as the most important skill. Information retrieval skills, oral communication skills, team working skills and self-confidence come next with equal importance. Entrepreneurial skills, ethical consciousness and mathematical and

natural science skills are seen as the least important. The new graduates value the different skills in a similar order as their elder peers, but interestingly the level of importance is higher. Young graduates are in the beginning of their careers and are likely see most of the professional competencies as important. As seen in Figure 6, many of the skills are developed through work experience in addition to formal education. Skills that should be emphasized in education are those where the gap between the level of importance and development of skills is largest. According to the results these include supervisory skills, foreign language skills and oral communication skills. Currently they are not adequately well developed in formal education nor through work experience.

5. CONCLUSIONS

According to the results problem solving skills and information retrieval skills clearly form the basis of engineering competence. Across the age groups self-confidence is the most important of the competencies from the category of values and attitudes. In the category of interaction, internationalization and organizational skills there are differences between the age groups in what is considered as the most important skill. This might be explained by the fact that different generations may have great differences in what they comprehend as essential in interaction. In the category of interdisciplinary competencies all age groups considered knowledge of the basics of business operations significantly more important than entrepreneurial skills. However none of the groups considered skills from this category to the top 10 most important in working-life.

Each age group valued the same four skills in the group of five least important skills. Only the order in which they were valued changed with the age group. The four least appreciated skills were mathematical and natural science skills, knowledge of research in own field, ethical consciousness and entrepreneurial skills.

The need for entrepreneurial skills has increased with each age group most probably since globalization has moved a lot of traditional industry out of Finland. In the same time the need for creativity has increased over the years and as more and more jobs will be created by the small and medium sized companies. Engineers in Finland, whether working as leaders, experts or entrepreneurs, also face an increasing demand for social interaction skills, such as oral communication, teamwork and especially supervisory skills. According to the results, entrepreneurial skills are not among the important ones. In fact, they are considered as the least important across all the age groups. However, there seems to be hope in the future as the younger groups consider entrepreneurial skills more important than their elder peers.

The importance of sustainable development and building ecologically, economically and socially sustainable society is increasing. Actions taken by engineers have heavy impact on the nature and society. This explains the leap in the demand for ethical consciousness. Unfortunately according to the results, this is still not highly valued by engineers. All age groups ranked ethical consciousness among the least important skills.

Even though the results for each age group vary quite a lot, table 6 shows that the age groups are quite similar when compared together. Even though there are differences in what skills the groups emphasize, the overall layout is very similar. This seems to be a typical competence profile for Finnish engineers, no matter what age they are. Most importantly the surveys show that engineers today feel that they are facing more demands ever before. New graduates rank the importance of almost all the knowledge skills and competencies higher than the generations before. The modern day engineer cannot rely solely on the expertise of his or her field of study, but needs to be more of an all-around player with strong social skills.

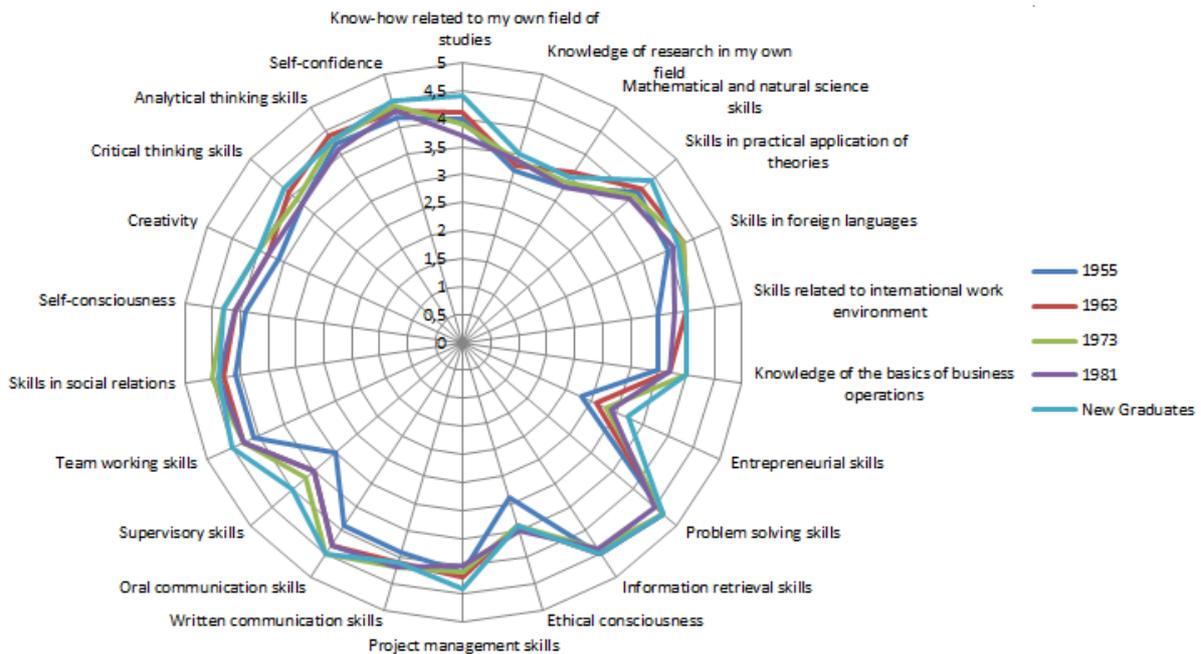


Figure 7. Comparison of the importance of the knowledge, skills and competencies of all respondents

Engineering education needs to meet the demands of globalized and digitalized economy. TEK participates in the development of engineering education mainly by providing facts and information based on research as well as collaboration forums to distribute them. TEK believes that discussion and distribution of up to date information on state and demands on engineering education among the different stakeholder groups will steer the engineering education to the right track. For example in Tampere University of Technology the student union representatives actively bring up the topics and facts of education development in the university administrative organs.

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