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Closing the gender gap in ICT higher education: exploring women's motivations in pursuing ICT education

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Rapid development of digital technologies has stemmed profound changes in the society, positioning the ICT sector as a key driver and contributor. This sector, including education, is however characterized by a gender gap, which is problematic in the light of the increasing demand for digital competence and the ability to move toward a sustainable egalitarian society. In this study, we argue for a need to explore the concept of ICT in higher education. This involves assessing the success of educational programs in attracting women and exploring the perceptions of female students regarding their academic environment. With a specific focus on Sweden, through a survey involving 82 respondents, we provide evidence on motivations and perceptions of women regarding leading choices on pursuing ICT higher education. We propose a holistic approach to studying gender representation and inclusion in ICT higher education, with a focus on women's perceptions, experiences, and suggestions.

KEYWORDS

ICT education, gender, women, digital transformation, inclusion, motivation

1 Introduction

Digital transformation has stemmed structural changes in society. These changes are driven by the advancement of digital technologies which have permeated all aspects of working life (Parviainen et al., 2017; Bussemeyer et al., 2022). This has positioned the ICT sector at the forefront of digital transformation and acknowledged it as a crucial driver for economic development. According to IT&Telekomföretagen (2020), only during 2010–2016, this sector contributed with six out of ten new jobs in Sweden. Nevertheless, the ICT sector, including education, represents a male dominated sector (e.g., Lehman et al., 2016; Buse, 2018). Statistics suggest that the corpus of ICT specialists in the EU is very disproportionate, accounting for only 17.9% women (Eurostat, 2020). In addition, this sector is facing a scarcity of workforce with digital competence and skills (IT&Telekomföretagen, 2020), a need which is predicted to increase significantly in the coming years. In light of the digitalization of our society and the pervasiveness of digital technologies in all facets of work, this gender imbalance is both concerning and problematic. Inclusion of women in ICT is key to address the increasing demand for digital competence, fostering innovation, and promoting a sustainable and egalitarian society. This importance became particularly evident with the rise of Artificial Intelligence (AI), where bias is attributed to the limited representation of women in design

and development reflecting historical patterns of male dominance over the years (Smith and Rustagi, 2021; Hall and Ellis, 2023).

Having this in mind, the role of higher education becomes important, due to its mission in delivering education and computing skills necessary to equip individuals for the job market. The situation in higher ICT education inevitably mirrors the situation of the ICT industry. Women comprise only 25% of graduates in ICT related higher education (European Commission, 2023). Ample evidence of scholarly work has unraveled the reasons for the underrepresentation of women in the ICT related education (e.g., Lamers and Mason, 2018; Morton et al., 2018; Corneliussen, 2020; Corneliussen, 2024). The ICT field is value-laden (Colomo-Palacios et al., 2020), and stereotyped perceptions and biases related to the ICT education and profession are a major obstacle which women face when choosing to pursue this type of education (e.g., Wong, 2016; Corneliussen, 2020). The lack of knowledge or even a narrow view of ICT is also a contributing factor which discourages women to consider an education and career within ICT (Corneliussen, 2020). The prevailing discourse on ICT profession and education is built on a rather narrow and simplified view of the ICT, primarily associating it with programming and gaming. Moreover, ICT is often not recognized as a career option for women (Morton et al., 2018), an issue further exacerbated by the lack of access and identification to female role models (e.g., Morton et al., 2018; Corneliussen et al., 2019; Berry et al., 2022; Taylor-Smith et al., 2022). However, as Armstrong et al. (2016) argue, inclusion in the context of education is not a unitary concept, and typically requires understanding the social context within which education is embedded to be properly analyzed and addressed.

We build on this insight and argue that increasing women in ICT education is one step among many to address the issue of inequality. Apart from that, we argue that there is a need to explore the concept of ICT education in order to see if there are programs and specializations that are better at attracting women, and if yes, find out how female students perceive their situation. Moreover, our research builds on the insights of critical and inclusive pedagogy and suggests that education takes place within a pedagogical environment that could be gender-conservative, or conducive of inclusion. As such, counting students alone might not rectify the problem of gender balance among the teachers, or in the content and the pedagogy of the program. Moreover, while higher education leads to working life for many, the education itself might not be enough to rectify gendered recruitment patterns within the ICT industry. Thus, we propose a holistic approach to studying gender representation and inclusion in ICT higher education, with women's perceptions in focus to better represent their point of view and their experiences.

While we recognize that dominating discourses have been built on a view of a systematic underrepresentation of women in ICT related education, we posit that this is not a universal and homogeneous issue. To nuance the discussion, we specifically investigate the Swedish context. In the Swedish higher education, if all programs and courses are taken into consideration, women are in majority (Swedish Higher Education Authority, 2023). For example, during Fall 2022, 61% of all registered students in Sweden were women. However, the distribution of students between programs follows a gendered pattern, where women are a majority in areas such as nursing and social work, whereas men are a majority in programs in areas such as engineering and technology. ICT education is no exception to the national gendered pattern, and in 2016 female

students made up 32% of all students nationally in Sweden. However, there are some ICT education programs that attract women, in some instances more than men, such as Interaction Design. ICT programs at a University in Sweden are empirical examples that support our argument that there is a proportion of women that are interested in studying ICT; to work with design and use of ICT. Therefore, in this research we move beyond the emphasis on the gender gap, and instead embrace the inclusion narrative (Lagesen et al., 2022), to focus on the motivation and perception of women to pursue ICT related higher education. To achieve this aim, the following research questions were addressed in this study:

1. What are the factors that motivate women to study ICT?
2. What are the perceptions of existing gender balance in the ICT programs?
3. What factors contribute to a greater inclusion of women in ICT?

The rest of the paper is structured as follows. In the following section we present a review of related scholarly work. Next, we provide a description of the research methodology. After that, we report our results. Finally, we discuss the results and present conclusions and suggestions for future research.

2 Literature overview

Scholarly and policy-oriented discussions on how gender inclusion can be best accomplished in educational settings, particularly those that are voluntary, such as higher education, have been ongoing for many decades (e.g., Lawrence-Brown and Sapon-Shervin, 2014; Armstrong et al., 2016; Plows and Whitburn, 2017). Equality in educational settings is debated because in most societies, education facilitates access to other societal arenas, impacting distribution of influence and income, as well as participation in development of the society toward a particular direction. Moreover, gender representation in higher education has for a long time reflected the gendered division of labor. This is also evident in other societal sectors, with women overrepresented in education settings that focus on people, ideas, communication and care, and men overrepresented in settings focused on science and technology. In recent decades, these patterns have become more complex. For example, in a country such as Sweden, women succeed better in primary education, are more likely to apply to higher education, and tend to be the group that has higher rates of graduation (Dryler et al., 2016). Similar patterns can be seen in OECD countries (Encinas-Martín and Cherian, 2023). In this context, ICT education stands out as one of the few educational areas that remains male-dominated among the students.

Surprisingly, despite the ever-growing digital market and employment opportunities, the number of women pursuing ICT education and profession is decreasing (Morton et al., 2018). The number of women who studied and graduated on ICT was higher in the 80s, with a noted decrease later on (Beyer, 2014). Same results are reported from the study of Colomo-Palacios et al. (2020) conducted in three countries. They investigated the correlation between gender imbalance in ICT education in Norway, Spain and Tunisia with socio-economic factors such as GDP and unemployment rate. While there is a negative correlation between women in ICT and GDP, the results showed a positive correlation to the unemployment rate. These

patterns raise a question whether women view ICT education as a less desirable educational choice, and if yes, why.

Women's underrepresentation in ICT higher education has so far attracted some research attention, looking for possible causes and thus also remedies to the gender imbalance. One set of explanations revolves around why women are less likely to choose the ICT field as an educational choice. Here, the predominant view is that lack of in-depth knowledge on the ICT field, or, conversely, stereotypes about the ICT field repel women. For example, [Corneliusson \(2020\)](#) study shows that the lack of knowledge on what the ICT education represents, is what discourages girls. Their perception of ICT education is that it represents a field dominated by men portrayed as "geeks" and "hooded gamers," who are already familiar and knowledgeable in programming. This lack of knowledge is reported to be very visible in the transition period from high school to university. Generally, this stereotypical image of the ICT field made of intelligent but socially incompetent men is prevalent ([Wong, 2016](#)). These beliefs held by women discourage them from participating in the ICT higher education, since women have a hard time relating to this identity they prescribe to the ICT. In a similar line, [Lopez et al. \(2022\)](#) address the limited participation of women in ICT education through the lens of identity. Specifically, they sought to explore the alignment between their own and the ascribed identity to ICT. Results of the study indicate that women commonly perceive ICT professionals as software developers, problem solvers, technical experts, innovators, and enthusiasts for technology. The group of women who have concrete conceptualizations of ICT, embraced the identity in contrast to those who ascribed abstract categories to ICT professionals. All these embedded stereotypes are further nurtured by the way ICT is portrayed in the media such as TV, films, games and advertising ([Lamers and Mason, 2018](#)). Similarly, [Christensen et al. \(2021\)](#) in their experimental study investigated the gender differences in the "People-Things" dimension among high school students in relation to ICT education. Their results show that women found "People-themed activities" more appealing compared to men, who preferred "Things-oriented activities" more than women. In addition, the effect was more prominent when the level of programming experience as a variable was included. The stereotypes on the content of education and the future career might be the explanation for contradictory results regarding young women's perception of career possibilities in the field. In some cases, research suggests that women high school students do not perceive the ICT field as a career prospect ([Morton et al., 2018](#)). However, the opposite was reported by [Corneliusson et al. \(2021\)](#) who argue that female high school students in Norway see ICT field as well-paid employment opportunity and career development choice. In addition, they argue that women perceive technology as a means to contribute to society, specifically in addressing challenges.

Some of the research focuses on the experiences of students, and here the results suggest that the gender imbalance is not completely understood and is also perceived differently by women and men in higher education ([Ying et al., 2021](#)). Men compared to women are less aware of the gender gap, and the latter group emphasized more the need of closing it. Moreover, despite performing equally well as male counterparts in their education, women feel less confident in their ICT competence ([Ying et al., 2021](#)). The same is noted among the teaching staff, where women are more likely to receive a more negative course evaluation from students compared to men ([Ying et al., 2021](#)). This

might be an indicator of implicit gender stereotypes present within the educational environment.

The research results on gender and ICT education suggest that there may be several complementary, and sometimes contradictory explanations for the relatively low women participation in the field. Stereotypical perceptions of the ideal student (and in extension employee) as a male gamers and geeks could influence women's choice to avoid this type of education. Concerning the perceptions of employment and career possibilities, the research is contradictory, and it might reflect the impact of national context when studying gender, education, and labor market. Similarly, experiences of gendered stereotypes and the lack of confidence among women students might be tied to a particular educational or cultural setting, and would require more research to map it out across various programs and national settings.

Thus, studies on how more women could be attracted to ICT education tend to focus heavily on representation, i.e., on how to make the educational programs more attractive to women. For example, [Lamers and Mason \(2018\)](#) discuss the role of advertising and provide several recommendations such as the use of female role models, and that the representation of females in advertising besides soft skills must also convey technical competence. The importance of female role models has been highlighted by several authors (e.g., [Morton et al., 2018](#); [Corneliusson et al., 2019](#); [Berry et al., 2022](#); [Taylor-Smith et al., 2022](#); [Corneliusson, 2024](#)). In addition to role models, [Berry et al. \(2022\)](#) highlight other mitigating factors such as mentoring programs, advertising strategies, outreach events, and the engagement with industry as important and encouraging factors to increase the female participation in the ICT higher education. To remedy the gender imbalance, [Taylor-Smith et al. \(2022\)](#) introduce and propose the Participant-Centered Planning Framework, which is a structured approach that prioritizes the active involvement and input of participants in decision-making processes.

3 Methodology

The data collection method used in this study was an online survey. Our study focused on a Swedish university offering 16 programs within the field of ICT. The target sample were female students of bachelor and master programs in the field of ICT namely, Computer Science and Media Technology, and Informatics. For the selection of the study programs, we followed [ACM IEEE Computer Society IEEE-CS \(2020\)](#) that delimits computing education to the following programs: computer engineering, computer science, cybersecurity, information systems, information technology, software engineering and, data science.

Initially, responsible teachers for respective programs were informed and they helped us convey the information to the students through their learning platforms and also in different lectures. An online questionnaire through a web survey tool (Survey and Reports) was administered by emailing a link to all female students. The survey was designed and administered in two languages, English and Swedish, so students had the possibility to choose the language they preferred. Initially, the survey was formulated in English and translated into Swedish. The translation process was conducted by one of the paper's authors, who is a native Swedish speaker. The survey included questions with predetermined answers, open questions, and

few Likert Scale questions, which can be seen in the [Supplementary Appendix 1](#). The survey was accessible for 3 weeks, within which period, a total of 82 out of 276 students responded to the survey (30% response rate). The survey was sent to ten bachelor and six master programs within ICT, however responses were received only by those enrolled in the programs presented in [Table 1](#). Among responders, 84.1% listed Sweden as their country of residence, whereas 15.9% of respondents reside in 10 other countries. 70.7% of the respondents were bachelor level students and 29.3% were currently studying in the master level.

An information letter stating the purpose of the study, the importance of participation and other relevant details accompanied the link. This letter also informed respondents about their anonymity and safeguarding that the information provided could not be traced back to them.

Survey questions of quantitative nature were analyzed by assessing the number of responses provided by respondents. Most of the questions required respondents to select only one option, however, there were questions where multiple values were possible for selection. We indicate those cases when we report such results. Also, most of the questions were a five-level Likert scale ranging from Strongly Disagree to Strongly Agree. Considering that the sample size is relatively small and that answers are spread among multiple programs, we grouped the five-scale responses to three-scale, namely, Disagree (for Strongly Disagree and Disagree), Neutral, and Agree (for Strongly Agree and Agree).

The responses in the open questions were coded thematically. First, the responses in Swedish were translated into English by the author who is a native Swedish speaker and double-checked by the other authors, who have good proficiency in Swedish. Each response was carefully read and labeled with one or several codes that best reflected the content in the response. For example, in respondents' written elaboration on their motives, responses such as "my brother is in ICT" or "my mother works within industry" were first coded as "brother" or "mother." Once the responses were labeled with codes, they were themed into common categories such as relationship, interest, employability and similar, and responses were counted to identify how common each theme was. The table with the codes and themes is included in the Appendix 2. The coding of the open question responses offered the possibility to identify several key themes within a single response. Moreover, the coding allowed us to identify relationships between themes in each response. For example, in

response to why they have chosen ICT education, respondents elaborated on multiple motives which were related to each other.

4 Results

One of the first questions we set to answer in this study is to identify factors that motivate women to study ICT. Responses indicate that the majority of women are attracted by the good employment opportunities found within ICT programs that motivate them to pursue such education. As seen in [Figure 1](#), such a factor is quite dominant, especially that is followed by the entrepreneurship potential listed as the second most selected motivating factor. Other factors, such as parents, friends and so on are found to be less of a motivating factor as seen in the figure. Respondents could select more than one option for this question.

Respondents had the possibility to provide other motives for their choice to pursue an ICT education and to elaborate on those motives. Here, many respondents chose to mention personal interest in the field of ICT, not seldom in conjunction with good employment opportunities and/or friends and family already working in a similar profession. For example, one respondent wrote that:

"I have a sister and a partner that are system designers which brought me to IT (...)",

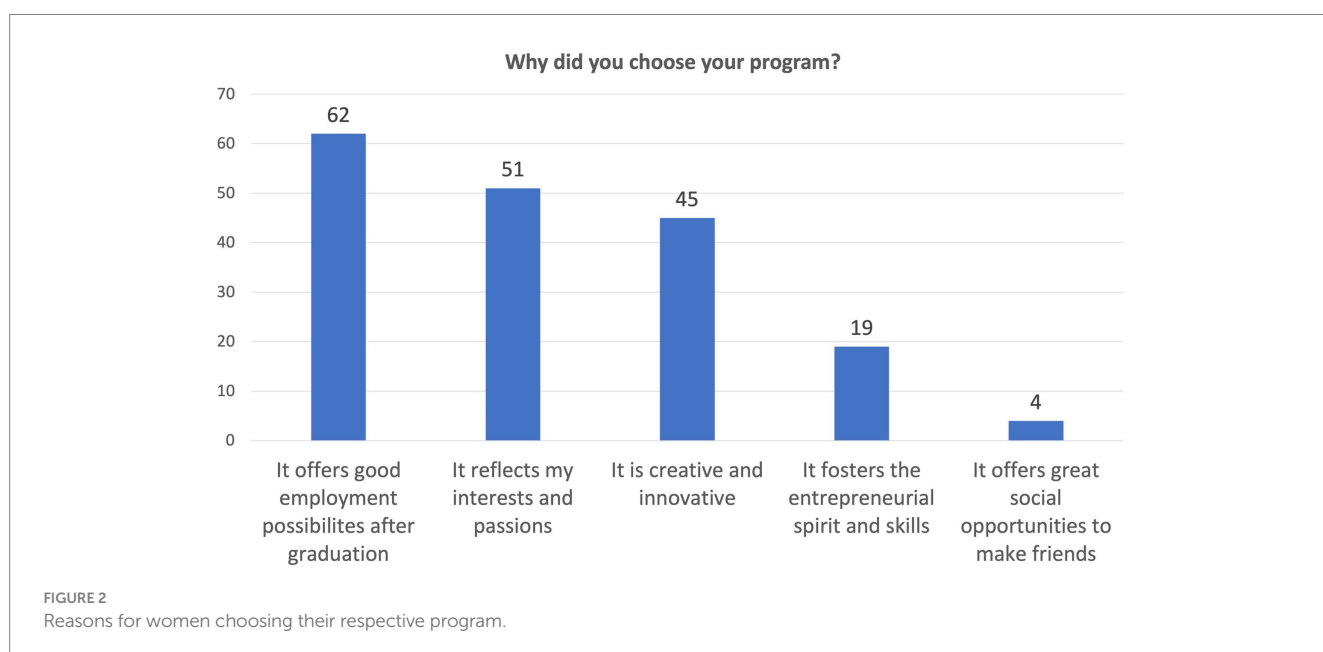
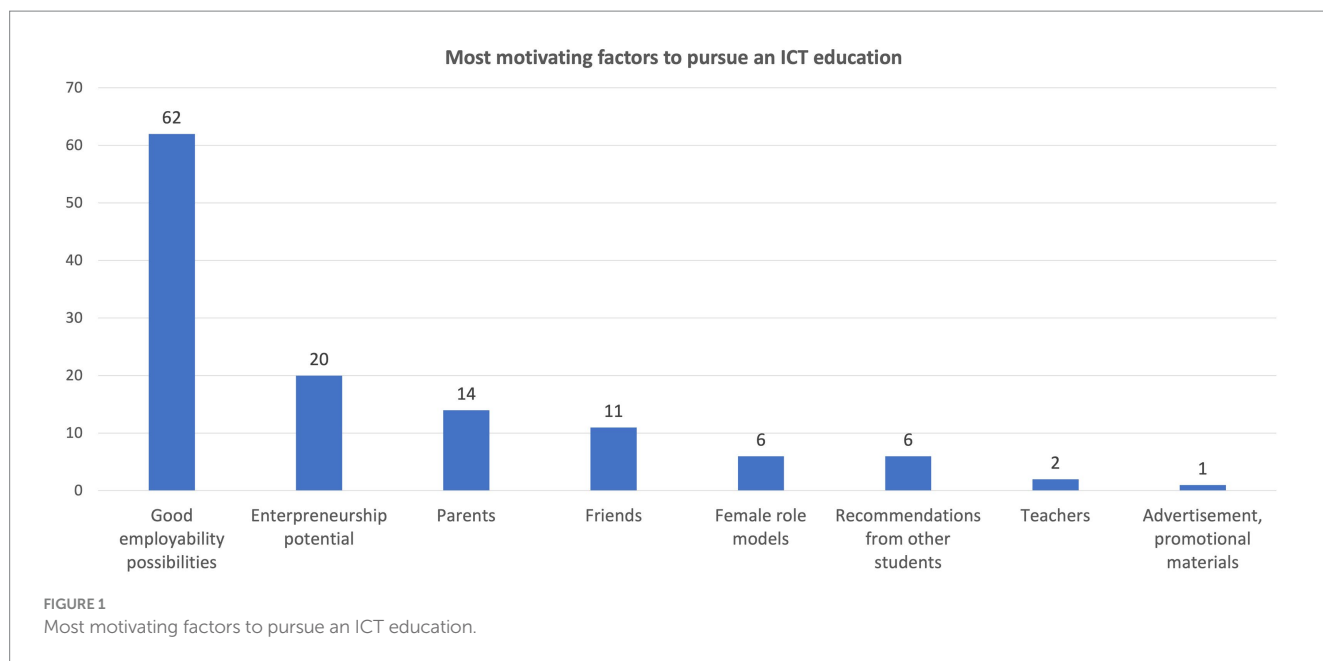
an indication that close affiliation with professionals in the field helped the respondent to understand the industry and become interested in it. This was echoed in other responses as well, as siblings, parents and friends were mentioned primarily as a sign of familiarity with what the industry is like. Several responses contained a mention of mother and/or sister within the industry. The familiarity with the industry often went hand in hand with good employment opportunities. For example, another respondent wrote:

"Have siblings and friends that work within the IT-industry (female and male) and via them have gotten a very positive impression of the working environment (...)"

The same respondent continues to write about the positive benefits of the working environment in terms of flexibility, creativity, openness, high salaries and good employment opportunities. Thus, it

TABLE 1 Programs from which we received responses.

Informatics	Computer science and media technology
Interaction design (Interaktionsdesigner)	Web programming (Webbprogrammerare)
Digital business development (Digital verksamhetsutveckling)	Software technology programme (Programvaruteknik)
Information systems, bachelor level (Systemvetarprogrammet)	Social media and web technologies (Sociala medier och webbt teknologier)
Master of information systems, 1 year (Informationssystem, magisterprogram)	Bachelor of science in software engineering (Mjukvaruteknik, högskoleingenjör)
Master of information systems, 2 years (Informationssystem, masterprogram)	Interactive media and web technologies (Interaktiva medier och webbt teknologier)



is important to note that for the respondents, several of the motives go hand in hand. The availability of many jobs, the good salary and in some cases specifically the possibility to distance work were recurrently mentioned in many responses. Another group of responses described the program as the next step in career development within a group of respondents that already had employment and/or career experience. In those cases (7 responses), the ICT program was chosen as the next step in career development. Interestingly, possibilities for entrepreneurship were mentioned once, and only a couple of responses described the technology as bringing about positive social change.

In relation to this question, we also asked respondents about why they chose to study the respective programs, in order to see if there were any distinct patterns that were related to the program itself and

not the overall ICT orientation of their education. As shown in Figure 2, the majority of responses are linked to the employment possibilities that their respective program offers after graduation. This finding corroborates with findings in Figure 1, which indicated that the employment dimension is a deciding factor when it comes to women choosing study programs. However, as shown in Figure 2, factors related to passion, innovativeness and social aspects are also highly considered by women when choosing a program. Respondents could choose more than one option for this question.

Many respondents provided elaborate answers on their motives in relation to this question. The choice of the specific program seems to echo the predominant view that good employment opportunities are the most important. It could be that the choice of ICT education and the choice of a specific program are very deeply linked for the

respondents, and the same motives are repeated in both responses. In the open-ended answers, students also highlighted the possibility of distance education (3 responses) and the use of English language (2 responses), as a factor on why they chose respective educational programs. This could mean that the choice of the program was in part influenced by the perceptions of the ICT industry, but also practical considerations such as language and location when choosing from many similar programs nationally. For example, one respondent wrote that there are:

“Very few options in Sweden for online masters’ courses (...).

The remaining responses were a reiteration of the categories of the previous question, such as personal interest in the area and employability.

One prominent question we wanted to seek answers to is the perception of women about the existing gender balance in the program they were enrolled in. In Figure 3, we show that the majority of women did not think that the gender balance in their program is good (in other words, they disagreed that the gender balance is good).

Additionally, in Figure 4, we show that such perception is similar among women studying in Informatics compared to the Computer Science and Media Technology department.

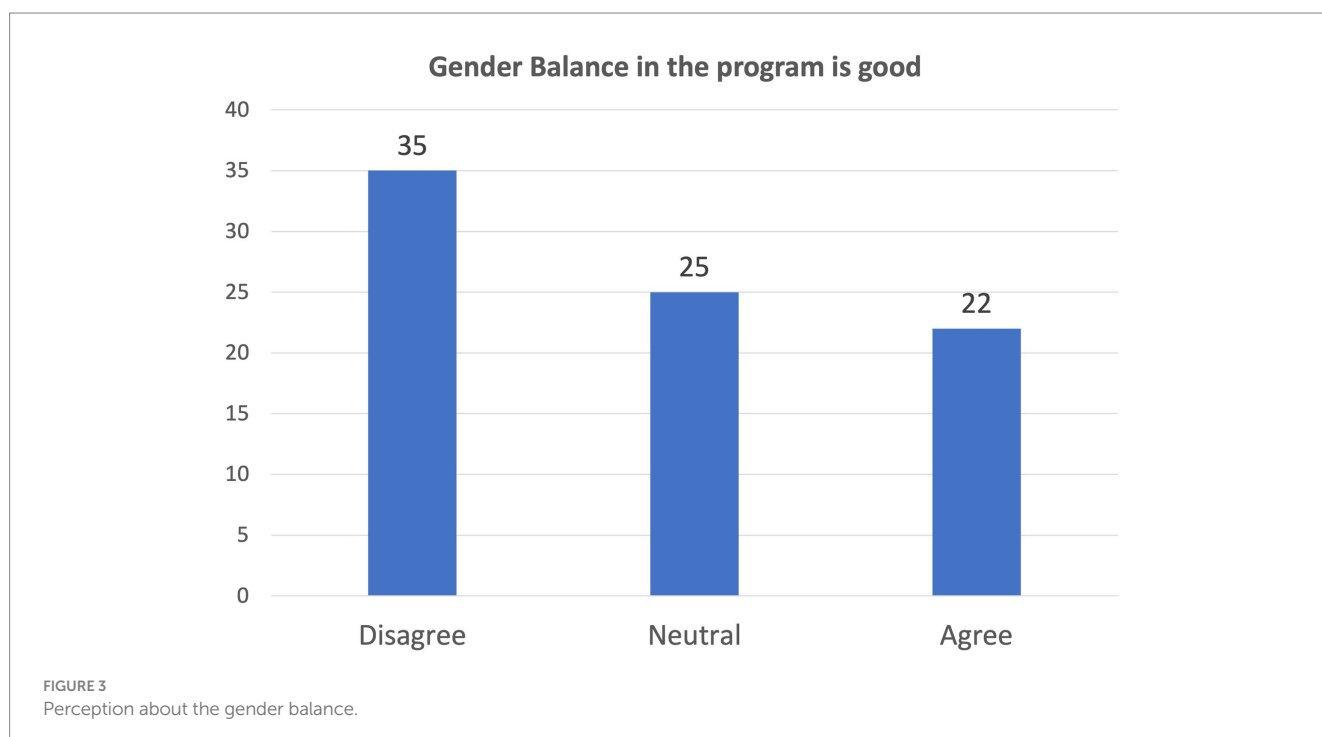
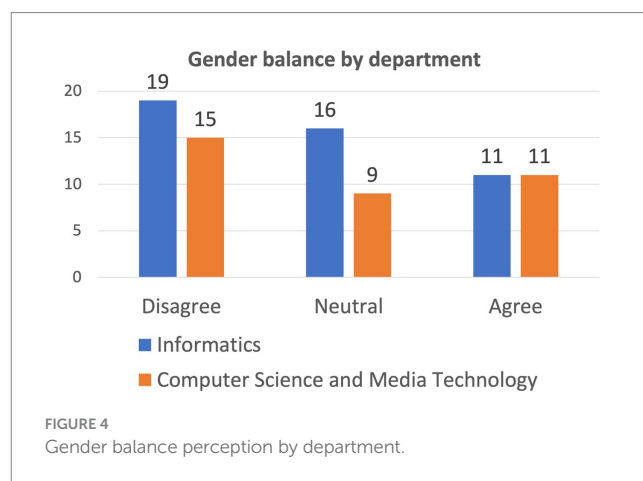
When approaching this question, we were intrigued to see whether perceptions change if women are coming from a program with an already high number of women (over 70%), close to gender-balanced (between 30 and 60%), and programs with a low number of women (below 20%). Program percentages are shown in Figure 5.

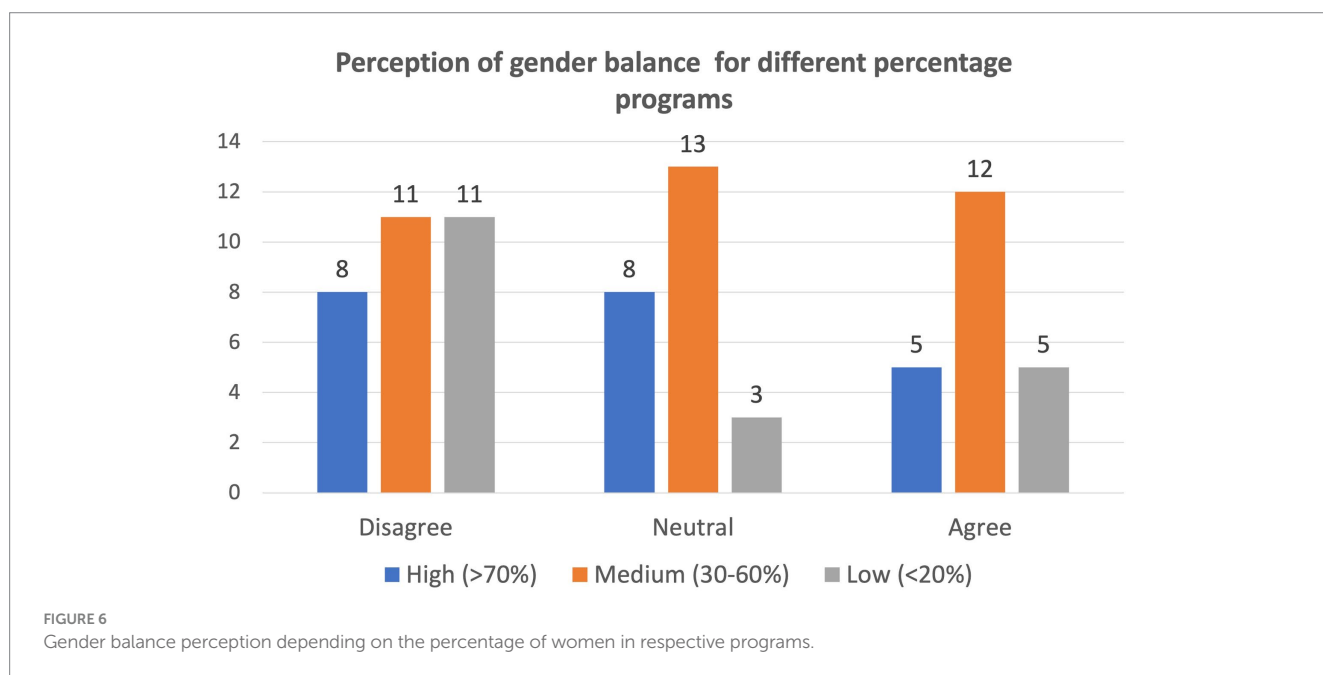
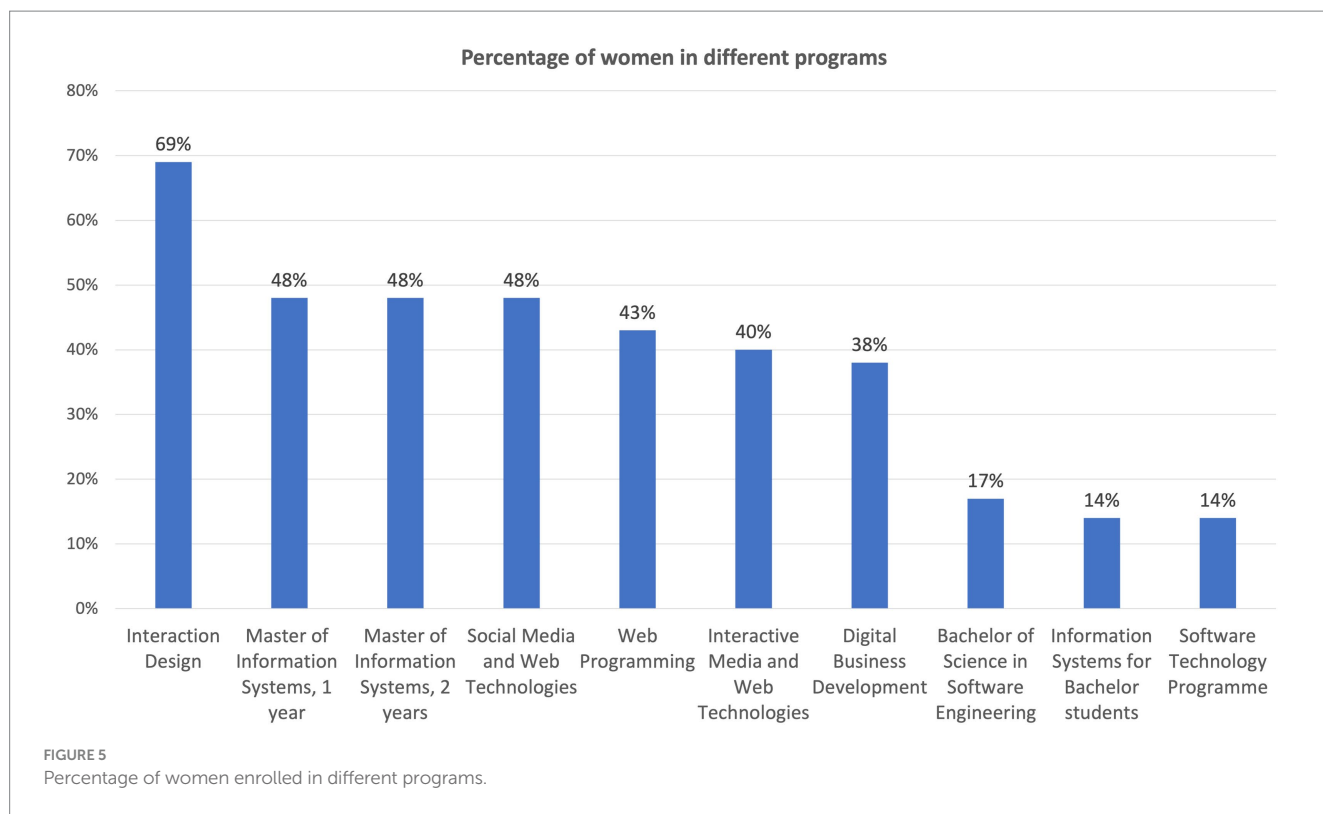
In Figure 6, we show that respondents coming from programs with lower than 20% women enrollment mostly disagree that the gender balance in their programs is good. Similarly, respondents from programs with higher than 70% women enrollment mostly disagree or are neutral that the gender balance in their respective programs is

good. Moreover, respondents from programs of 30–60% women enrollment are equally spread among disagreeing, agreeing and being neutral. In other words, the tendency is that respondents from gender-balanced programs do not have any strong opinion, whereas respondents from programs with lower than 20% and higher than 70% women enrollment are not pleased with the current gender proportion in their program.

This was also an open-ended question where the respondents had the opportunity to elaborate on how the gender balance in their respective program could be increased. Many of the responses suggested that the gender balance in their respective program was good (10 responses).

One aspect we wanted to investigate is respondents’ perception on whether their study program needs more female and male students. Figure 7 indicates a prevalent perception among respondents that their program requires an increased representation of female students.



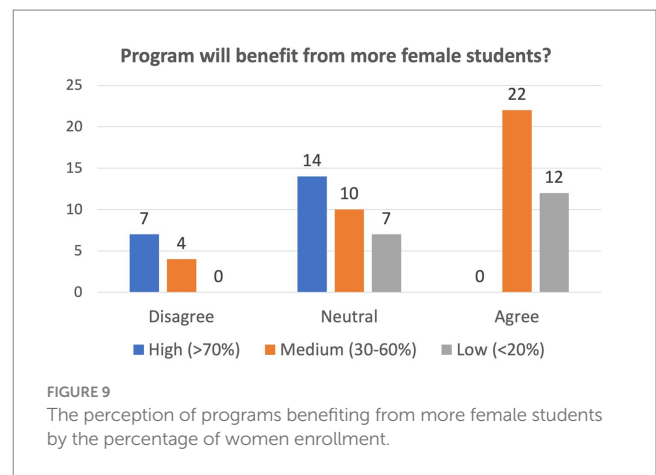
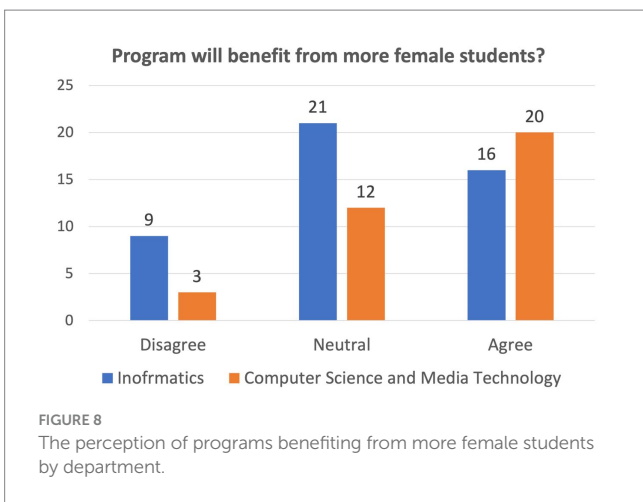
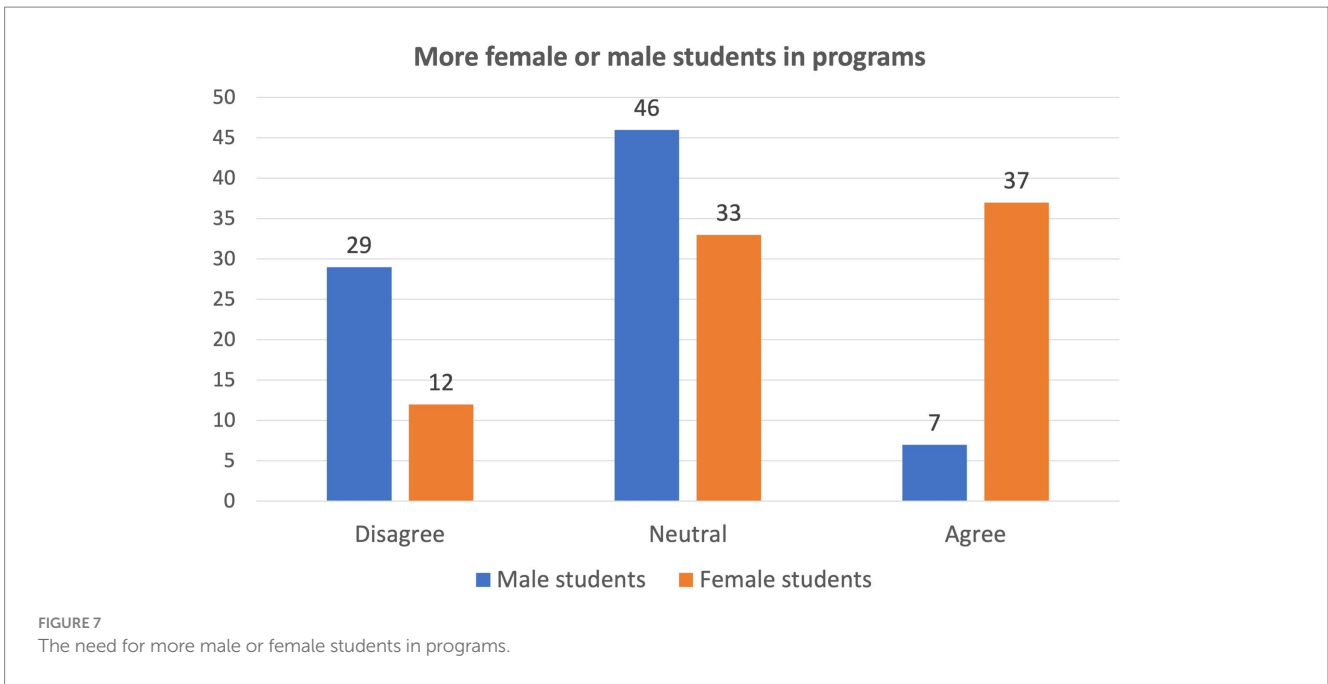


The graph further suggests a high level of neutrality among respondents regarding the need for more male students, with a considerable number expressing disagreement with the idea of their program needing more male students.

Considering the finding on Figure 7, we further investigated respondents' opinions on different departments. Figure 8 shows that the majority of women enrolled in Informatics do not have an opinion whether their program will benefit from having more female students.

However, women enrolled in Computer Science and Media Technology mostly agree that their programs need more female students.

We also explored the same question looking at whether respondents came from a program with a high, medium or low percentage of women (Figure 9). The results indicate that women coming from gender balanced programs think that their program could benefit from more female students. Similar is the case with



women coming from programs with a low percentage of women. However, women coming from programs with a high percentage of women are mostly neutral and slightly disagree that their program will benefit from more female students.

Considering the existing general sentiment that the number of females should increase in study programs, we wanted to elicit respondents’ opinions on what are the most effective factors that could contribute to increasing the number of female students in their respective programs. Results indicate that most factors are: inviting female representatives from the industry, female role models, and showing successful students stories. Figure 10 shows the count referring to each of the factors respondents voted on. It is worth mentioning that respondents of different departments gave similar responses. Respondents could select more than one option.

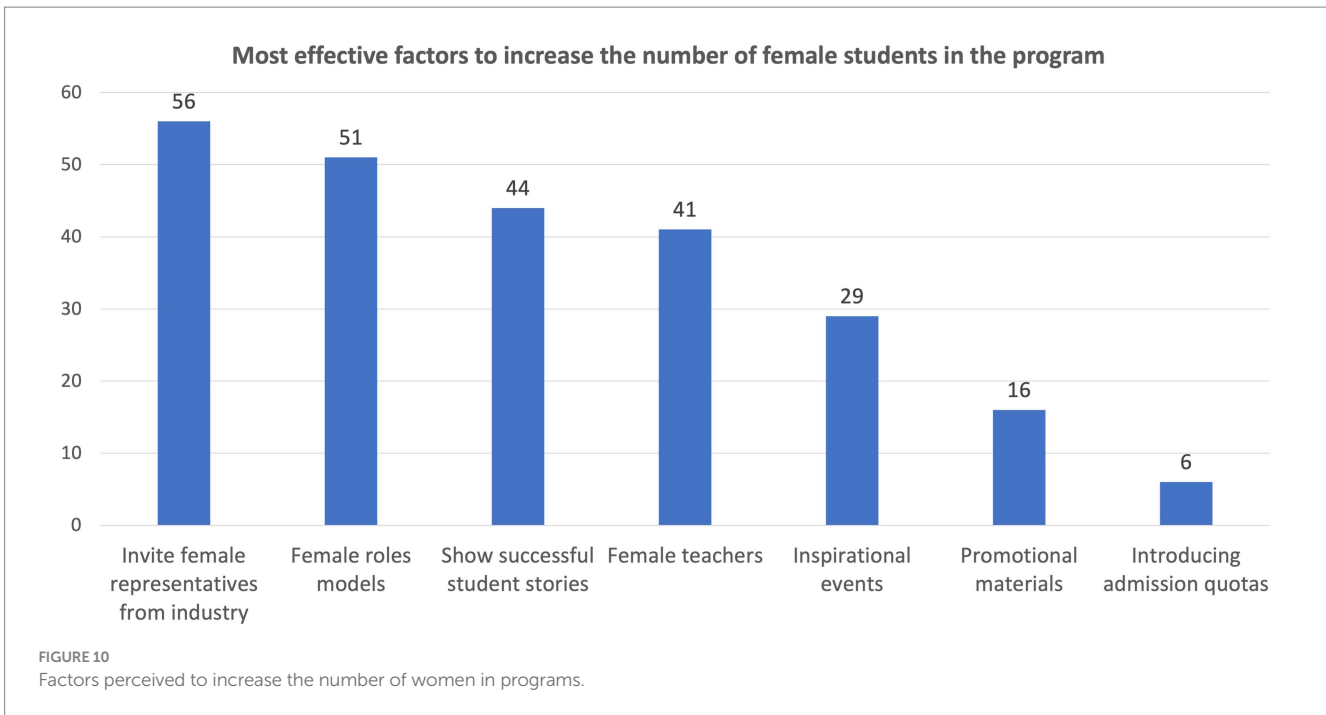
In the open-ended questions, the respondents had the opportunity to elaborate on how gender balance in their respective program could be increased. Many of the responses suggested that the gender balance

in the respective program was good (10 responses) and there was no need to address the gender balance. However, some of the respondents did elaborate on what they thought would be helpful to make the program even more attractive for women. Role models was the most common suggestion (16 responses), and role models were described both as women teachers and women from the industry. For example, one student wrote:

“I am very satisfied with my education, the only thing I miss are female role models. A female teacher/lecturer and more female role models would have been good”.

Another respondent instead made a reference to the lack of female teachers, especially in programming courses, arguing that:

“There are very little to no [female] teachers who give lectures and teach about programming”.



Similarly, the role models from the industry were mentioned as for example by this respondent who suggested that:

“Ads and such can give the impression as of quotas and as something artificial. That is not so inspiring. Instead, it is more important to see the actually successful women students. Have them come and talk to the classes, promote their companies etc. That gives a chance to see how successful women actually act and how they have been doing in the industry”.

Some of the responses indicated that gender balance represents a societal issue, and that ICT needs to be put on the map already in primary schools (8 responses) or generally by combating gender stereotypes (4 responses). For example, one respondent wrote that:

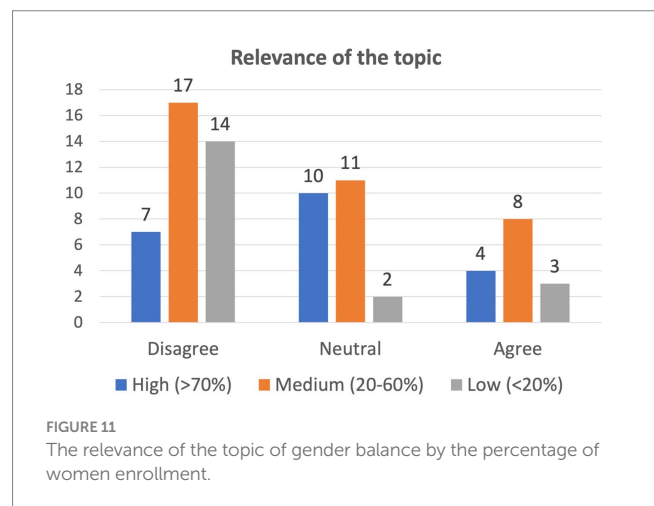
“I think it's not this programme that needs to change but society that needs to grow out of sexism and gender stereotypes”

and another suggested that:

“Increase interest already in grade school. Go there and tell children about different options”.

In addition, some respondents referred to the lack of information as a discouraging factor. They claimed that advertising and promotional materials should entail information about programs, and they must portray female students. One of the respondents specifically commented on the Information Systems, bachelor level program in Informatics, claiming:

“More advertising about what the systemvetarprogrammet actually entails. I think many people think it's just programming, which it really isn't, I think it would attract more girls if there were ads with women students and more information about what the



program is. When I tell you that I'm studying systems science, 85% of the people I tell don't know what the program entails or is about.”

Finally, in line with RQ2, we wanted to see whether respondents maintain that the topic of having a gender balance in study programs is a relevant one. In particular, we wanted to see how this compares among respondents coming from programs with various percentages of women enrolled. In our question “Gender balance in the program is irrelevant,” findings in Figure 11 show that women coming from programs that have good gender balance (medium) state that the topic of gender balance is a relevant topic (that is, disagree that the topic is irrelevant). The same is also true for women coming from programs with a low percentage of women. However, women who come from programs that have a high percentage of women are mostly neutral about the relevance of the topic.

5 Discussion

This paper aimed to investigate the motivations and perceptions of women to pursue ICT related higher education. Findings from the study have provided insights on several crucial factors related to women's motivation and perceptions to pursue ICT higher education. This section discusses key findings in relation to the related literature and highlights their implications.

5.1 Motivating factors

The first research question that guided this study was “*What are the factors that motivate women to study ICT?*” As evident from the data collection and analysis, the leading motivating factors identified were good employment possibilities and the potential of ICT to offer opportunities for entrepreneurship endeavors. This finding largely aligns with previous research, which emphasizes the importance of career opportunities as a primary motivator (Lamers and Mason, 2018; Corneliussen et al., 2021). Nevertheless, this stands in contrast to the study by Colomo-Palacios et al. (2020) and Morton et al. (2018) who have provided evidence that the ICT field is not perceived as a career prospect by women. The rapid advancement of digital technologies underlines a growing demand for emerging ICT skills and competencies. In their study, Smaldone et al. (2022) identify the current expectations of employers in terms of skills and qualifications and emphasize a strong correlation between employability and the ICT skill level. Our study, which also unveiled the employability potential as a motivating factor, aligns with their suggestion for a continuous synergy between academia, particularly ICT programs, and industry, with the aim of aligning the curricula with the employability skills and competences sought by potential employers.

Although not quite dominant, other social structures such as parents, siblings, and friends seem to play an important role in motivating young women in choosing an education and career within ICT. Earlier studies, however, show conflicting outcomes on this matter. The study by Cohoon (2002) shows that women were generally discouraged by their parents and friends to pursue an education in ICT. On the other hand, a study by Turner et al. (2002) found the opposite evidence, that parents and friends were the most encouraging factors. This is an indication that there might be more factors at play such as the social context that influences women's choices (Vainionpää et al., 2019).

In another question, respondents also provided strong indication that choosing an ICT education reflects their interests and passion. A similar study conducted with Finnish adult women exploring their motivation to switch careers to the software industry, confirms passion for technology to be a relevant driver (Hyrnsalmi and Hyrnsalmi, 2019).

Our study suggests that those respondents that chose to elaborate on their motivation often wrote of the three above factors in conjunction with each other, namely that relatives and/or friends in the ICT field gave insights into the work possibilities in the field, and that personal interest and good employability were also related.

5.2 Gender balance perception

Additionally, this study also sought to investigate the perception of female students regarding gender balance with the research question stated as “*What are the perceptions of existing gender balance in the ICT*

programs?” Whereas the study by Ying et al. (2021) claims that women and men perceive the gender balance differently, in our study we elucidate only the perspective of women. Although most women expressed their view that gender balance in their program is not good, there seems to be a disparity when it comes to how they perceive gender balance in their respective programs. Their perception was very much dependent on the existing gender balance in their respective programs.

As results indicated and perhaps as expected, respondents from the programs with low percentages of women enrolled, mostly disagreed that the gender balance in their program is good. Additionally, respondents from the department of Computer Science and Media Technology expressed that there is a need for their programs to have more women enrolled, even if their program already constituted at least 40% women. The clear indication is that if a program is close to gender-balanced or has less women, then there is a need for more women to be enrolled. Achieving gender-balanced programs seems to not only benefit women, but also men, as studies indicate that men dropout was lower in ICT programs with gender balance (Lagesen et al., 2022).

5.3 Factors for greater women inclusion

This study also investigated the factors which respondents perceived as important to increasing the participation of female students as stated in the third research question “*What factors contribute to a greater inclusion of women in ICT?*” The importance of female role models and female representatives from industry was evident. This aligns with previous research highlighting the impact of visible female role models in the field (Lamers and Mason, 2018; Berry et al., 2022). This factor was prevalent in most previous studies.

An interesting aspect to mention is that this study empirically reveals that despite the existing gender gap in ICT higher education, this is not a homogeneous and universal phenomena. Some programs included in this research, such as Interaction Design for example, have more female than male students. On the other hand, there are programs such as bachelor programs in Software Engineering, Information Systems and Software Technology, which only have few female students. This in a sense affirms the belief and perception that rigid and narrow conceptualization of ICT reduced to programming and gaming, discourages women to consider ICT as a viable educational and career path.

5.4 Implications

The findings of this study contribute to the scholarly work on gender and ICT education and have the following implications for the field. Firstly, our findings add to the study of the motivation of women students within the ICT field. Earlier research tends to provide contradictory results on what motivates women to choose the ICT field (Lamers and Mason, 2018; Morton et al., 2018; Colomo-Palacios et al., 2020; Corneliussen et al., 2021). Our findings suggest that motivating factors are several, with employability in the field being the most important to women students, and they are also often interrelated. For example, having knowledge of the industry through family and friends makes it easier for women to assess if they would be interested in the field, and evaluate the employment possibilities within it.

Secondly, our findings suggest that women students in the ICT field view gender inclusion as being broader than gender representation among the students. The importance of role models

among teachers and industry representatives was mentioned as the most important factor beyond student representation, but our respondents also indicate a need to engage in gender equality work beyond the higher education setting, e.g., by broadly increasing the knowledge of ICT education among younger generations and by working against gender stereotypes associated with the ICT field in general. A broader view of inclusion is supported by existing research (Morton et al., 2018; Corneliussen et al., 2019; Berry et al., 2022; Taylor-Smith et al., 2022) and implies that gender equality in educational settings cannot be reduced to only the matter of students. Quite the contrary, the students in our study are quite aware of the importance of gender equality that includes the teachers, the industry in which they hope to work, and even younger generations that will choose their educational path in the coming years. Thus, we would suggest that this implies a need for a holistic and systemic analysis of the gender balance in the ICT field.

Thirdly, our study supports the view that digital transformation is not only about digital technologies. It is a rather socio-cultural process (Saarikko et al., 2020) which transcends the technical aspects and challenges the existing rules of the game (Hinings et al., 2018). Digital transformation has empowered women, creating possibilities for digital entrepreneurship (Sahut et al., 2021), and creating novel non-conventional forms of employment. As a result, we argue that it is necessary to contest the dominating discourse of the ICT sector and education as being male dominant. To do so, we need a conception which does not exclude but rather includes women, and we argue that digital transformation is a broader conception which provides a diverse picture and understanding of ICT profession and education.

Finally, the insights generated from our study have several practical implications. Higher education institutions need to proactively advocate the inclusion of female role models from the ICT industry into ICT related educational programs. These can be manifested through several initiatives such as an implementation of mentorship programs during internships, organizing different events in collaboration with the ICT industry, and similar undertakings. In addition, a clear communication of the potential of ICT education toward entrepreneurship must be emphasized. Also, in line with our findings, ICT educational programs should prioritize and promote the inclusion of more female teachers in the programs. In addition, our findings provided evidence that most women decided to continue with ICT education after secondary school, even after completing a higher education degree. Some even in later stages of their lives. Higher education institutions and the ICT sector could take this into consideration in further expanding their efforts and target.

6 Conclusion

In this paper, we provide insights about students' motivation and perception regarding leading choices on pursuing ICT related education. Through a survey, we specifically aimed to answer three research questions, which resulted in the following main take-aways:

- Most motivating factors to women pursuing an ICT education are good employability and entrepreneurship opportunities followed by influencing parents, siblings and friends.
- In programs with an adequate gender balance or low number of women enrolled, the perception is that such programs need more women.

- The inclusion of women in ICT education is a relevant topic and suggestions are that it can be achieved by utilizing women role models and representatives from the industry.

Despite the valuable insights that this study brings, it is not without limitations. The scope of this study was on a single university in Sweden, thus despite yielding meaningful results, it only covers a part of the Swedish context. Thus, the sample is too small to be able to draw generalizable conclusions about gender patterns in Swedish ICT higher education. However, the sample is nevertheless indicative of high gender awareness and commitment toward equality and inclusion among the students, which could be a distinctly Swedish pattern. Considering that Sweden is a developed country with a strong gender equality policy, future research would benefit from further investigating our findings to see if they bear relevance not only for Sweden as a nation, but also in the broader context of developed countries. In addition, the university subject in this study is also unique in that the majority of master programs included offer distance education, with a significant number of international students. Our survey does not seek to answer questions about the relationship between students' nationality and their view of gender, but it is interesting and important to address this dimension of gender in ICT higher education in future research. Hence cultural and previous educational background could have had an impact on study results, which could hinder the generalizability to Swedish context. Considering these limitations, we recommend some future venues of research. First, future studies could include other ICT programs in Sweden in order to offer a generalized view on the Swedish context. Second, future research may consider the inclusion of more countries with different cultural and educational contexts, and compare similarities and differences, especially in light of the so-called "educational gender-equality paradox" (Stoet and Geary, 2018). This paradox highlights a phenomenon where countries characterized with higher gender equality exhibit fewer women in STEM education, compared to those with lower levels of gender equality. In addition, our study focused on female students only, aligned with the intention of the study, consequently offering only a partial view of the situation. In order to have a more holistic understanding, future research could enhance its scope by also incorporating the perspectives of male students as well as university personnel including teachers, administrators and other educational support staff.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because the survey was anonymous, thus ethical approval from a board was not necessary. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

EK: Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. MF: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. VK: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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