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# Sense Of Belonging Among Technology Students In Finland

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# FINNISH TECHNOLOGY STUDENTS' BELONGING IN TECHNOLOGY (RESEARCH)

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## ABSTRACT

This paper examines Finnish technology students' belonging in technology. The phenomenon is studied at the level of the field (belonging in the field of technology) and at the level of institution (belonging in one's study community). The data were collected within the annual student survey conducted by a professional organization for academic engineers in 2022, and analysed statistically. Results suggest that men strongly experience they belong in technology while women express some doubts, and non-binary respondents are even less certain of their belonging. Gender differences in belonging in the field of technology are more prominent than those of belonging in the student community.

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## 1 INTRODUCTION

Sense of belonging has been defined as “the subjective feeling of fitting in and being included as a valued and legitimate member in a particular setting” (Lewis et al. 2017) and as “a self-representation that indicates how much students see themselves as fitting in with those around them” (Master and Meltzoff 2020). As a theoretical concept, it has been used to explain for example students’ motivation and persistence in education (Tinto 2017), gender differences in persistence in engineering (González-Pérez et al. 2022), gender gaps in STEM (Master and Meltzoff 2020), and even academic performance (Krause-Levy et al. 2021).

Empirical studies have shown a high correlation between a sense of belonging and self-efficacy (Lewis et al. 2017) and revealed that high confidence in succeeding with one’s studies strengthens the sense of belonging whereas struggling to understand the subject matter can make the students feel that they do not belong (Rainey et al. 2018). The lack of science identity was noted to weaken the sense of belonging among STEM students whereas a strong science identity strengthened it (Rainey et al. 2018). Women in engineering are suggested to experience weaker belonging due to numerical male dominance which can isolate them from the social group in the workplace, as well as normative male dominance which can hinder fitting in the typically masculine workplace culture (Wilson and VanAntwerp 2021).

Master and Meltzoff’s (2020) STEMO model suggests that the sense of belonging, ability beliefs, and identity contribute to academic outcomes and interest. In the model, identity is connected to linking oneself to a domain (such as engineering) and to a social group (like engineers or engineering students) and valuing that domain or group. Tinto’s (2017) model of persistence in education links the sense of belonging to self-efficacy and perception of curriculum to influence motivation, which then affects the intentions to persist in one’s choice of education. Rainey et al. (2018) discovered that students explained their sense of belonging through personal interest in the course subject and the lack of belonging through explicit lack of interest, yet the lack of personal interest was rarely cited as the reason to leave STEM majors.

Acknowledging the close connections between the concepts of sense of belonging, self-efficacy and ability beliefs, and identity, this study considers belonging in technology to include the facets of the sense of belonging, self-efficacy and ability beliefs, and identification and identity. These conceptual relationships are illustrated in figure 1. In essence, the phenomenon resembles Master and Meltzoff’s (2020) concept of self-representations, which focuses on identification, ability beliefs, and a sense of belonging. However, instead of calling the phenomenon self-representations, which could also refer to other kinds of self-images, this study concentrates on the students’ attachment to technology as a field of study.

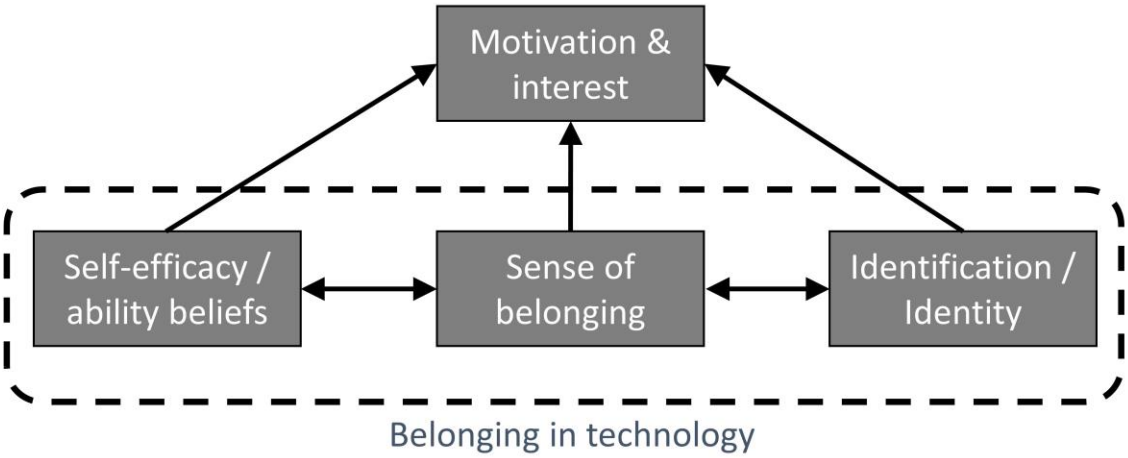


*Fig. 1. The conceptual constituents of belonging in technology in the research model for this study*

Studies have also indicated the sense of belonging being important factor in students' persistence in engineering (González-Pérez et al. 2022) and in STEM (Lewis et al. 2017; Rainey et al. 2018).

So far, the research findings on female engineering students' sense of belonging seem inconclusive. A literature review by Wilson and VanAntwerp (2021) shows how some studies conclude that female undergraduate students feel they belong in engineering majors, whereas other studies find that they do not, and a third group of studies arrives at mixed results. Belonging appears to be more fragile for graduate students and those undergraduates who did not persist in engineering. However, the belongingness deficit is most evident in studies of racially underrepresented groups, as studies repeatedly show that students of colour report a lower sense of belonging than 'white' engineering students.

It remains also somewhat unclear whether male and female students' sense of belonging in engineering differs. On the class level, some studies indicate that female undergraduate students feel less belonging than male students, some studies report stronger belonging of female students, and some studies found no difference. On the field level studies, female undergraduates report the same or less belonging than males, but on the institutional level, they report the same or more belonging than men. Nevertheless, Wilson and VanAntwerp (2021) suggest that lack of belonging is often among the reasons women leave engineering majors.

Despite a vast body of research on belonging in engineering, little is known about the belonging of non-binary students, and "*the experiences of transgender, gender nonconforming, and nonbinary students are glaringly absent from ongoing discussions of equity and social justice in engineering education*" (Haverkamp 2018, 3). Also, most of the studies on belonging have been conducted in the U.S. and, for example, European or Nordic contexts have scarcely been studied so far. This study aims to fill both of these gaps.

## 2 METHODOLOGY

### 2.1 Research question

The main objective of this study was to better understand how gender impacts belonging in technology and engineering in the Finnish context. Another aim was to understand if and how gender as a non-binary variable relates to belonging in engineering/technology. The objectives were pursued by seeking to answer the following research question:

> *Does the sense of belonging of Finnish engineering/technology students differ by gender, related to a) belonging in the field of technology, and b) belonging in the study community?*

### 2.2 Data

Data was collected by a professional organization for academic engineers in Finland whose members also include students of engineering/technology, computer science, and natural sciences. The data used in this study was derived from the organization's Student Survey which is conducted annually as an online survey, targeting all student members except first-year students. The purpose of the student survey is to collect information on the wellbeing and employment situation of students as well as to gather data on timely, varying topics.

In 2022, the data gathering took place during September 14-30. The invitation to answer the survey was sent to 15 941 students, and altogether 1708 student members participated (response rate 11%). The response rate and the number of respondents were surprisingly low compared to previous years. One explanation may be that during COVID-19 pandemic students were confined to their apartments whereas in 2022 the usual live teaching and events were taking place, thus reducing the interest of the potential participants to respond. Nonetheless, the number of participants was deemed sufficient for statistical analysis and for making inferences about student members in general.

The gender distribution of the population was known, as the information on gender as a binary variable (male/female) based on the Finnish ID could be derived from the organization's membership register. However, the respondents were asked to state their gender in the survey on a 4-point scale (Male/Female/Other/Does not want to disclose). Comparison between the respondent data and the population data showed that the responses were strongly skewed gender-wise, with 55.1% male respondents (72% in the population), 41.3% female respondents (28% in the population), 1.6% other (no information in the population) and 2.0% preferring not the disclose their gender. Therefore, to adjust for the overrepresentation of female respondents and to compensate for the lack of respondents in category other in the original population, gender was weighted as follows: Male 71%, Female 27%, and Other 2%. Those who responded 'does not want to disclose' (n=32) were coded as missing. For this study, we used weighted data and selected engineering/technology/architecture students (n=1488), resulting in the following gender composition: Male 72 %, Female 27 %, Other 1.4 %.

The questions concerning the sense of belonging were adapted from previous studies (e.g., Lewis et al. 2017; Rainey et al. 2018; Wilson and VanAntwerp 2021) and divided into two sub-scales: a. belonging in the field of technology (7 items) and b. belonging in the study community (7 items). A five-point Likert scale (1=strongly disagree to 5=strongly agree) was used for all question items.

### 2.3 Data analysis

Statistical analyses were done with the statistical software SPSS (version 29). Kruskal-Wallis tests, including pair-wise comparisons, were used to assess differences between the three gender categories of respondents (Male/Female/Other). A significance level of $p<0.05$ was used for all tests. Internal consistency (reliability) of the sub-scales was measured using Cronbach's α and two negatively worded items were reverse coded for this purpose. The correlations between items were examined with Pearson correlation coefficients.

## 3 RESULTS

The Pearson correlations between individual items in the belonging in the field of technology subscale were according to (Cohen 1988) moderate or strong (between 0.32 and 0.66) as were also most of the correlations between the items in the belonging in the study community subscale (between 0.23 and 0.73). Summated scores revealed a strong correlation ($r$ = 0.55) between the sub-scales. However, the correlations between items across the sub-scales were either small (<0.3) or moderate (between 0.3 and 0.5).

### 3.1 Belonging in the field of technology

The seven items in the sub-scale 'belonging in the field of technology' had a high internal consistency (α=0.858). The results are collected in Table 1. The distribution of the belonging scores were not similar for all groups, as assessed by visual inspection of the boxplots. The differences between gender groups were statistically highly significant (below $p < 0.01$) for all items. However, the effect sizes were small, and none reach even moderate level, remaining below 0.06. We presume the small effect sizes reflect the unequal number of respondents in the three gender categories and recommend conducting confidence interval analyses for the effect sizes in the future to interpret better the differences between the groups.

The results reveal that scores given by male respondents for belonging in technology were the highest for all but one item. The scores given by female respondents were lower than males for six items but higher for "I am proud of studying the field of technology". On the other hand, the scores given by respondents of other gender were the lowest for all items. The largest differences between genders can be discerned for the following items: "People like me can succeed in the field of technology" (Male 4.38; Female 4.09; Other 3.59), "It is important for me to belong in the field of technology" (Male 3.73; Female 3.69; Other 2.94), "Others see me as belonging in the field of technology" (Male 4.13; Female 3.72; Other 3.41) and "I feel like I belong in technology" (Male 4.14; Female 3.80; Other 3.47). Furthermore,

persons of other gender have more often considered leaving technology, as the reverse-coded item obtained the lowest score from them.

*Table 1. Gender differences regarding Belonging in technology*

| Question item | Male (mean) | Female (mean) | Other (mean) | Krusk.-Wallis H | p (asympt.) | Effect size |
|---|---|---|---|---|---|---|
| I feel like I belong in the field of technology | 4.14 | 3.80 | 3.47 | 51.93 | <0.001** | 0.034 |
| Others see me as belonging in the field of technology | 4.13 | 3.72 | 3.41 | 74.06 | <0.001** | 0.049 |
| It is important for me to belong in the field of technology | 3.73 | 3.69 | 2.94 | 10.74 | 0.005** | 0.006 |
| I will be able to acquire the right skills to succeed in the field of technology | 4.25 | 3.98 | 3.76 | 39.80 | <0.001** | 0.026 |
| People like me can succeed in the field of technology | 4.38 | 4.09 | 3.59 | 54.67 | <0.001** | 0.036 |
| I have often considered changing away from the field of technology [REVERSE CODED] | 3.98 | 3.76 | 3.53 | 11.96 | 0.002** | 0.007 |
| I am proud of studying the field of technology | 4.22 | 4.34 | 3.76 | 9.65 | 0.008** | 0.005 |

**highly significant difference

The pairwise comparisons show that with most of the items, there were no statistically significant differences between respondents in categories female and other. However, the items “It is important for me to belong in the field of technology” and “I am proud of studying the field of technology” were rated significantly higher by females than others. The two items are also the only ones that show no statistical difference between the responses of males and females.

### 3.2 Belonging in the study community

The seven items in the subscale ‘belonging in the study community’ had a high internal consistency (α=0.855). The results are collected in Table 2. The distribution of the belonging scores were not similar for all groups, as assessed by visual inspection of the boxplots. The differences were statistically highly significant (below $p < 0.01$) for two items. The effect sizes were small and none reach even moderate level. Again, we presume the small effect sizes reflect the unequal number of respondents in the three gender categories.

The results show that gender differences for belonging in the study community were much smaller than those for belonging in the field of technology. Differences between men and women were far less pronounced, as scores given by female

respondents slightly exceeded those given by males (for four items) or were on par with them (for two items). The only item where scores given by men and women clearly differed was “I sometimes feel like an outsider in my study community” (reverse coded) which also showed highly significant differences between genders (Male 3.05; Female 2.88; Other 2.35). Another item with highly significant differences was “I can be myself in my study community” (Male 4.07; Female 3.98; Other 3.35).

*Table 2. Gender differences regarding Belonging in study community*

| Question item | Male (mean) | Female (mean) | Other (mean) | Krusk.-Wallis H | p (asympt.) | Effect size |
|---|---|---|---|---|---|---|
| I can be myself in my study community | 4.07 | 3.98 | 3.35 | 9.17 | 0.010** | 0.005 |
| I feel I am accepted in my study community | 4.03 | 3.96 | 3.59 | 5.70 | 0.058 | 0.003 |
| I feel that I am appreciated in my study community | 3.70 | 3.71 | 3.29 | 3.34 | 0.188 | 0.001 |
| I am excited about my studies | 3.56 | 3.62 | 3.29 | 1.98 | 0.372 | 0.000 |
| Students support each other and help when necessary | 3.93 | 3.99 | 3.47 | 4.68 | 0.097 | 0.002 |
| I believe I will graduate from my current studies | 4.38 | 4.43 | 4.18 | 1.43 | 0.489 | 0.000 |
| I sometimes feel like an outsider in my study community [REVERSE CODED] | 3.05 | 2.88 | 2.35 | 9.47 | 0.009** | 0.005 |

**highly significant difference

The scores given by respondents in the gender category other differed from those given by males and females. Besides the two items mentioned earlier, these respondents less often agreed with the statements “Students support each other and help when necessary”, “I feel I am accepted in my study community”, and “I feel that I am appreciated in my study community”. Yet, the pairwise comparisons showed no statistical differences between the responses of others and males or others and females. This is rather surprising, considering the much lower means of others especially in the items which show statistically significant differences in the simultaneous comparisons of all the three groups. Nonetheless, this could probably be explained by the large deviation in the responses of others from males and females in these particular items.

## 4 SUMMARY

The results show that students' experiences of both belonging in the field of technology and belonging in the study community differ to some extent by gender also in Finland. However, the gender differences for belonging in the study community (class or institutional level belonging) are much smaller than those for belonging in the field of technology. Although the correlation between these different subscales was strong in the level of summated scores, the correlation of items across the subscales was moderate at the most. This relative independence of the measures of belonging at different levels may provide some degree of explanation of the incongruent findings in prior literature (Wilson and VanAntwerp 2021).

Men are generally strongly convinced that they belong in the field of technology, whereas non-binary respondents feel least often that they belong in the student community. Men's firmer belonging in the field appears to arise from having stronger self-efficacy (ability to acquire the right skills and succeed) and a sense of belonging (feeling of belonging and being seen as belonging) than the other two groups. The importance of academic ability beliefs for men's belonging in engineering has been discovered also by Antonio and Baek (2022). However, the items related to valuing the field of technology (importance to belong and being proud of studying tech) showed no statistical differences between men and women. This aspect was also the only one where women and non-binary respondents differed significantly, with women showing stronger identification with the field of technology.

Although the gender differences for belonging in the study community were smaller than those in the disciplinary level, non-binary respondents more commonly felt like outsiders and not able to be themselves in the community. No statistically significant differences could be detected with respect to feeling accepted, appreciated, or supported in the community (sense of belonging) or being excited or believing in graduation (ability beliefs). Hence, in this subscale, the identity and identification with the community appear to hinder the belonging of others more than self-efficacy or sense of belonging.

Overall, the results suggest that men strongly experience they belong in technology while women express some doubts, especially with respect to their abilities and sense of belonging. Moreover, non-binary respondents are far less certain. In terms of our conceptualisation of belonging in technology and the STEMO model (Master and Meltzoff 2020) high self-efficacy and sense of belonging seem to support especially men's belonging in the field of technology whereas weaker identification with the field as well as the student community decreases the belonging of others. This implies that one key to improving belonging may lie in the broader image of technology, offering more diverse possibilities to identify with.

Probably the biggest limitation of this study is the small number of respondents in the gender category other. In order to reach real gender diversity, equity, and inclusion in engineering education, the views and positions of non-binary gender minorities need to be included in the research on gender and engineering (Haverkamp 2018). Our results show that belonging in technology is not gender equal, and more future research on all gender minorities' belonging in engineering and technology is needed to understand the specific belonging challenges they face.

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