

VALUES AND COMPETENCES RELATED TO SUSTAINABILITY AMONG ENGINEERING STUDENTS

J.-P. Teini

Academic Engineers and Architects, TEK
Helsinki, Finland

A.-M. Tuikka

University of Turku
Turku, Finland

V.-P. Pyrhönen

Tampere University
Tampere, Finland

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ABSTRACT

Current estimations e.g. on climate change and loss of biodiversity have transformed sustainability as one of the most influential global trends. For example, universities promote sustainability as their core value and include sustainability related content in their curricula. These actions are consistent with SDGs (Sustainable Development Goals) proposed by United Nations. Engineers are essential for achieving SDGs since their skills and know-how are required to present estimations, develop and implement technological solutions and transform processes. Accordingly, engineering education is in key role to foster these competences and related values.

Hence, we study in this paper values and competences related to sustainability among engineering students in Finland. Our research questions are: How do engineering students perceive the importance of sustainable development for their future professional career and how have they developed in studies? Are engineering students willing to advance SDGs as part of their upcoming career? To answer these questions, data from two separate surveys are analysed. The data of the first survey was collected during 2016–2018, which focused on engineering students on the brink of graduation. The second survey focused on engineering students from the second year onwards and the data was collected in 2019. The preliminary analysis shows that engineering students do not perceive sustainability as an important competence in engineering careers. Accordingly, their competences related to sustainability evolve less during studies compared with other engineering skills and competences. However, students expressed their will to advance sustainable development through their professional careers.

1 INTRODUCTION

Climate change alongside other environmental issues have set sustainability as a global megatrend. Higher education plays a central role to share skills and knowledge to ensure sustainable development [3] and it has responsibility to spread awareness of the importance of conserving the environment [9]. Hence, Sustainable Development Goals (SDGs) proposed by the United Nations [11] are now relatively common in the strategies, curricula and other operations that higher education institutions have implemented.

Engineers have essential role in attaining SDGs, because activities that advance industrial development are rooted in engineering [1]. Hence, values and competences related to sustainable development would need to become integral part of engineering education in higher education institutions. This would require a gradual and long-term change of educational paradigm towards sustainability [5]. Some universities have integrated sustainable development into their curricula decades ago [4], whereas others have not [2]. In Finland, sustainable development is relatively new trend in engineering education.

Prior study in one Finnish university revealed that sustainable development is one of the competencies that engineering graduates perceive as least important [8]. Accordingly, academic staff and industrial employers considered sustainable development among the least valued competencies although industrial employers expected its importance to grow in future. While the values among engineering graduates, academic staff and industrial employers appear to be in line, these findings inspire to study the phenomenon further. Hence, this study aims to discover values and competencies regarding sustainable development among engineering students in Finnish universities. The development of competencies during engineering studies between 2016–2018 and the values of engineering students in 2019 were investigated by analysing responses for nationwide surveys conducted by the Academic Engineers and Architects in Finland (TEK).

2 METHODOLOGY

2.1 Methodology

In this study, we assess values and competences related to sustainability among engineering students in Finland. Our research questions are: How do engineering students perceive the importance of sustainable development for their future professional career and how has sustainability developed in their studies? Are engineering students willing to advance SDGs as part of their upcoming career?

To answer these questions, data from two separate surveys; namely, TEK Student Survey and TEK Graduate Survey are analysed. Both surveys include sustainability-related questions that provide insights to our research questions. We also assess how competences and values are affected by background factors such as field of study or gender. Both surveys cover data from all Finnish universities that offer engineering education. These include five Aalto University schools: Arts, Design and Architecture (Aalto ARTS), School of Science (Aalto SCI), School of Chemical Engineering (Aalto

CHEM), School of Electrical Engineering (Aalto ELEC) and School of Engineering (Aalto ENG). Other universities that offer engineering education include Lappeenranta-Lahti University of Technology (LUT), Tampere University (TUNI), University of Turku (UT), University of Oulu (UO) and Åbo Akademi University (ÅAU).

2.2 TEK Student Survey

TEK Student Survey is an annual survey for all of TEK's student members excluding first year students. The survey is used to measure how well engineering students get employed during their studies and how their job experience is contributing to the development of their skills and competences regarding later career. This paper examines data from the 2019 TEK Student Survey in which the topic was focused on sustainable development. The response rate of the survey was 20 % with 3393 respondents.

2.3 TEK Graduate Survey

TEK and the Finnish higher engineering education institutions have conducted a joint feedback survey, TEK Graduate Survey, on a national scale for engineering graduates since 2011. The survey assesses various aspects of engineering education including employability of graduates, satisfaction with studies and study guidance, and development of skills and competences during studies. The survey is sent to all M.Sc. (Tech) graduates in Finland. In this paper, we examine results from surveys between 2016–2018. The answer rates were 68 % in 2016, 78 % in 2017 and 82 % in 2018. The survey is continuously open so that graduates can answer the survey in the brink of their graduation and the data is processed to yearly reports afterwards.

The survey does not explain in detail the skills, competences and knowledge that the respondents are asked to evaluate. Hence, the respondents might have different perceptions what the specific skills, such as knowledge in sustainable development, means.

3 RESULTS

3.1 Importance of promoting sustainable development in engineering careers

TEK Student Survey in 2019 included questions about students' attitudes toward promoting SDGs in their career. The results of the survey are collected in Table 1. The results are presented by gender and by university. The original survey questions, which are abbreviated in Table 1, are as follows:

How important is it to you to be able to further the following Sustainable Development Goals in your career?

- **sustainable economic development:** balanced economic growth without incurring debt or overusing capital stock while taking in account future generations and the carrying capacity of the environment
- **sustainable social development:** reducing inequality between people and guaranteeing adequate livelihood, appropriate healthcare, availability of education and fulfilment of fundamental rights

- **environmentally sustainable development:** sustainable use of natural resources and taking into account the limits of the planet
- **cooperation and partnerships** in furthering sustainable development goals
- furthering **peace, fairness and good governance**

Table 1. Importance of furthering sustainable development goals through career. (1= not at all important, 5 = very important)

	sustainable economic development	sustainable social development	environmentally sustainable development	cooperation and partnerships	peace, fairness and good governance
Male, n=1931	3,66	3,46	3,94	3,55	3,69
Female, n=908	3,89	3,92	4,41	3,84	4,00
TOTAL, n=2802	3,73	3,61	4,09	3,64	3,79
Aalto TOTAL, n=1111	3,75	3,64	4,17	3,67	3,79
Aalto ARTS, n=44	4,06	4,25	4,83	4,11	4,42
Aalto SCI, n=288	3,66	3,60	3,96	3,51	3,78
Aalto CHEM, n=201	3,84	3,72	4,39	3,77	3,76
Aalto ELEC, n=229	3,70	3,57	3,99	3,62	3,83
Aalto ENG, n=318	3,76	3,62	4,24	3,73	3,71
LUT, n=383	3,66	3,48	4,08	3,65	3,68
TUNI, n=972	3,65	3,48	4,02	3,57	3,71
UT, n=133	3,76	3,70	4,05	3,55	3,92
UO, n=448	3,81	3,75	4,07	3,66	3,89
UVA, n=89	3,80	3,63	4,03	3,78	3,88
ÅAU, n=94	4,05	3,90	4,28	4,04	4,22
Other, n=153	3,80	3,80	4,02	3,62	3,86

Several interesting observations can be extracted from Table 1. For example, female respondents are much more interested in pursuing a sustainable career. As women are underrepresented in engineering studies in Finland and represent approximately only one fourth of total student population [7], the total results are closer to the male average than female average.

Besides gender, the study field of respondents has a significant effect on how important sustainability as a part of their engineering career is. The study fields with the most interest towards promoting sustainability include students of Architecture, Environmental Engineering, Chemical Engineering and Biotechnology, and Energy Engineering. The least interested students in promoting sustainability were students of Mechanical Engineering, ICT and Electrical and Automation Engineering. It should also be noted that the fields of science that value sustainability high are also more

balanced in gender while the fields of science that value sustainability low tend to have very low number of female students.

When comparing results between universities or schools, the respondents from Aalto ARTS were most interested in promoting sustainability through their career. The students of technology in Aalto ARTS include mostly students of architecture, and unlike the average field of technology in Finland, students of architecture are mostly female. But even compared to the average female respondent, the students of Aalto ARTS were more oriented to furthering sustainability in their career. When looking at the universities with larger student population including Aalto TOTAL, TUNI, UO and LUT, the ones that stand out with more positive attitudes towards sustainability are UO and Aalto TOTAL. This finding can not be solely explained by gender and field of education since e.g., UO does not have a large share of female students or students in fields of science that are sustainability-oriented.

3.2 Development of skills in sustainable development in engineering education

The TEK Graduate Survey measures expertise and skills development and importance in one's own career by evaluating 29 different factors. The graduates assess all factors from the following three standpoints: 1) what is the perceived importance of the factor in their own career, 2) how has the expertise or skill developed in formal studies and 3) how has the expertise or skill developed through work experience during studies. In Fig. 1, the average values of each standpoint of all rated skills and expertise are displayed.

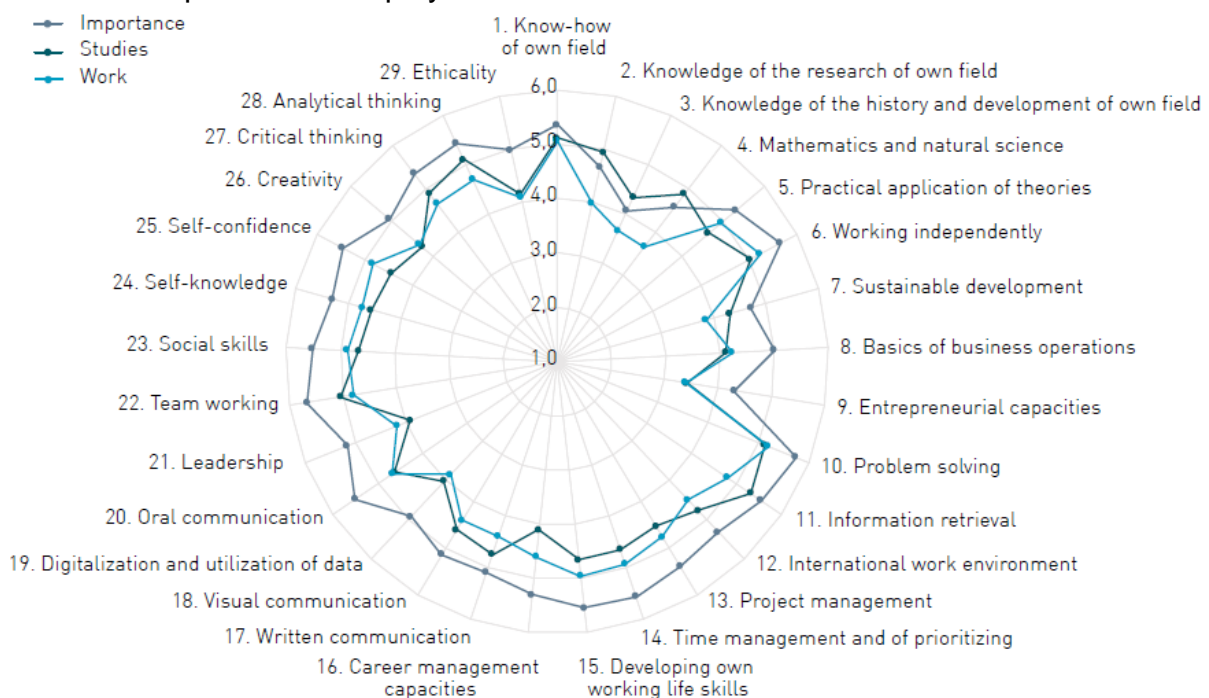


Fig. 1. Expertise and skills: importance and development of skills, competences and knowledge.

Further in our analysis we only focus on factor 7, Sustainable development, for which the official form in the survey is “Knowledge in sustainable development”. Fig. 2 presents the importance and development of knowledge in sustainable development

compared to the average importance and development of all skills in annual surveys between 2016–2018. As can be seen from the results, all measured dimensions of knowledge in sustainable development have increased gradually every year while the the average development of skills have mostly remained stable in the three year period, but even still the development of knowledge in sustainable development is lagging behind the average skill.

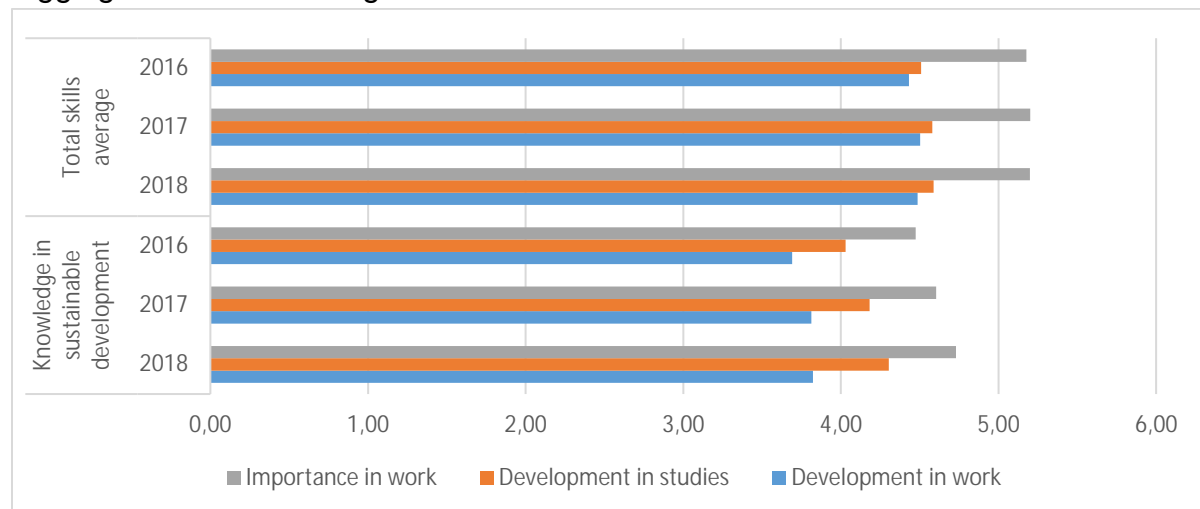


Fig. 2. Importance and development of the average skill and knowledge in sustainable development, comparison of 2016–2018.

The results indicate that the perceived importance of sustainable development is low compared with many other competences; however, it has grown each year. Also the development of these competences through formal education and through work experience gained during studies has risen every year although they develop less than many other competencies.

Since we perceived such differences between male and female respondents in importance in furthering sustainable development in career, we will again examine if there are gender differences. To demonstrate the possible differences, we only look at data from one year, 2018. The results are presented in Fig. 3.

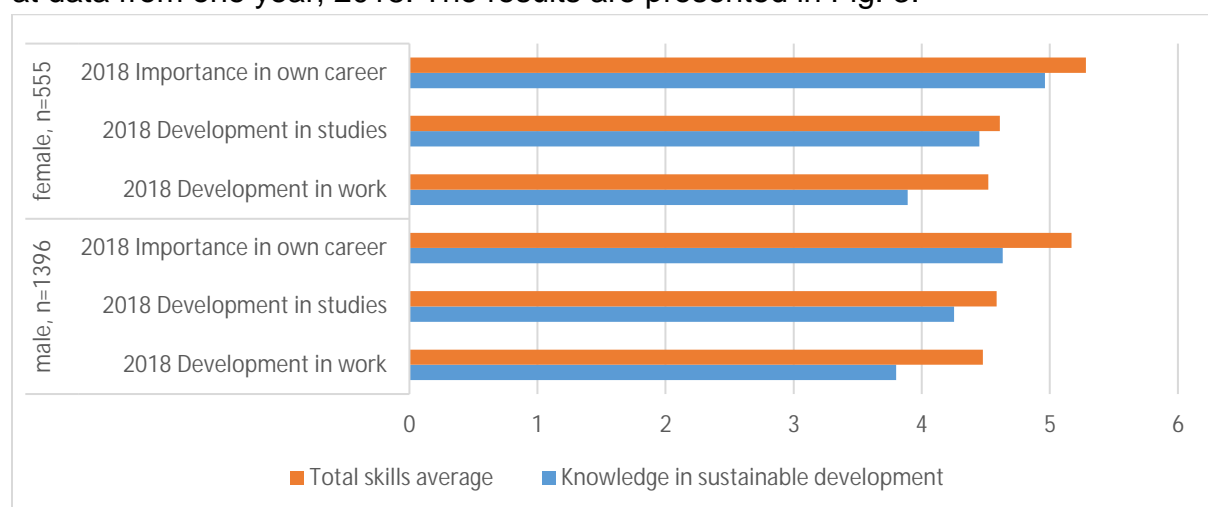


Fig. 3. Importance and development of the average skill and knowledge in sustainable development. Differences between male and female respondents.

The difference in average importance or development of skills between male and female respondents is very small, but we observe more significant differences when looking at the specific skill. In the case of knowledge in sustainable development, both the perceived importance in own career and the development in formal studies are closer to the average skill development for female academic engineers.

In addition to gender differences, there are once again differences between fields of studies similarly to that of the TEK Student Survey data. The graduates from Architecture and Landscape Architecture, Materials Technology, Energy Engineering, Environmental Engineering and Chemical Engineering perceive the importance and development of knowledge in sustainable development in the higher end of the scale, whereas Science and Engineering, Biotechnology and Information Technology rate them in the lower end of the scale.

3.3 Concluding remarks on survey results

The survey results of TEK Graduate Survey and TEK Student Survey are not comparable as they assess very different factors, but the contradictions between the expectations of furthering sustainability and the perceived importance in work and development through formal studies is a very interesting phenomenon. Promoting sustainability in future engineering careers is important or very important for most of the students, but knowledge in sustainable development is perceived as one of the least important skills in engineering careers. It is also important to highlight that engineering students in Finland have worked approximately two years in their field of study by the time of graduation, so the graduates are at least somewhat qualified to assess the importance of different skills at the beginning of their engineering careers.

4 SUMMARY AND DISCUSSION

Engineering students are very willing to promote different aspects of SDGs through their own careers. Reflecting to this trend, higher engineering education in Finland seems to be developing in the desired direction with students reporting increasing values in the development of knowledge in sustainable development each year. However, sustainable development is currently perceived as one of the least important skills in one's own career, which is to say that graduates do not expect that they get to promote sustainability in their careers, at least when compared to other competences. An intriguing question that is left unanswered is: how well the Finnish labour market is equipped to meet the expectations of those graduates that wish to promote sustainability in their careers? Many graduates might be disappointed in the short run as many jobs do not embrace sustainability, but hopefully in the long run increasing number of jobs will play a part in building a more sustainable world.

Both gender and field of study were discovered as factors that affect how engineering students value sustainability in their careers. Female respondents valued sustainability more than male respondents. This finding is consistent with prior studies on values among engineers and engineering students. For example, Finnish engineers in general do not consider the use of ethics in their work as important as

other competences and capabilities; however, women perceive ethics more important than men [10]. As attracting more female students is continuously pursued by many academic organizations, we can expect the importance of promoting sustainability in engineering careers to be even higher in the future.

There are also differences in values towards sustainability between engineering students in different universities. In this study, we could not provide any insights to what causes these differences, as they are not attributable to our findings in differences on gender and field of study. For example, fostering competencies related to sustainable development during engineering education would require intensifying collaboration between teachers in curriculum development [6]. A further study on what causes students in individual universities, such as the University of Oulu, to stand out in the importance on promoting sustainable development in careers would be very interesting.

The results presented in this study are consistent with prior value studies conducted by TEK. The TEK Student Survey of 2017 focused on the values of students and the main finding was that the top 3 values for engineering students are benevolence, universalism and work. With the importance of benevolence and universalism, it was expected that the importance of promoting sustainability in engineering careers would be high. According to values research, not only do people with the similar values choose similar fields of studies, but also the values of students in a given field of science tend to equalize over the course of studies [12]. Therefore the results presented in this paper do not provide insights to how engineering studies in general or in a specific engineering profession affects values and attitudes, but it would make of an interesting research topic.

Conclusions that can be made from the data are limited as the data does not provide further insights on the differences between genders and different fields of studies on their attitudes towards sustainability. It would be interesting to conduct a longitudinal survey study to observe how attitudes towards sustainability develop during studies in different study fields and between genders.

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