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Why engineering needs women—insights of female and nonbinary Finnish upper secondary schoolers

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Introduction

Gender parity is known to advance the development of technology for more inclusive products and services, create better work and study environments, enhance general societal equity, and even increase the financial outcomes of enterprises. Unfortunately, these motives are not always explicit in the endeavors for getting more women into engineering, and the objective of increasing the share of women may appear as an end instead of a means. This, on its part, may reduce the interest in participating in these activities.

Engineering outreach activities and initiatives come in various forms with most of them relying on hands-on activities in some way or another [1], [2]. Unfortunately, the research evidence of their impact or effectiveness is scarce [3], [4]. Although the tinkering aspect of engineering has been shown to be attractive to both girls and boys [5] it may not be sufficient to convey the need for diversity in technological development or societal benefits through technology.

Finland is known to be a very egalitarian country, where gender equality is highly valued and endeavors for advancing diversity, equity, and inclusion are generally appreciated [6]. The strong gender segregation of job markets, however, is acknowledged as one of the major challenges to gender equality in Finland [7]. Hence, one could expect dismantling of the overrepresentation of men in the fields of technology and engineering to motivate Finnish young women, at least to some degree.

Although many young women in Finland likely agree that engineering needs more women, the actual justifications behind their opinions probably vary considerably. This study aims at a better understanding of young women's insights into equality and technology. This knowledge is hoped to be of use in developing more efficient recruitment and outreach activities to get more women into engineering as well as in addressing the issues of diversity, equity, and inclusion in the wider culture of engineering education and work.

Gender equality in Finland

Finnish people regard gender equality as a highly recognized and widely shared societal value. Gender equality is perceived to be an integral part of western democracy and the ethos of the Nordic welfare state, and hence must be supported. Most people have a positive attitude toward measures for improving gender equality in Finland, and a great majority of people are also in favor of dismantling gender segregation in the labor market [6]. Nevertheless, the issue is far from nonproblematic. Finnish discourse on gender equality often involves assumptions of equality having already been reached despite many facts and figures that prove otherwise. Gender equality is also often regarded as an individual and women-oriented question, which easily draws attention away from the structures producing and maintaining inequalities [6]. This kind of tendency to emphasize the liberal discourse over radical was also observed in Norway as opposed to Sweden, where the structural aspects of gender (in)equality are more readily addressed [8].

Young people and students regard men and women as equal more often than people in the older age groups. Forty percent of female and over sixty percent of male students perceived

women's position in society as equal to that of men. However, more than half of the female students considered men to have a better position. Eighty-eight percent of young people considered a future scenario of improving gender equality as desirable, but only seventy-one percent regarded it as plausible [9]. Hence, young people seem to have a fairly positive view of gender equality in Finland and also a high appreciation for it.

Gender segregation in the Finnish labor market starts already in secondary and tertiary education. Half of the women study in disciplines where women are overrepresented, whereas about a third of men study in men-dominated disciplines [7]. Paradoxically, at the same time, fifty-six percent of young women and one-third of young men perceived the strong segregation of professions as problematic [9]. Students hold rather gender-neutral, yet somewhat contradictory views on expertise. On one hand, more than ninety percent of the students agreed that gender plays no role in expertise in business and economics, on the other hand, forty percent of male and twenty-five percent of female students regarded men as more appropriate experts in the matters of military and defense [9]. One study of Finnish adolescents' science and technology views showed a much stronger belief in men's innate proficiency in science and technology among boys than girls, with girls generally opposing the idea [10]. In general, Finnish girls report letting their gender influence their occupational considerations much more seldom than boys [11].

Reaching out to young women

Engineering is often stereotyped to involve social isolation, an intense focus on machinery, and inborn brilliance [12]. These features can attract many people, but they are also likely to push many away. Among Finnish adolescents (age 15–18), girls and boys seem to hold a similar appreciation for the societal aspects of technology—interest in how technology promotes well-being and impacts the environment—but boys hold significantly stronger interests in the functional aspects of technology [5], [13]. Simultaneously, functional orientation toward technology was a strong predictor of adolescents' interest in engineering studies, whereas an interest in societal aspects did not have an effect [13]. The phenomenon is present also among preteens (age 11–13), where Finnish boys hold stronger engineering attitudes (interest in equipment and how it works) toward science than girls, but the societal attitudes toward science (usefulness of science, the importance of science in solving global problems) showed no gender differences [14]. In the context of a mobile science exhibition focusing on hands-on exploration of science, technology, and engineering objects, preactivity social attitudes were discovered to have a small negative effect on postactivity engineering attitudes [14] suggesting that mere tinkering opportunities do not similarly serve the development of all the young people.

Outreach activities designed to elicit children's and adolescents' interest in engineering rely heavily on hands-on exploration [1], [2], which may come with or without reflection. Although research suggests that embedding hands-on activities in a wider pedagogical framework like inquiry-based learning and good contextualization of content in real-world issues or needs increase the effectiveness of outreach activities [15], it can be doubted that all the practical experiments with science and technology make use of these aspects. Even engineering students seem to struggle with relating the social aspects of engineering, like recognizing the needs of users and society or collaborating with stakeholders, to engineering problem-solving, which is viewed predominantly as a technical activity [16]. Hence, it is not surprising if the picture of "engineering with, for, and as people" [16] is not readily conveyed through outreach activities either.

Providing diverse role models to emphasize the need and fit of different kinds of people in engineering is another element often included in outreach [1], [2] many times with success, but sometimes with unintended consequences. In an Israelian outreach project, the perception of a woman scientist or engineer became more negative and self-confidence in dealing with STEM declined for a group of girls visiting a company compared with a control group, who did not encounter real female scientists and engineers at their work [17]. Reasons for this were sought from the cognitive or developmental gap created by the meeting, the short-term nature of the meeting, and the cultural context of the girls [17]. In a U.S. website aiming to inspire young women to become engineers, female engineers share their experiences and advice through personal stories. Despite the good intentions, many of the stories voice frustrations with discrimination and gendered obstacles, yet do not address these issues as structural inequality to be corrected. Instead, advice is given to young women on how to adapt to the situations and ”go for it” [18]. This way of solving structural problems through individual actions places a lot of pressure in women and echoes the wider tone of gender equality discussions also in Finland [6].

Methods

The objective of this study is to understand whether Finnish female and nonbinary upper secondary school students see the goal of dismantling the male dominance of engineering as personally valid and meaningful, and what kinds of arguments they present for or against it. This understanding is believed to be useful in formulating more compelling arguments for recruiting currently underrepresented genders to both outreach activities and engineering studies. It can also show which aspects of outreach activities and engineering education need to be emphasized and developed for more efficient tackling of some of the structural gendered obstacles to the entry to the discipline.

These goals are hoped to be reached by answering the research questions:

RQ1. How do Finnish female and nonbinary upper secondary students perceive the need for more women in the field of technology?
RQ2. How do they justify their opinions?

The data were collected as part of the application process to an event introducing engineering and engineering education opportunities to female and nonbinary upper secondary school students. The application process was open for two months from mid-October 2021 onward, as the event was supposed to be organized in January 2022. Unfortunately, the event had to be postponed to the autumn of 2022 because of the Covid-19 pandemic, but the decision was made only after the application period. Applicants were not requested to identify their gender, but the marketing of the event was directed to women and nonbinary upper secondary school students, hence there supposedly were no male-identified students among the informants.

Applicants under eighteen needed a written consent from a guardian to apply for the event, but they could decide for themselves whether their data were used for research. In Finland, a parental consent for participating in nonmedical research is not required if the adolescent is over fifteen, the research is not considered harmful to the child, and the child can be regarded as capable of forming their opinion. The data were anonymized before any analysis for research purposes.

A total of 507 young people applied to the event and 482 of them consented to the use of the application data for scientific research. The sample was self-selecting as anyone identifying themselves as a woman or nonbinary and studying the long syllabus in mathematics could apply to the event. Hence, the sample was limited to those who would in reality be eligible to apply to the engineering programs at the university level, and owing to the nature of the event, also biased toward people who held a higher than average interest toward engineering careers to start with.

In the application form, the applicants were asked to answer an open question **"Do you think that more women are needed in the field of technology? Justify your answer."** Answers were submitted as open-ended text and varied from a couple of words to paragraphs with several hundred words. Written answers were analyzed by qualitative content analysis following the ideas of theory-directed coding in the Atlas.ti software.

The event website introduced the aim of the event as follows:

At the Shaking up Tech event, universities want to offer a diverse understanding of technology as a discipline and career choice. The aim is also to demonstrate that young women and other genders have more than enough abilities and skills to study in the field. The event is partnered with a group of companies with the same objective. Technology is an area of the future that needs different people to challenge the sector and think in a new way. Various ideas and diverse teams lead to better results and are the key to sustainable success and a good working environment. (free translation from Finnish text in [19]*)*

The website also illustrated the strong gender segregation of the technology profession through some graphs and stated that according to a PISA study, Finnish girls' proficiency in mathematics and natural sciences is the world's top. The information provided is likely to have prompted applicants' answers to the question to some extent.

Results

The coding process

The coding process started with a readthrough of all the responses. After that, twenty-three preliminary codes were named according to the first impression and the literature on women in technology and engineering. In the first round of coding, preliminary codes were assigned to the quotations, and seventeen new codes emerged from the data. Some refinement of the code naming was done alongside the coding. Each response was handled as a single quotation with sometimes several simultaneous codes instead of breaking the responses into smaller pieces. This was done to enable a co-occurrence analysis between the codes. After coding all the quotations with the forty codes, the codes with less than ten hits were revisited, more quotations were looked for with text searches with particular strings, and some of the codes were merged into new ones. In the end, there were thirty-nine codes left, most of which with more than ten connections to the responses.

At this point, the codes also included codes that were not relevant to answering the research questions of this paper. Hence, four codes were chosen for further analysis to answer RQ1, and twenty codes were chosen for answering RQ2. The latter codes were then grouped into seven categories, and these were combined into three themes. The twenty codes for RQ2 were described and illustrated with translations of appropriate excerpts from the quotations.

Are more women needed in technology?

As would be expected, a great majority of respondents were of the opinion that more women are needed in engineering. Only 2/482 responses took a clearly negative stand:

> *Hmm. I would say that the industry should develop on its own, so my answer is no. Equal treatment is needed, and this also applies to how young people are encouraged to apply. I am not on the side of privileges, but I understand that women in this field would also help to develop equality. Providing information on opportunities is important. (341)*

> *I wouldn't say they are "needed". What I mean is that those who are interested in technology should apply there and no one should be forced to do so as a woman. (441)*

There were, however, some respondents, who explicitly stated that they do not know how to answer the question:

> *I can't say. (456)*

some responses where the stand was unclear:

> *Women in the field of technology are not an absolute value. However, work should be done to ensure that no one fails to apply because of being a woman. (449)*

and some responses, which were generally difficult to interpret. Hence, altogether 459/482 respondents answered explicitly "yes".

A small group of respondents (22/482) who were of the opinion that more women are needed in engineering still expressed either a kind of reluctance to address the question of gender or emphasized it to be of minor importance or not relevant in all fields of engineering. Many of them also stated that it is an individual's qualities that matter instead of gender.

> *I would not want to divide people by gender because young men are just as much needed in the field of technology. I think that we should focus less on gender and create an opportunity for all skilled workers to apply to the sector they want. However, I also think that an increase in females in the field of technology would be good for the sector and perhaps would also increase the number of reforms. (127)*

It was also recognized that even if a situation where gender does not matter may be the ideal of the respondent, it is not reality at the moment and needs to be corrected.

> *I do not feel that we specifically need representatives of any particular gender in any field. The most important thing is to find the most qualified individuals in each field. At present, however, there are certain attitudes and ways of thinking in our society that can cause gender to slightly guide career paths. But, yes, more women are needed in the field of technology. (160)*

Hence, the question of whether gender should play a role in entering and recruiting people in engineering is, in fact, a more complicated issue than just increasing the number of women in the field.

Why are women needed in technology?

A multitude of justifications were given mainly to argue why more women are needed in engineering and technology. Arguments fell into three broad themes: technology, equality,

and society. Slightly over half of the respondents presented technology-related arguments and slightly less than half equality-related arguments, and around one-tenth of the respondents took their arguments to the level of society. Arguments related to technology are presented in Table 1, arguments related to equality in Table 2, and arguments related to society in Table 3.

Technology arguments seemed to relate to three broader categories: field, business, and culture; better knowledge and products; and labor force and skills. The first category included issues related to the field and work at large, what kinds of topics are addressed and how, what kind of atmosphere and image the field holds, and how these things are reflected in working life and business. The second category got the most hits of all the categories with almost half of all the respondents referring to the idea of technological knowledge and artifacts becoming better through the acknowledgment of diverse ideas, views, and needs. The arguments in the third of the technology categories emphasized the need for women as skilled workforce. However, women were not seen as reserve labor to compensate for the shortage of men, but as a workforce needed for the sake of its added value to the field.

Table 1. Codes and categories addressing the respondents' arguments related to technology

Name and description	**Illustrative quotes**
Technology: field, business, and culture	
Development of the field More women in the field were perceived to advance technological research, produce more innovative technologies, help to question existing practices, find new problems to be solved and realms to be conquered, and take technology in a more multidisciplinary direction.	The increase in the number of women in technology will certainly broaden the sector's vision of the problems it solves, thus making better use of technology and creating it more inventively than in the past. (43) Women bring a new perspective on technology and question existing practices. This will strengthen the fields of technology and make them a sustainable part of building the future. (104) I also believe that the technology sector is expanding and becoming more cross-disciplinary because today's problems require more than just technical expertise. For example, when solving climate change it is not only technology that can be considered but also its impact on people. This is where I think women are especially strong. (323)
Cultural change An increasing number of women were hoped to create a more respectful and approving culture as well as change the atmosphere and spirit in general.	In my opinion, women generally have a lot of new and interesting ideas, especially from different perspectives, so they can bring new ideas, and change the climate and spirit of technology fields. (10) There would also be a more acceptable climate for all in the field of technology, and women as a minority would not be put at a disadvantage. (144)
Improving enterprises Women were thought to bring financial as well as other kinds of benefits to companies.	Companies too would benefit from female workers, because if there are as many women as men in the company, the company gives a good impression of itself and can do better. (288) Women may also understand the customer differently from men, which improves the customer's experience of the company. (374) Of course, from a purely economic point of view, it is also useful for companies to hire women because different perspectives are the strength of the company. (410)
Technology: better knowledge and products	

Ideas, innovations, and solutions More women and more diversity, in general, were argued to initiate new, different, and better ideas, innovations, and solutions, which would also serve larger audiences and application areas.	[W]omen bring a different perspective to the field, which will enable us to find new solutions to existing problems. (7) Women's approach to technology is likely to be different from that of men, which can contribute to the emergence of new innovations. (68) The more evenly the different genders are involved in technology, the better the different perspectives, ideas, and needs can be identified. (150) I am sure that women's point of view would bring about new innovations that would not only help women's lives but also the lives of all those to whom "the world designed for men" does not fit. (155) I believe that by women, technology can be utilized in areas where it has not been realized to be of use before. (280)
Views and perspectives For new ideas, innovations, and solutions to arise, the world and problems need to be viewed from perspectives which currently may be missed, overlooked, or even suppressed. New perspectives amend the current ones and improve the technologies further.	Half of the users of technology are women, and therefore products must also be designed from a woman's perspective. (20) Although knowledge and skills are not gender-specific, I still believe that women can bring the field of technology new perspectives and ways of thinking that are needed to develop the common future of our planet. (36) A variety of different perspectives is important. There is always room for improvement, but if the workers are too much alike, no one will notice the things to be improved. (76) In the field of technology, the influence of men is evident. Women's viewpoints don't get out. (104) In an ideal situation, the goods and services produced by the technology sector would meet the needs of as large a part of the population as possible. It is quite logical to conclude that in order to achieve such a state, product developers should have as broad a view as possible of the characteristics and wishes of different user groups. (425) Today's world and young women bring a new perspective to the field of technology that men have not been able to offer before. (436)
Needs In line with the diverse perspectives, diverse needs, and especially women's needs have to be recognized and considered for technology to serve them fully. Women's needs are often forgotten or overlooked, and many of them stem from everyday life.	The design stage of many devices/systems does not take into account half of the world's population, which may cause practical problems. Women in the field of technology make it possible to achieve the most balanced process and ideas that take account of the whole population. (418) Especially the technological applications regularly used in everyday life require multifaceted development. The more diverse people from different backgrounds end up in technology, the better technology applications can be developed to meet the needs of all kinds of people. (373) Starting from the design of everyday products, the safety and needs of women could be better taken into account if more women were involved. (241)
Technology: labor force and skills	
Potential Women hold potential, which is easily missed by the field of technology. This potential was described on one hand as equal to men's potential, on the other hand, as different	[T]he potential is greatly lost when excellent female candidates are replaced by mediocre men. (78) Women have their own strengths, which should be made use of to a larger extent in the field of technology. (133) I believe that women have a huge potential that can be harnessed in technology for their own benefit and the benefit of society as a whole. (209)

and drawing from the special strengths of women.	The fact that women's potential to act, for example in the management of technology, is still being neglected today is not only unfair but also unnecessary. (213)
Resources Women can also be an unused resource reserve as the field of technology is in need for a lot of workforce now and in the future. However, women were very rarely addressed only as a resource.	Technology is a growing field of the future, so experts from all backgrounds are needed. (117) There is already a shortage of people, especially women, in the field of technology. (191) Partly because technology fields are areas of the future, and it would be absurd not to use half of society's resources (241) I don't really care as long as there are enough employees. (457)

The equality arguments also formed three categories: general, individual stand, and structural. Most of the statements viewed equality at a rather general level referring to the need for dismantling the male domination of engineering, better gender parity in all fields, and promoting equality in different environments. Some arguments approached equality from an individual viewpoint emphasizing personal freedom of choice, the right to good employment and career, and equal opportunities in working life as well as in life in general. The third category of equality arguments concerned structural equality. These statements concentrated on the pay gap, harassment and discrimination, and the elements of power and influence. Albeit harassment and discrimination were addressed only in four comments, it was kept as an individual code and included in this category because of its nature as a widely recognized equality problem also in technology and engineering.

Table 2. Codes and categories addressing the respondents' arguments related to equality

Name and description	**Examples of quotes**
Equality: general	
Male domination The current state of male domination of technology and engineering was often a stand-alone justification for the need for more women in the field.	Technology is very male-oriented, so it would be great to have more women in these sectors. (64) I believe that more women would be needed in the technical fields because they are very male-dominated. (168) I think it is important to have more women, especially in male-dominated sectors. (237)
The ideal of even distribution An even distribution of gender was generally regarded to be a good thing for any discipline, and engineering was noted to be far from it.	Gender equality is important in working life and it should extend to all sectors so that there are no separate men's and women's fields of work and study. (4) There should be gender balance in the field of technology, but unfortunately, this is not the case. (202) In my opinion, all fields require in principle the same number of men and women, because both genders and different people, in general, have their own perspectives and ideas for doing things. In a male-dominated sector, the advantages rising from the common features of women may be omitted. (282)
Promoting equality Having more women in engineering and technology	[I]t would be necessary to get men and women in the fields equally, just for the sake of equality. (52)

was perceived to promote equality in technology, society, Finland, and the world. Sometimes promoting equality was considered the most important aspect and sometimes more of a by-product.	It is necessary because the technology sectors are easily perceived as men's fields. These stereotypes should be broken. It would also promote equality in our society. (100) The world would be a more equal place if there were more women in the fields of technology that are highly valued. (290) In addition, I believe that women's progress in technology is good for equality in terms of economic and social status. (321) I think it is necessary, not just in the name of equality, but I believe that women have the same skills and passion for technology as men do. (427)
Equality: individual stand	
<u>Freedom and the right to choose</u> The right to make one's own choices without restrictions or influence from others or circumstances was considered important.	In my opinion, when choosing the field you should be able to choose the one you really like and not have to question the decision just because it might be difficult or uncomfortable to be in as a woman. (86) Women must get at least as high positions as men and have a full right to show their real abilities! (205) I would also like to see more women working in their dream work. So that they don't get the feeling that I can't go in there but that they'll do it willingly and with a free mind. (389)
<u>Employment and career</u> Good employment and career opportunities in engineering were seen to benefit women, albeit often not realized by them.	[Field of technology] has a good employment outlook today and in the future, and there is a need for more experts in these areas. (41) The field of technology offers good career options, which many women do not even think about because the field is so male-dominated. (85) Women should be encouraged even more into the field of technology because I think that many could find there a pleasant career that they would otherwise not even think about. (323)
<u>Equal opportunities</u> The importance of equal opportunities was emphasized also with respect to succeeding in life, changing the world, and fulfilling one's dreams.	The most important thing would be to get rid of prejudice and to give women, especially young women, an opportunity to succeed and change the world. (190) More women are needed in the fields of technology because women have equal opportunities for studying technology and also for success in working life. (405) [E]veryone should have the right to make their dreams come true. (196)
Equality: structures	
<u>Pay gap</u> Closing the pay gap in technology and society was considered important.	Balancing the gender distribution in different sectors and occupations is important because it will also help to prevent the pay gap between men and women. (83) The pay gap between women and men would be reduced if there were more women in "well-paid engineering". (219)
<u>Harassment and discrimination</u> The need to stop harassment and discrimination was recognized but only mentioned in four responses.	The more gender balance in all sectors, the less gender-related discrimination, and the more courage [for women] to apply. (157) Sexual harassment of women, reported in the news, can also be reduced by getting more women in the field so that they can act as a safety net for each other. (349)

Power and influence Respondents advocated for more women in decision-making, more influential positions for women, more visibility for women in history, and moving away from patriarchism.	Without women's opinions and input in the negotiating tables, decisions are only taken from the perspective of half the population. (8) Fields of technology are very influential and provide many opportunities for rising into important positions, where in my opinion more women are needed. (199) [W]e live in a patriarchal world, where women are easily sidelined, and their achievements are ignored. (29)

The third theme, society, was the one appearing the least in the responses. Three of the individual codes related to this theme, and no further categorization was made. All the aspects of the theme were somewhat equally distributed among the responses, with no particular view outweighing the others.

Table 3. Codes and categories addressing the respondents' arguments related to society

Name and description	**Examples of quotes**
Society	
Benefit for all More women in engineering were thought to benefit society through technology that serves the needs of a larger group, general improvement in equality, better use of common resources, and making society function better for women and everyone.	When women, too, participate in the development and practical use of technology, different perspectives become more diverse. This will promote equality, which will benefit society as a whole. (13) Modern society revolves around technology. If women are not involved in technological development, society does not meet the needs of women as well as it meets the needs of men. (68) Women have enormous potential and, if not exploited, it is detrimental to society as a whole. (94) In many areas of technology, work is carried out with a major impact on society and people's everyday lives. In order to ensure that the largest possible proportion of the population is successfully taken into account in the work, it is important that as many perspectives as possible be taken into account in the technical fields. (251)
Hearing everyone's voice Having more women in engineering was argued to make the different societal aspects more likely to be encountered and the voice of all the relevant stakeholders heard.	A balanced gender distribution in the field of technology would be desirable for society as a whole so that no one would be excluded because of the homogeneous nature of technology professionals. (117) It would be useful for society to have a wide range of perspectives in order to maximize the use of technology. (192) In my view, more women are absolutely needed in the fields of technology, because the greater the variety of people developing the technology of our society, the better they will be able to take into account all the necessary aspects. (207) The [technology] sector solves complex social problems that can affect different populations in different ways. For example, better consideration of the perspective of women in the planning of community structures could contribute to social equality. (337)
Common world and future On the widest scale, the increase in women in technology was hoped to	Although knowledge and skills are not gender-specific, I still believe that women can bring new perspectives and ways of thinking into the field of technology that is needed to develop the common future of our planet. (36)

improve the whole world and the future of humankind.	We need development now, perhaps more than ever, which is why the world also needs innovative and courageous young people who are able to develop solutions to the problems of today and the future. (160) Women could provide insights and experience in creating new innovations and a better world. (295) Given the long-standing male-dominated nature of technology, women have to offer new perspectives and ideas for solving problems. It also increases equality in society and offers women new opportunities to influence the present and the future. (334)

Limitations

There are several limitations to this study. The event, related to which the data were collected, first originated as something marketed only for young women. As time passed, it was realized that the language used in communicating the event was unnecessarily binary, and more efforts were made to also include the nonbinary upper secondary school students among the prospective audience. However, the application form for the event still had the question referring to gender in a binary form and may thus not have been the most appropriate for all the respondents. Should the perceptions and opinions of the same audience be used in research later, more attention must be paid to using more inclusive language throughout the data collection and analysis and in the problem formulation.

The sample of this study is obviously quite biased toward young people already having some interest in engineering and technology. Therefore, the generalizability of results to upper secondary school students without a preliminary interest in engineering is limited. If the target is to extend the audiences of the outreach and recruitment activities to people whose interest in engineering is hoped to be initiated instead of strengthened, data must be collected and analyzed from more general groups, such as whole classes or years.

As the study was conducted by a single researcher, whose position is that of a middle-aged white female with an engineering background, also the data are unavoidably interpreted through those lenses. Having a more diverse research team would bring more diversity also to the research process and might help to discover issues that now have been missed.

Discussion and Conclusions

> *Yes [more women are needed in the field of technology]. Firstly, women and men have different approaches to problem-solving. The more viewpoints, the better the planning becomes. Secondly, technology is shaping our lives. It changes, for example, our housing, traffic, and cities. If only men are creating/modifying something as important as traffic, how can we expect traffic to be safe for women, too? Third. Equality. It has long been stereotyped that men are wiser than women and that women cannot succeed, for example in physics. This may have a very strong impact on the image of young girls in science and its different fields. We need more women's examples for young girls from the science fields. This is how girls dare to dream of engineering jobs. (429)*

The quotation above illustrates well the way Finnish female and nonbinary upper secondary school students view the need for more women in technology and engineering. An increase in women in the field was perceived to improve technological work and products, enhance equality, and serve society through advances in both technology and equality. Even though the event website might have prompted the applicants to mention women as a source of improvement in the culture and atmosphere in engineering fields, the respondents' most cited technological aspects related to the better knowledge and products gained through more

diverse ideas, views, and needs. This indicates that to young women technology represents more than mere functioning of technical artifacts, and the aspect of how technology can be used to promote the well-being of humans is appreciated and interesting as earlier studies suggest [5], [13].

The responses show a high valuation of gender equality, which is typical in Finland [6], [9]. General improvement in equality is often seen as an objective in its own right, without a need for further justification. Digging deeper into different facets of gender equality reveals that individual viewpoints are recognized and emphasized more readily than structural aspects, which is also typical for the Finnish discourse [6], although both liberal and radical feministic arguments are present in the gender equality discussion as the case often is in the Nordic countries [8].

Societal benefits of getting more women into engineering are present but somewhat less prominent in the responses. Many of the respondents appeared to be familiar with the book *Invisible Women* by Caroline Criado Perez, which had opened their eyes to the profound effect of technology and engineering to (in)justice and (in)equality in society. When the role of engineering in solving global problems and making the future of humankind better was recognized, it was also highly valued and the importance of the diversity of technology developers was regarded vital. However, often the observed benefits of advancing technology and/or equality remained at the level of individual people.

Notwithstanding the great majority of respondents favoring the idea of more women in technology and engineering, certain ambiguity around using gender as an argument in alluring people to the field remains. Some respondents seemed to think that in a situation with full gender parity gender becomes a totally irrelevant factor, whereas other respondents thought that women possessed certain qualities related to their gender and deemed these qualities valuable for the field.

So, how can this knowledge be used to improve outreach and recruitment activities? First, it appears imperative that if activities are arranged with the aim of reaching out to underrepresented genders, then it should be made explicit why more gender diversity (or less gender disparity) is needed in engineering. If the motives are not explicit, some members of the target audience can mistake the recruitment of the underrepresented as an end instead of means, and this may cause a backlash.

The benefits of having more gender diversity in engineering should be addressed from the viewpoints of technology, equality, and society to provide relatable objectives to as many people as possible. At least in the Nordic context, one should present the enhancement of gender equality as an explicit objective of outreach and recruitment activities, as equality is a widely shared and valued objective. However, one should be cautious about messages that convey the idea of solving structural problems with individual actions [18] in order to avoid putting an unnecessary burden on individuals, and the structural challenges in gender equality should be addressed as something to be tackled together in the engineering community.

The social advantages of more gender diversity in engineering as well as the societal effects of engineering in general should be discussed more overtly in the context of outreach and recruitment but also more widely as part of engineering identity and the public image of engineering. As the societal aspects appear to be more invisible to young people, they hold the potential to attract the kind of people who may not have considered engineering as a career option before.

Finally, the language of outreach and recruitment activities should be steered from gender-neutral or binary to more inclusive, emphasizing gender diversity. However, this should not mean forgetting about the equality challenges that have been recognized in women in engineering research, but rather introducing them as examples of inequality faced by one gender minority group in engineering. Research-based evidence is a powerful tool to prove the need for equality work, especially in Finland, where the illusion of gender equality already being at hand still pops up from time to time [6].

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