Young women's interests in different branches of technology: clusters, interrelations, and implications for student recruitment

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Abstract— **The underrepresentation of women in engineering education is a global challenge, but the challenges of recruiting women are not equal in different engineering disciplines and degree programs. This study aims to understand how young Finnish women's interests in different kinds of engineering programs are constituted. A more elaborate view of subdisciplinary interests and their relationship is hoped to help in reaching out to a more diverse pool of applicants to the engineering programs. The data from 482 female upper secondary school students interested in engineering education opportunities were statistically analyzed to see how their interests in different kinds of engineering programs group together and interlink with each other. The results reveal a pattern worrisome to most of the traditional engineering programs. The interests not only seem to concentrate on few programs related to bio- and chemical engineering or architecture but the interest in the most popular cluster, bio- and chemical engineering, is also negatively connected to the interest in many other engineering fields.**

Keywords—women in engineering, subdisciplinary interests, people-thing orientation, student recruitment

I. INTRODUCTION

The underrepresentation of women in engineering education is reality in most countries. The gender differences in interests in engineering have been explained by many theories, such as people–thing orientation [1], role congruity theory [2], goal congruity theory [3], work value profiles [4], social capital [5], person–environment fit [6], and career outcome expectations [7], to name but a few. Regardless of the theory applied, much of the research findings revolve around perceptions of human aspects in the engineering profession.

The challenge of recruiting women is not alike in different engineering disciplines and degree programs. Yet, studies are often conducted at the level of all engineering fields or even at the more general level of science, technology, engineering, and mathematics (STEM). Although the proportion of women, as well as knowledge, methods, and focus are known to be different in various subdisciplines, differences in the gendered interests between subdisciplines are relatively rarely studied. Hence, also the general explanations behind the gendered interests in engineering are not likely to serve different subdisciplines in the best possible ways.

A. Engineering and people

Engineers' interest in things as opposed to people is repeatedly offered as an explanation behind the current situation, where men seem to be more interested in engineering as a career than women. People and thing orientations are often considered to be the opposite ends of the same continuum, resulting in a conclusion that if engineers are interested in things, they cannot be interested in people. When this assumption is combined with the research finding that women prefer working with people instead of things [8], it is tempting to explain the gender disparity in engineering with women's lack of interest.

Engineers' thing orientation has been demonstrated in many studies, but the lack of people orientation among engineers has not been equally shown. Yang and Barth [2] compared the people–thing orientations of students majoring in biology, CEMP (computer science, engineering, mathematics, and physical sciences), and health sciences and discovered that CEMP majors scored significantly higher on thing orientation and lower on people orientation than the other students. However, there was no statistically significant difference between the thing orientation and the people orientation of CEMP majors [2]. Bairakratova and Pilotte [1], on the other hand, discovered that the people orientation of engineering students and practitioners was generally higher than the thing orientation, and the difference was more significant for women than for men. Interestingly, the first-year engineering students had equal thing orientations but significantly lower people orientations than practising engineers [1].

Regarding the career interests, male CEMP majors were shown to be more interested in thing jobs than people jobs, but female CEMP majors were equally interested in both [2]. As people jobs were rated as affording family and social impact goals more than thing jobs do, and thing jobs were rated as affording more status goals than people jobs, it has been suggested that demonstrating the people side and societal impact of STEM professions could attract more women to these professions [2]. Cech [9] has also found that female engineering students are less likely than men to value technological leadership but more likely to value social consciousness.

Despite the fact that the people side of engineering may be obvious to engineers, it may not be evident to the young people having to choose their field of study. Bairakratova and Pilotte suggest that the difference between students' and practitioners' people orientations indicates that some factors influencing student perspectives of the profession may inadvertently discourage more diverse students from pursuing engineering [1]. A Dutch study [3] found that although many grade 12 students have a more accurate, realistic, and positive view regarding the social orientation of hard science careers than might be expected, the role of hard science in combating social and ecological problems still remains somewhat unclear.

Gender stereotypes of interests start early and predict academic motivation to pursue engineering and computer science more than gender ability stereotypes [10]. To challenge these stereotypes, a more diverse view of both gender and engineering must be conveyed to the young people making career choices. In addition to emphasizing the people side of engineering, a richer picture of engineering can also be created through the varying features and characteristics of different engineering subdisciplines.

B. *Subdisciplinary differences*

Although the research on adolescents' interests in different engineering subdisciplines is scarce, the existing studies show that different subdisciplines are viewed rather differently. Potvin et al. [7] compared the gendered interests in electrical, computer, and biomedical engineering, and discovered that students in introductory engineering courses in the U.S. associated various career expectations differently with different fields of engineering. Electrical engineering was positively associated with career outcomes of "inventing/designing things" and "developing new knowledge and skills," computer engineering was positively associated with "inventing/designing things" but negatively associated with "working with people," and bioengineering/biomedical engineering was positively associated with "helping others" [7]. There were no gender differences in career outcome associations in electrical or computer engineering, but, in general, the female-identified students were less interested in both of them than non-female-identified students [7]. Contrary to that, female-identified students were more interested in bioengineering/biomedical engineering and had a significantly stronger association between the discipline and "helping others" than the non-female-identified students [7].

In an earlier study [11] where Potvin et al. tested the relationship between different identity and career outcome expectation variables and eight engineering disciplines, seven variables, namely "making money," "having job security and opportunity," "becoming well known," "working with people," "having an easy job," "being in an exciting environment," and "making use of my talents and abilities" had no significant dependence on engineering discipline. However, several other variables showed considerable dependences indicating that students show substantial inter-disciplinary distinctions in the different engineering domains, like the high science identities of bioengineering and chemical engineering students, civil engineering students' high desire to supervise others, and environmental engineering students' high desire to solve societal problems [11].

A comparison between engineering disciplines with below average, average, and above average female representation also reveal that women interested in engineering have significantly different attitudes and beliefs, career goals, and career plans depending on their more focused subdisciplinary interest [12]. Women in the below average female representation group demonstrated more interest in masculine traits (making money, becoming well known, supervising others, inventing/designing), and were more likely to be interested in an industry career and starting a company than other women [12]. They were also the only group to identify themselves as engineers [12]. Women in the above average female representation group were more interested in helping others and working with people and were more likely to be interested in a career in a nonprofit/nongovernmental organization than others, whereas women in the average group were more likely to identify themselves as mathematics people and have high competence beliefs in mathematics [12].

C. *Case Finland*

In Finland, the research on gendered interests is quite limited even at the aggregate level of STEM, and almost nonexistent at the level of engineering or engineering subdisciplines. Even though the gender distribution of the applicants in different engineering disciplines is known to be very different [13], there is very little research knowledge to explain the differences. At the level of STEM, Guo et al. [4] discovered that different work value profiles (monetary-oriented, prospect-oriented, family-oriented, society-oriented) did not predict differences at the professional level between life-science- and math-intensive choices, indicating that young adults are likely to believe that professional-level STEM careers have similar characteristics. However, being in the family-oriented or the society-oriented group increased the likelihood of choosing support-level life science occupations, such as nurses, dental assistants, pharmaceutical technicians, or health associate professionals [4].

In a study of Finnish female applicants' interests in different engineering and science degrees, a considerable subdisciplinary variation was detected between the applicants' mutual and exclusive interest in engineering and/or science [13]. Among the female engineering applicants there are subgroups with a considerable interest in science degrees as well as subgroups with virtually no interest [13]. Among the mutual interest in the engineering and science groups there are the applicants in the subdisciplines of Engineering sciences & Technical physics, Information and Communications technology, and Chemical & Process engineering, and in the exclusive interest in technology degrees group there are the applicants in the subdisciplines of Electrical engineering & Energy technology, Mechanical & Automation engineering, and Architecture & Landscape architecture [13].

Finnish ninth-graders refer mostly to a gender-typical interest when justifying the suitability of certain occupations for women and men [14]. Guidance counsellors report ninth-graders' perceptions of occupations to be very gender-stereotypic and have an influence on academic and occupational choices at least in the transition from basic to secondary education [14]. Guidance counsellors evaluate the parents to be the main source for occupational gender stereotypes but note that gender-typed views are also clearly present in education- and career-related discussions in friend groups [15]. The latter view is confirmed by the responses of ninth-graders, who also perceived that their friends held gender-based stereotypes regarding certain jobs more than their parents or teachers [15].

II. METHODS

A. *Research questions*

The objective of this study is to understand how young Finnish women's interests in different kinds of engineering programs group together and interlink with each other. A more refined picture of subdisciplinary interests and their relationship is hoped to provide insights of different groups of prospective applicants and the potential ways of communicating better the richness and diversity of engineering disciplines and topics to them.

The objective is pursued by answering three empirical research questions:

1) How are the young women's interests in different engineering programs grouped together?
2) Which engineering programs and topics do the young women find most/least interesting?
3) How do the interests in different engineering programs influence each other?

Finally, to generate a more wholistic understanding and to suggest some implications for student recruitment, the empirical findings are discussed in the light of literature on gendered career interests.

B. Data collecting

The data were collected as part of the application process to an event introducing engineering and engineering education opportunities to female upper secondary school students. The event was planned to be organized in January 2022, and the application process was open for two months from mid-October 2021 onward. After the application period, the event was decided to be postponed to the autumn of 2022 because of the Covid-19 pandemic. Altogether 507 young women applied for the event and 482 of them gave their consent to use the application data for scientific research. Applicants younger than eighteen needed a written consent from a guardian to apply for the event, but all the applicants could decide for themselves, whether their data was used for research. In Finland, a parental consent for participating in non-medical research is not required if the adolescent is over fifteen, research is not considered harmful for the child, and the child can be regarded capable for forming their opinion. The data were anonymized before any analysis for research purposes.

As a part of the application form, the applicants were asked to indicate which engineering programs / subdisciplines of engineering they were interested in by choosing all the appropriate choices from a list. The list contained twenty-eight entries, and it was formed by combining and modifying the list of degree programs in engineering or architecture available in Finnish universities. Modifications were made to avoid multiple entries with the same content, as the same program can be taught in several universities under a slightly different name. Computer science degrees were not included in this list as in Finland they are mostly taught in different institutions and faculties from engineering programs.

The final data consisted of 482 respondents, who had chosen between 1 and 20 engineering programs they found interesting. The names of the degree programmes were the only information given in the form. The respondents were between 16 to 19 years of age and came from more than 140 different schools, all over Finland. The sample was self-selecting in the sense that anyone identifying themselves as a woman or nonbinary and studying the long syllabus in mathematics could apply to the event. However, at the same time, the sample was also limited to those who would in reality be eligible to apply for the engineering programs at the university level.

C. Data analysis

First, some descriptive statistics were performed at the level of single interest items. As the reporting of the interest in particular degree programme was done in binary terms (i.e. ticked, if found interesting) the mean of interest also tells us the share of respondents interested in different programs. All statistical analyses were conducted with the statistical software Stata.

The grouping of the interests was carried out by clustering the responses with a hierarchical cluster analysis. Since the outcome of the cluster analysis is dependent on the method applied, several different methods for clustering the data, such as single linkage, average linkage, weighted average linkage, complete linkage, and Ward's linkage, were tried, and the resulting dendrograms were compared by eye. The different methods resulted in many similar clusters, but some of the clusters were combined differently together depending on the method in use. Finally, a Ward's linkage method was chosen as the one to proceed with as it produced the most distinctive clusters. Ward's method has been noticed to outperform many other methods especially in the cases where clusters are overlapping [16].

After the clustering, the respective sum variables were generated by calculating the average interest in each cluster, where 0 denotes that none of the respondents have interest in any degree programs in the cluster and 1 denotes that all the respondents are interested in all the cluster's degree programs. The internal consistency of the clusters was measured with Cronbach's alpha and the statistical significance of the differences between the average interest in different clusters was examined using two-sample t-test with unequal variances. The interrelations of the clusters were inspected by conducting a linear regression analysis for each of the sum variables denoting the different clusters, with all the other cluster sum variables as the explanatory variables. The statistical significance of the relations was observed in three different levels, $p<0.05$, $p<0.01$, and $p<0.001$.

III. RESULTS

The single most interesting program to the respondents was biomedical technology, and the least interesting program was mining technology. The share of respondents interested in different engineering and architecture subdisciplines are illustrated in Fig. 1. Particularly the most popular programs seem to follow quite neatly the U.S. programs that have above average female representation [12], whereas the average and below average programs in the U.S. are more evenly distributed along the Finnish continuum.

In the cluster analysis, the interests in different degree programs grouped together rather as expected. However, there were some topics that were associated with each other in a more surprising manner. The cut-off level of 0.9 was chosen visually to form relatively evenly sized clusters, many of which had already appeared in trials with other clustering methods. The twenty-eight programs were grouped in nine groups with the degree program of mining technology left as an outlier. The dendrogram of clusters is presented in Fig. 2, and the generated clusters are listed in Table I.

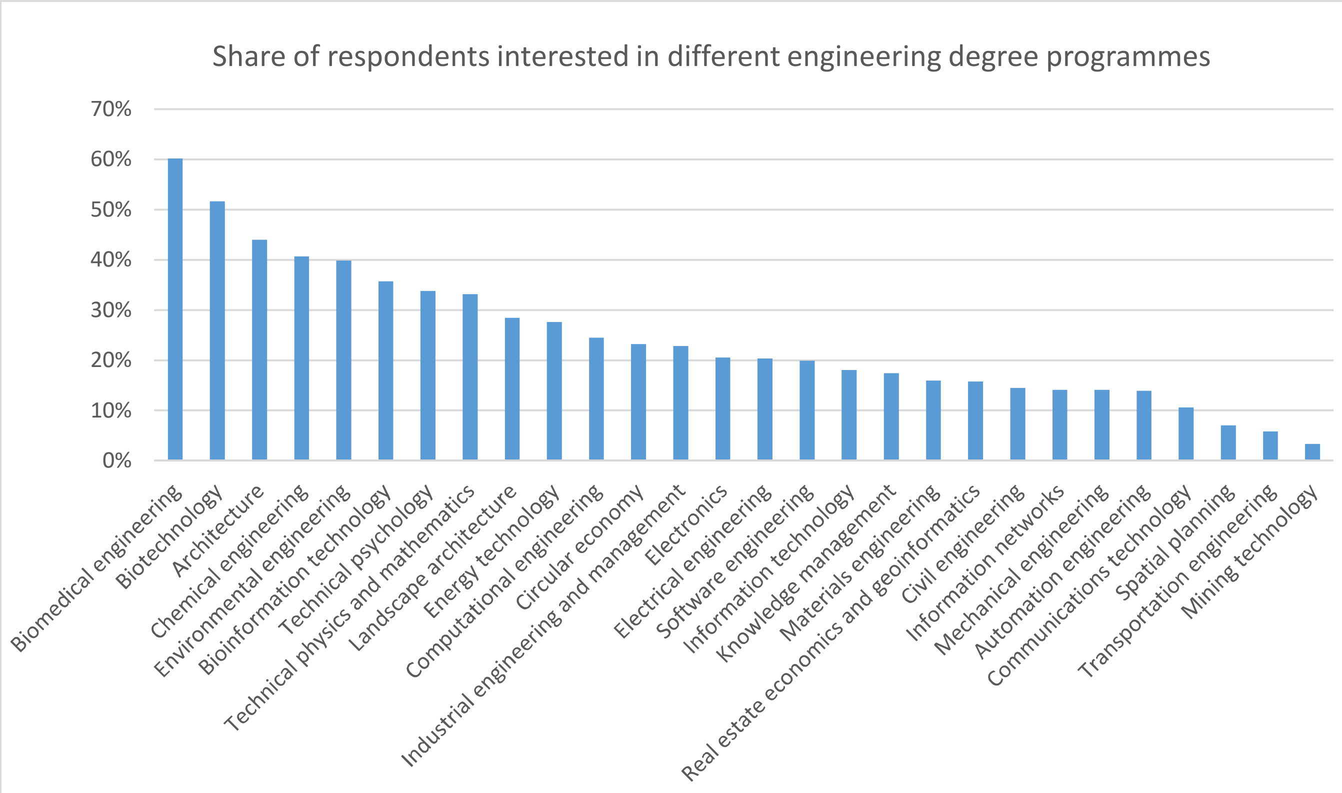

Fig. 1. Respondents' (N=482) interest in different engineering programs

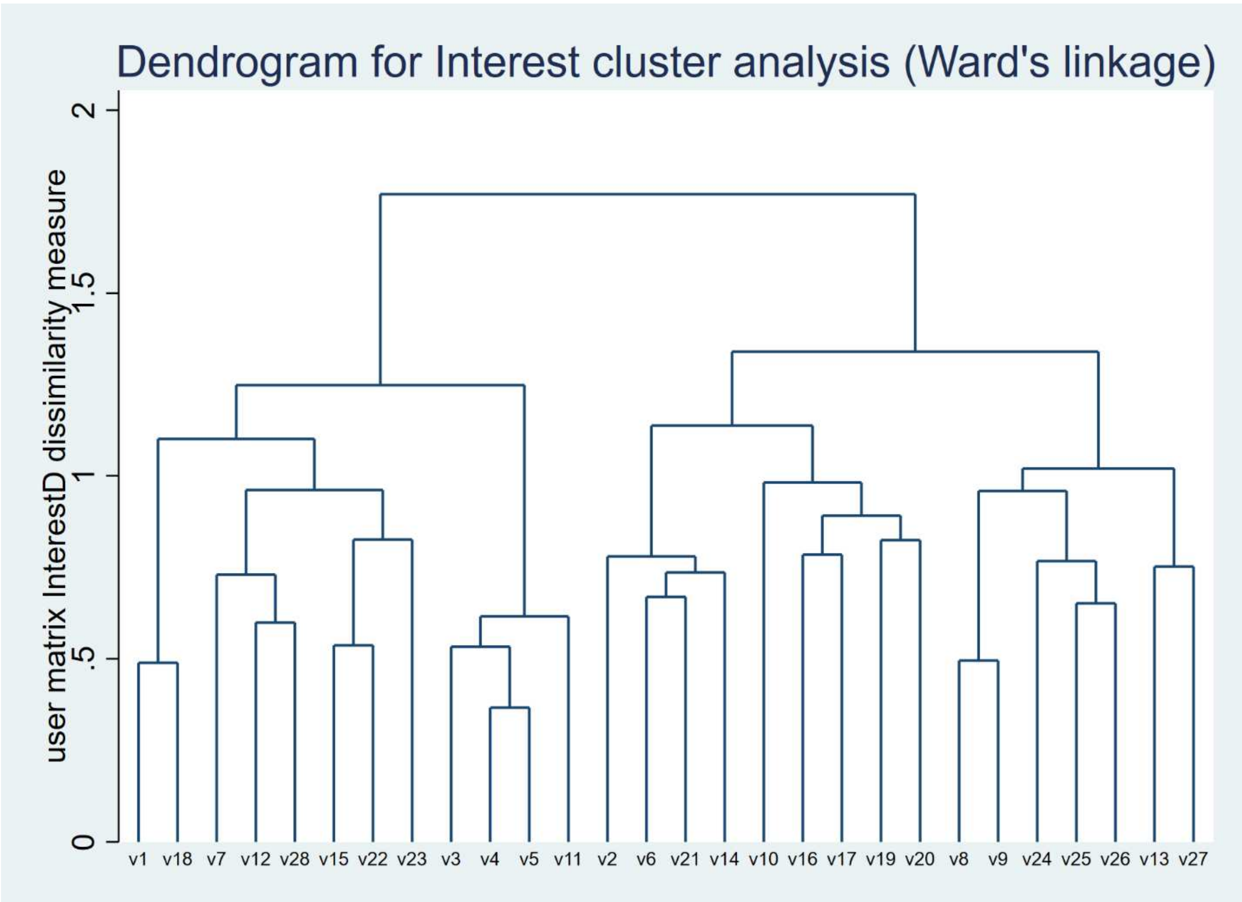

Fig. 2. Hierachical clustering of interest in engineering programs using Ward's linkage method

TABLE I. CLUSTERS OF INTEREST AND THE DEGREE PROGRAMS IN THEM

Cluster (abbreviation)	Degree programs	Cronbach's Alpha
Architecture (ARC)	v1=Architecture v18=Landscape architecture	0.6951
Sustainability (SUST)	v7=Energy technology v12= Circular economy v28=Environmental engineering	0.5748
Science and mathematics (SCI)	v15=Computational engineering v22=Technical physics and mathematics v23= Technical psychology	0.4949
Bio- and chemical engineering (BIOC)	v3= Bioinformation technology v4= Biomedical engineering v5=Biotechnology v11= Chemical engineering	0.7225
"Traditional" engineering (TRAD)	v2= Automation engineering v6= Electronics v14= Mechanical engineering v21= Electrical engineering	0.6487
Civil and materials engineering (CIV)	v16=Transportation engineering v17= Spatial planning v19= Materials engineering v20= Civil engineering	0.5067
Information systems engineering (INF)	v8= Information technology v9= Information networks	0.7597
Information and communications technology (ICT)	v24= Knowledge management v25=Communications technology v26= Software engineering	0.6234
Management (MAN)	v13= Real estate economics and geoinformatics v27= Industrial engineering and management	0.4177

Viewing the average interest in different clusters (see Fig. 3) shows that bio- and chemical engineering cluster is the most interesting one to the respondents, and the difference from all the other clusters is statistically significant (p=0.000). Also the second cluster in interest, Architecture, was significantly more interesting (p=0.018) than the third cluster of science and mathematics. The difference in interestingness between Science and mathematics and Sustainability clusters was not statistically significant, but the difference between Sustainability and Management clusters was (p=0.000). The Management, "Traditional", Information systems, and Informations and communications technology clusters did not differ statistically, but the least interesting cluster, the Civil and materials engineering, was again statistically different from all the others.

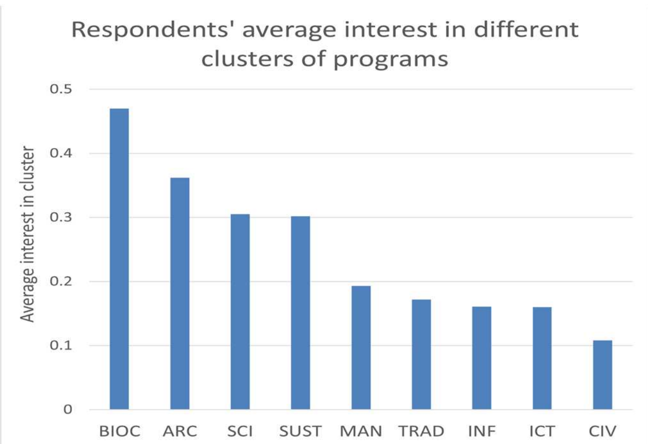

Fig. 3. Respondents' (N=482) interest in different clusters of engineering programs.

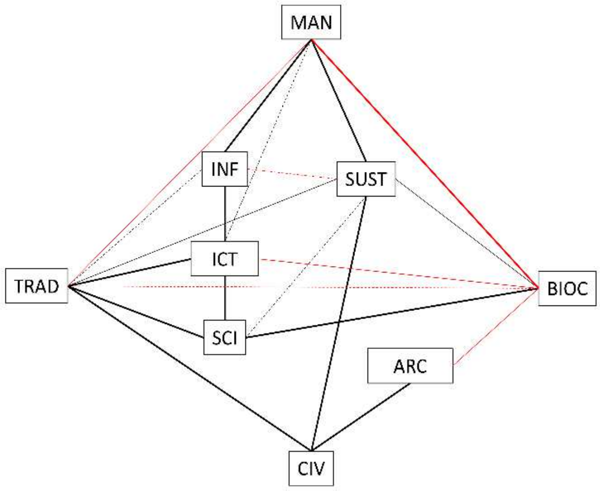

Fig. 4. Relationship between female respondents' interest in different clusters of engineering programs.

The relationship between the clusters was studied with a series of linear regression analyses, which indicated several connections with different levels of statistical significance between the clusters. Most of the correlations were positive, but some were negative. Table II presents the standardized coefficients for all nine linear regressions and shows the statistical significance of the relations. The detailed results of all the nine linear regression analyses are collected in Appendix I. The relationships of the different clusters are graphically illustrated in Fig. 4. In the figure, only the statistically significant relations are indicated by connectors between the clusters. The weight of the line denotes the strength of statistical significance, and the color of the line indicates whether the correlation is positive (black line) or negative (red line).

The results of the linear regression analyses suggest that the respondents' interest in architecture-related degree programs is quite specific and not much related to any other interests. The interest in bio- and chemical engineering programs is negatively correlated with the interest in most of the other programs having a strong positive connection only with science and mathematics programs and medium positive connection to sustainability-related programs. Management programs have positive connections to information-, ICT-, sustainability-, and civil-engineering-related programs but negative connections to electrical, automation and mechanical engineering as well as to bio- and chemical engineering, and no connection to the interest in science- or architecture-related programs.

The interest in Electrical, automation, and mechanical engineering is connected to all clusters, but architecture, with negative correlations to the interest in management or bio- and chemical engineering and positive correlations to the interest in other programs. The interest in science-related programs is not negatively connected to the interest in any other program, but bears no connections to the interest in information-, management-, civil-engineering-, or architecture-related programs. The interest in sustainability is weakly negatively connected to the interest in information and not connected at all to the interest in ICT or architecture. Other connections are positive.

TABLE II. STANDARDIZED ESTIMATES OF LINEAR REGRESSION ANALYSES FOR INTEREST IN DIFFERENT CLUSTERS

Explanatory variables	**Variables explained with linear regression analysis**								
	ARC	*SUST*	*SCI*	*BIOC*	*TRAD*	*CIV*	*INF*	*ICT*	*MAN*
ARC		-0.016	0.008	-0,130**	-0.057	0.301***	0.075	-0.006	-0.031
SUST	-0.017		0.095*	0.156**	0.136**	0.168***	-0.112*	0.054	0.208***
SCI	0.008	0.098*		0.221***	0.178***	0.039	0.075	0.179***	-0.017
BIOC	-0.131**	0.151**	0.206***		-0.097*	0.039	0.015	-0.114**	-0.210***
TRAD	-0.067	0.153**	0.194***	-0.113*		0.245***	0.112*	0.219***	-0.166**
CIV	0.346***	0.184***	0.041	0.044	0.238***		-0.018	-0.001	0.131**
INF	0.083	-0.119*	0.077	0.016	0.106*	-0.017		0.294***	0.207***
ICT	-0.008	0.063	0.202***	-0.137**	0.227***	-0.002	0.323***		0.101*
MAN	-0.033	0.208***	-0.016	-0.217***	-0.147**	0.120**	0.194***	0.087*	
R^2	0.1311	0.1704	0.1964	0.1413	0.2648	0.2427	0.2204	0.2900	0.1700

Note. *p<0.05, **p<0.01, ***p<0.001

IV. Discussion and Conclusions

The results of the statistical analyses confirm that many of the features related to young women's interest in different engineering disciplines and topics discovered elsewhere also apply in Finland. Women seem to be more interested in issues related to biological rather than physical sciences [17], value sustainable development [18], and shy away from ICT or mechanical and electrical engineering [13].

All in all, the results reveal a pattern that is not very promising for most of the traditional engineering programs. Female upper secondary school students' interests seem to concentrate on few programs related to bio- and chemical engineering or architecture. In addition to that, the interest in the most popular cluster, bio- and chemical engineering, appears to be negatively connected to the interest in many other engineering fields. The two other more popular clusters of programs, Science and mathematics and Sustainability, are positively connected to many of the other programs, but the potential applicants interested in those programs are also likely to be interested in science degrees outside engineering [11] [13]. In addition to the BIOC cluster, the interest in management programs is negatively correlated with the interest in electrical, automation, and mechanical engineering programs, suggesting that women possibly interested in management careers may not be able to see themselves as engineers [12].

Can the findings be explained by the people–thing orientations and aspects? Biological, chemical, and environmental engineering are known to be associated with helping others [7], [11], [19] especially by women [7]. Individuals interested in environmental engineering also report the desire to solve societal problems [11]. In addition, students with marginalized genders have reported a significant negative relationship between altruistic interests and an interest in electrical engineering, computer engineering, and information technology [19]. Hence, at least some of the findings of this study can probably be linked to the perceptions regarding the people orientation of the different engineering subdisciplines. However, the rather specific and isolated interest in architecture, also noted earlier by [13], might be better explained by other factors, relating for example to creative or artistic associations with the field.

There are, of course, some limitations to this study. Gender has been defined as a binary variable, which unavoidably leads to some simplification of the issue. All the analyses have been made based on answers to one question and the respondents were not asked to comment or justify their choices. Hence the data provides no insights to the possible grounds for their decisions. The interestingness of programs was judged only by their name, as no other information was provided. This may have resulted making the decisions based on intuition as opposed to factual knowledge about different disciplines. This, however, is probably also the case with at least some of the high-school graduates applying for tertiary education. These limitations pose potential topics for future research on the motives for choosing or not choosing different engineering disciplines, as well as the effect of information level of adolescents on their interest in engineering in general and different engineering disciplines in particular.

The results of this study indicate that the often-posed suggestion of reframing the curriculum, culture, and image of engineering in a more people-oriented direction could indeed help to attract more women and other gender minorities to engineering also in Finland [1] [2], providing that this new image of engineering is also recognized by the potential applicants. It should, however, not be done at the expense of the perceived thing orientation in engineering but emphasizing the orthogonal nature of people and thing orientations and the possibility to achieve both [1]. This can be particularly important in attracting more women to the subdisciplines like electrical or computer engineering, which are typically associated with career outcomes, such as inventing/designing things, and developing new knowledge and skills [7] [11]. Since peers have an important role in shaping the young women's intentions to pursue STEM fields [20], and they often hold gender-stereotypical views of occupations [15], informal learning environments, such as clubs and camps that allow young women to get to know and explore different fields of technology [21], could be beneficial in diversifying their perceptions of different engineering disciplines. This has also been the objective of the Finnish event whose application process was used to collect the data used in this study.

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Appendix I: Results of the linear regression analyses

Dependent variable		ARC	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
SUST	-0.017	-0.36	0.719
SCI	0.008	0.17	0.863
BIOC	-0.131**	-2.86	0.004
TRAD	-0.067	-1.34	0.181
CIV	0.346***	7.41	0.000
INF	0.083	1.72	0.086
ICT	-0.008	-0.15	0.882
MAN	-0.033	-0.70	0.486
Model fit			
F-value (8, 473)	8.92***	*R*-square	0.1311

Dependent variable		SUST	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	-0.016	-0.36	0.719
SCI	0.098*	2.11	0.035
BIOC	0.151**	3.38	0.001
TRAD	0.153**	3.17	0.002
CIV	0.184***	3.89	0.000
INF	-0.119*	-2.53	0.012
ICT	0.063	1.27	0.205
MAN	0.208***	4.62	0.000
Model fit			
F-value (8, 473)	12.14***	*R*-square	0.1704

Dependent variable		SCI	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	0.008	0.17	0.893
SUST	0.095*	2.11	0.035
BIOC	0.206***	4.75	0.000
TRAD	0.194***	4.11	0.000
CIV	0.041	0.86	0.388
INF	0.077	1.66	0.098
ICT	0.202***	4.21	0.000
MAN	-0.016	-0.35	0.723
Model fit			
F-value (8, 473)	14.45***	*R*-square	0.1964

Dependent variable		BIOC	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	-0,130**	-2.86	0.004
SUST	0.156**	3.38	0.001
SCI	0.221***	4.75	0.000
TRAD	-0.113*	-2.29	0.022
CIV	0.044	0.89	0.374
INF	0.016	0.34	0.374
ICT	-0.137**	-2.74	0.006
MAN	-0.217***	-4.75	0.000
Model fit			
F-value (8, 473)	9.73***	*R*-square	0.1413

Dependent variable		TRAD	
Independent variable	Std. beta coefficient	t-value	p-value
ARC	-0.057	-1.34	0.181
SUST	0.136**	3.17	0.002
SCI	0.178***	4.11	0.000
BIOC	-0.097*	-2.29	0.022
CIV	0.238***	5.42	0.000
INF	0.106*	2.39	0.017
ICT	0.227***	4.98	0.000
MAN	-0.147**	-3.44	0.001
Model fit			
F-value (8, 473)	21.30***	*R*-square	0.2648

Dependent variable		CIV	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	0.301***	7.41	0.000
SUST	0.168***	3.89	0.000
SCI	0.039	0.86	0.388
BIOC	0.039	0.89	0.374
TRAD	0.245***	5.42	0.000
INF	-0.017	-0.39	0.700
ICT	-0.002	-0.03	0.974
MAN	0.120**	2.75	0.006
Model fit			
F-value (8, 473)	18.95***	*R*-square	0.2427

Dependent variable		INF	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	0.075	1.72	0.086
SUST	-0.112*	-2.53	0.012
SCI	0.075	1.66	0.098
BIOC	0.015	0.34	0.733
TRAD	0.112*	2.39	0.017
CIV	-0.018	-0.39	0.700
ICT	0.323***	7.05	0.000
MAN	0.194***	4.45	0.000
Model fit			
F-value (8, 473)	16.71***	*R*-square	0.2204

Dependent variable		ICT	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	-0.006	-0.15	0.882
SUST	0.054	1.37	0.205
SCI	0.179***	4.21	0.000
BIOC	-0.114**	-2.74	0.006
TRAD	0.219***	4.98	0.000
CIV	-0.001	-0.03	0.974
INF	0.294***	7.05	0.000
MAN	0.087*	1.97	0.049
Model fit			
F-value (8, 473)	24.15***	*R*-square	0.2900

Dependent variable		MAN	
Independent variable	Std. beta coefficient	*t*-value	*p*-value
ARC	-0.031	-0.70	0.486
SUST	0.208***	4.62	0.000
SCI	-0.017	-0.35	0.723
BIOC	-0.210***	-4.75	0.000
TRAD	-0.166**	-3.44	0.001
CIV	0.131**	2.75	0.006
INF	0.207***	4.45	0.000
ICT	0.101*	2.04	0.041
Model fit			
F-value (8, 473)	12.11***	*R*-square	0.1700