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Girls in IT: intentionally self-excluded or products of high school as a site of exclusion?

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Abstract

Purpose – The low number of women in the information technology (IT) field is a concern. The purpose of this paper is to examine the factors behind the exclusion of girls from the IT field.

Design/methodology/approach – The present work includes a narrative literature review and an exploratory interview study with ten girls and six study guidance counsellors (GCs) from Finnish senior high schools. Using the nexus analysis as a theoretical lens, the authors examined the exclusion of girls from IT.

Findings – Earlier literature directed attention to the cultural norms, assumptions and stereotypes still prevalent in society and the lack of role models and positive media as factors contributing to girls excluding themselves from the IT field. In this research study's data, the authors not only found evidence of the unintentional exclusion of girls from IT by others but also by the girls themselves. Findings of this research study illustrate the various discourses, actors and their interactions, their background and history-related factors affecting girls' career choices. The novelty of this study is in approaching high school as a site of exclusion, where problematic discourses, interactions and histories come together, reproducing exclusion of girls from the IT field.

Originality/value – The authors contribute with a literature review of the research study on gender and IT and the inclusion/exclusion dynamics around IT. Using the nexus analysis, the authors identify the exclusion dynamics in this complex social issue. Several decades of research have shown that the inclusion of women remains low in IT disciplines. In this study, high schools are viewed as sites of exclusion, engendering a prevalent lack of information and education on the field. The authors offer novel insights into the role of curriculum, GCs and online information excluding girls from the IT field.

Keywords IT education, Career choice, Girls in IT, Gender imbalance, Study guidance counselling, Inclusion, Exclusion dynamics, Historical body, Interaction order

Paper type Research paper

1. Introduction

The reasons for the low number of women in the information technology (IT) field have been studied for decades, but effective solutions for motivating women into this male-dominated

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field are yet to be found. A large base of research from various disciplines – IT, computer science (CS), information systems (IS), engineering, education, gender studies, psychology and social sciences – has addressed this question and offered insights into the issue (for literature reviews, see Butler, 2000; Ahuja, 2002; Adya and Kaiser, 2005; Sanders, 2006; Pretorius and de Villiers, 2009; Rogers, 2015; Oehlhorn, 2017; Main and Schimpf, 2017; Vainionpää *et al.*, 2019b). Despite the plethora of research on this topic, it seems we still do not know enough about the reasons behind this gender imbalance as the problem has remained unchanged over the years.

The statistics tell a story where girls do not see the IT field as a career option. Across all Organisation for Economic Co-operation and Development (OECD) countries, only 20% of new IT students were women in 2015 (OECD, 2017) and in the USA, the number of female software developers was around 20–30% in 2014 (USDL, 2015). In 2016, 83.3% of the IT workforce in the European Union consisted of men, and the gender difference has been steadily increasing over the last 10 years (Eurostat, 2018). This is worrying information. We know that due to the digital transformation of society, the number of jobs in IT will increase even further in the future. Women could help fill these positions. On the one hand, segregation impairs the overall economic efficiency of countries (Melkas and Anker, 1997) and affects companies' competitiveness (Ahuja, 2002) – it is bad for business if mostly men participate in the planning, designing and development of IT as more viewpoints are needed for developing compelling and useful products. The Internet, for example, has an impact on everyone's lives and studies have found gender differences in how we use it (Colley and Maltby, 2008; Holmberg and Hellsten, 2015; Shao, 2018). Currently, our digital environments are largely constructed by men, and as the significance of digitalisation in our lives is growing steadily, we are in dire need of more diverse views on the type of "digital life" we could and should have. On the other hand, promoting gender equality is considered necessary for ensuring a democratic society within the European Union (European Commission, 2018). There is a rather unanimous view that the situation should change. To this end, lowering the gender divide on the occupational level is an important step.

We approach this topic from the career choice perspective and utilise the nexus analysis to answer the following research question: what kinds of factors create exclusion of girls from the IT field? The nexus analysis (Scollon and Scollon, 2004) offers a suitable lens for studying complex topics in-depth from multiple perspectives, acknowledging the various historical and social aspects and discourses at different levels that shape our actions (Scollon and Scollon, 2004). This method has been previously utilised to understand complex IT-related phenomena (e.g. Iivari *et al.*, 2014; Iivari *et al.*, 2018; Molin-Juustila *et al.*, 2015) and to structure literature reviews on complex topics (Iivari *et al.*, 2017; Molin-Juustila *et al.*, 2015; Norouzi *et al.*, 2019; Vainionpää *et al.*, 2019b). In addition, we scrutinised the literature on the concept of exclusion (e.g. Iivari *et al.*, 2018), which enabled a nuanced enquiry into the underlying dynamics shaping girls' career choices. We answer our research question through an extensive literature review (a previous version with a different focus was published in Proceedings of the 27th European Conference on Information Systems, see Vainionpää *et al.*, 2019b). To take our findings a step further, we gathered preliminary empirical insights by conducting an exploratory interview of ten Finnish high school girls and six high school study guidance counsellors (GCs) from five different schools. In this study, we use IT as an umbrella term for related fields, such as IS, CS and informatics. We used the nexus analysis on the selected literature and on our empirical data to understand the complex dynamics involved in the inclusion and exclusion of girls from the IT field. We hope to find new directions for making sustainable improvements in the future.

The next section introduces the theoretical frameworks utilised in this study to structure our literature review and the empirical analysis. The third section discusses the methods involved in the literature review and the empirical interview study. In the fourth section, we

outline the results of the literature review, while in the fifth the empirical ones. The sixth section discusses the implications of the findings, while Section 7 concludes the paper.

2. Theoretical background

Next, we present our theoretical lenses: the nexus analysis (Scollon and Scollon, 2004) and exclusion (Iivari *et al.*, 2018).

2.1 The nexus analysis as a theoretical lens

The nexus analysis has its roots in the "mediated discourse analysis" and is meant to address complex social situations (Scollon and De Saint-Georges, 2013). Methodologically, this approach has an ethnographic stance through participant observation and the discourse analysis (Pan, 2014). The focus of the nexus analysis is social action. It is constituted in the intersection (nexus) of three "aggregates of discourse" in real time and space: discourses in place, interaction order and historical body (Scollon and Scollon, 2004, p. 19). One of the general concerns of the nexus analysis is how the "discourses of our social life are engaged" in the "social actions of social actors" (Scollon, 2001, p. 139). The notion of discourses in place means that all social actions are mediated by cultural tools or mediational means, the most salient of which is language (Scollon, 2001, p. 141). The concept of discourses in place also emphasises the social space to which people have become accustomed (Blommaert and Huang, 2009, p. 273). Interaction order refers to the social arrangement between people. It originates from Goffman's (1955, 1983) observations: people behave differently in different configurations of participants. Finally, according to Nishida (1958), the life experiences of social actors are referred to as their historical body, a concept closely related to Bourdieu's (1990) notion of "habitus". However, the historical body refers more to participants' concrete embodied actions (Scollon and Scollon, 2004, p. 13).

The three concepts introduced above are analytically intertwined. Discourses arise from *in situ* interactions between individuals, all with their personal historical bodies, in the context affected by the emergent interaction orders (Scollon and Scollon, 2004, p. 14). These concepts can be used heuristically as analytical lenses to examine the social action under scrutiny (see, e.g. Molin-Juustila *et al.*, 2015). Similar to Molin-Juustila *et al.* (2015), we use the nexus analytical concepts to make sense of existing research and our empirical data.

2.2 The concept of exclusion

There is a vast body of research on social inclusion, defined as "the extent that individuals, families, and communities are able to fully participate in society and control their own destinies" (Warschauer, 2002). Inclusion and exclusion are complex concepts that concern individuals and social structures and should be approached from multiple perspectives: social, organisational, political, economic and cultural (Labonte, 2004; Mariën and Prodnik, 2014; Taket *et al.*, 2009; Trauth and Howcroft, 2006; Warschauer, 2002). The role of digital technology in creating or decreasing inclusion/exclusion has been examined from the viewpoint of access and ability to use digital technology in meaningful ways (Trauth and Howcroft, 2006) but more recently, also from the viewpoint of access and ability to innovate, design and build digital technology (Iivari *et al.*, 2018).

Iivari *et al.* (2018) have analysed factors in the exclusion of children from digital technology. Although their study focusses on younger children and pays only scant attention to gender, it provides useful conceptual tools and distinctions we can use to address the inclusion/exclusion dynamics in our work. So far, there is a lack of research examining the young generation's – particularly girls – inclusion/exclusion in/from the IT field in terms of choosing a related career. Iivari *et al.* (2018) highlighted that inclusion and exclusion can be

either intentional or unintentional and can be done by other people or by oneself. The literature prioritises inclusion/exclusion done by people themselves, emphasising their agency and empowerment in connection to inclusion (Andrade and Doolin, 2016; Taket *et al.*, 2009). Yet, past studies also point out that exclusion may be considered a desirable choice, which underlines the freedom of choice: that of not being included (Edwards *et al.*, 2001; Mariën and Prodnik, 2014). It is possible that one voluntarily and intentionally chooses to exclude oneself. Other works also highlight the powerful social, economic, political and technical structures and conditions that shape people's choices and that there is no free informed choice (Mariën and Prodnik, 2014). From this perspective, too much emphasis has been placed on human agency, while more focus should be directed to macro-level contexts and structural inequalities (Mariën and Prodnik, 2014).

Inspired by the nexus analytic theoretical lens (Scollon and Scollon, 2004), Iivari *et al.* (2018) acknowledged the roles of both discourses and concrete actions in creating exclusion and maintained that discourses and actions are complexly intertwined with the interaction orders and historical bodies of the participants. They stated that exclusion is often not the result of "an individual or force actively and intentionally preventing someone from participating; instead, exclusion emerges in more subtle ways through choices made, activities taken, and interactions that occur; all of which lead to neglecting many other choices, activities, and interactions. These subtle occurrences do not necessarily prevent anything from happening; they merely make things less likely to happen" (Iivari *et al.*, 2018). They also pointed out that exclusion can be intentional – the conscious choice of a person. Thus, people may intentionally or unintentionally exclude themselves, but it is also possible that they become intentionally or unintentionally excluded by others. The nexus analysis not only guides the study of exclusions *in situ*, in particular moments of time, but also connects exclusions *in situ* to wider societal issues. Circulating discourses may be significant in creating exclusion by implying who should or can join the IT field. The social interaction or relationships between people and the different actors present or implied may also exclude people from digital technology. Furthermore, people's background knowledge and experiences (or lack of them) related to, e.g. digital technology, play an important role. Iivari *et al.* (2018) proposed a model in which the factors creating exclusion take into account issues at both the individual and structural levels and those related to the historical body and interaction order. We will utilise this model to make sense of our empirical data on the exclusion of senior high school girls from the IT field.

3. The research methodology

This paper is part of a long-term effort that aims to battle gender segregation in the IT field. In the current phase, we attempt to understand what is causing inclusion/exclusion in this field.

First, we conducted a literature review using four databases: The Association for Computing Machinery (ACM), Google Scholar, Institute of Electrical and Electronics Engineers (IEEE) and EBSCO. The search words included variations on "girls", "women", "females" and "gender", along with terms such as "Information Systems", "Information Technology", "Technology", "ICT", "Computer Science" and "STEM" (science, technology, engineering and mathematics). This resulted in 325 articles, from which we selected those published in a peer-reviewed forum and which discussed gender, women or girls in IT education or work, including both empirical studies and literature reviews. As we focussed on high school girls (the subject of one-third of the included papers), papers on younger children were excluded. Articles related to women at various stages of their IT careers or studies were included if they discussed how they chose to pursue an IT career (the rest of the included papers). The studies typically discussed the IT field in general, so it was difficult to distinguish between different IT disciplines in the review. We also excluded articles that

focussed on women as users, provided highly theoretical accounts, addressed specific technology or described an inclusion project without any information about the factors behind girls' career choices. Due to the large number of articles, we generated a picture of the situation in Europe and the West, excluding studies related to very specific or different cultural contexts (~10). Papers related to STEM (~25) were excluded partly not only because of the large volume of papers on IT but also because most STEM papers had a stronger focus on science than technology. The publication year was not an exclusion criterion as papers from different times provided a historical perspective, although we placed more emphasis on newer publications, narrowing the selection further. The final data set included 68 articles: approximately one-third from IS, a third from IT/ICT and a third from CS.

Next, the literature was analysed using nexus analytical concepts. We searched for traces of historical body and interaction order, looking at what the authors reported on the history and background of their research efforts and the actors involved and on the interaction between different actors. For discourses in place, we focussed on the discourses of the academic authors as experts on the topic. Our analysis provides a fresh perspective on the social action of girls choosing a career in IT: the prevailing discourses, background and history-related aspects and interaction-related issues were involved in and shaped their choice. In many cases, these issues were not explicitly stated in the papers but had to be inferred or read between the lines. The results of this analysis have been reported in Vainionpää *et al.* (2019b). We continued examining the literature by focussing on the factors associated with the inclusion and exclusion of girls from the IT field. Although inspired by the nexus analytic concepts (e.g. Scollon and Scollon, 2004), our viewpoint of inclusion/exclusion dynamics was adapted from Iivari *et al.* (2018) and is shown in Figure 1. Similarly, we looked at the nexus analysis of the literature with a focus on exclusion dynamics, identifying discourses, actors, interactions and historical bodies of the actors that create exclusion and determining whether the exclusion was intentional or unintentional. In this

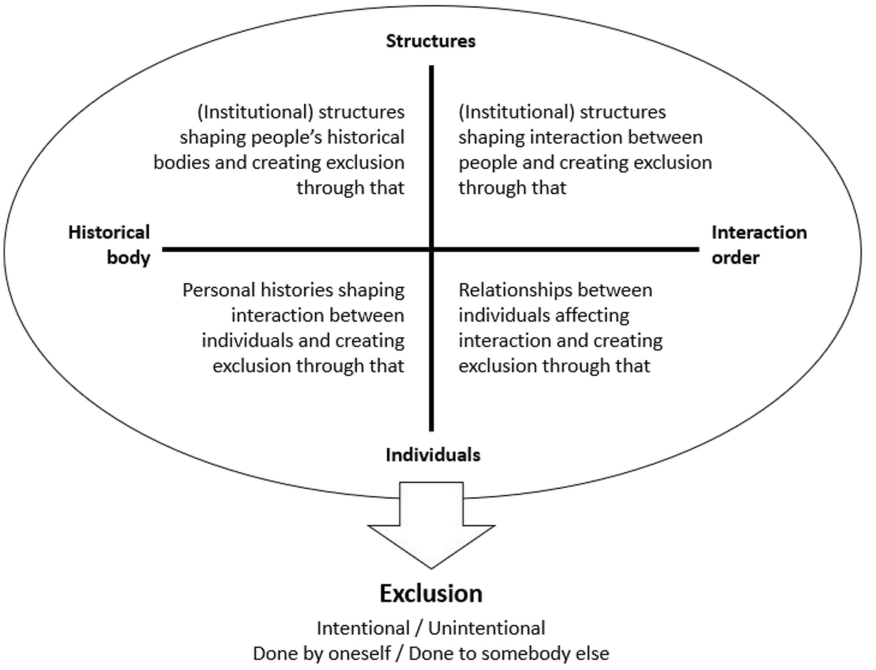

Figure 1.
The analytical lens combining the nexus analysis and inclusion/exclusion dynamics

phase, the literature base was further narrowed down to more recent studies to get a more current perspective but older sources were kept when relevant. We present the three categories of themes that emerged inductively from the literature analysis: the ones mostly related to the interaction order between actors, the ones mostly related to the historical bodies of actors and the ones mostly related to the discourses that affect girls' choice of a career in IT. We should recall that although it is possible to analytically separate interaction order, historical body and discourses in place, they are intertwined in real life.

To complement the literature review, we conducted an exploratory empirical study to gain a preliminary understanding of the inclusion/exclusion dynamics amongst Finnish senior high school girls. Our data collection was part of a project where we tried to raise high-schoolers' interest in IT studies. Finland is a high-tech Nordic welfare country, where young people can make their career choices based on their interests (see Hyde, 2014). High school students need to already consider their future career choice when choosing the school subjects they study for their matriculation exams. Furthermore, when applying for higher education, they need to choose a major in the application phase. In the Finnish national high school curriculum, IT is not on the list of subjects, but optional courses can be offered at schools (Finnish National Agency for Education, 2019). These courses often include basic software use and programming but provide little information about IT careers or the variety of IT works. This is a problem as the limited understanding of what work in the IT field entails in practice seems to affect their career choice (Vainionpää *et al.*, 2019a).

Our empirical study was conducted in five senior high schools that participated in the project and had an interest in offering their students information about the IT field. We recruited senior high school girls and their study GCs for interviews. The girls were recruited during high school events arranged by the project, where they were given information about the IT field as part of their mandatory classes or in optional events. Altogether, around 500 students in four of the high schools took part in the events, about 60% of which were girls. We asked for volunteers for the interviews at all the events and contacted all of them. The students were told we were interested in their perceptions of the IT field, even if they had no knowledge or interest in it. We interviewed all ten volunteers who responded. We did not manage to find any interviewees who had an interest in an IT career. Throughout our project, we experienced difficulties in getting senior high school girls to participate in the arranged activities unless they were mandatory for the students or specifically tailored for their interests. Being interviewed on a topic of no interest for the interviewee did not seem to arouse interest. Then again, these interviews provided us with plenty of insights into the factors excluding girls from the IT field. We consider the data we collected from the ten 16–18-year-old girls in May 2018 and January to March 2019 as a highly valuable outcome of hard recruitment work. The interviewees were from three senior high schools. Furthermore, two girls were interviewed together and the rest individually (interviews lasted 30–60 min, were conducted face to face and audio recorded). We asked the girls about their career plans and what influenced their choice, their IT skills and experiences, perceptions of IT jobs, thoughts on gender balance in work life and what knowledge the school offered.

We complemented the data set with interviews with senior high school study GCs. Counsellors are a significant stakeholder group regarding senior high schoolers' career choice in Finland, as they work extensively with this age group: their job is to guide students in studies, career choice and developing self-knowledge by offering courses and having one-on-one discussions. We recruited the GCs by emailing the high schools and asking for volunteers for interviews; all volunteers were interviewed. All GCs were women working as counsellors, with experience varying from 0 to 30 years. The GCs work in high schools with the number of students varying between 400 and 800. The GCs meet all students face to face for counselling. The interviews (50 min on average; all but one face to face) were conducted with six GCs from five senior high schools between January and May 2018. The interview topics included the

GCs' IT experiences, education and work background, their image of the IT field and education, IT adoption in their school, how their students perceived the field and what may influence students' career choice.

All interviews were transcribed. In the data analysis, we first identified what seemed to influence girls' career choice (particularly from the point of view of choosing an IT career) and then focussed on exclusion dynamics using the analytical lens in Figure 1. In the first phase, we studied the interview data with a focus on how the girls and GCs perceived the IT field and who and what appeared to affect that perception and the girls' career choice. Nexus analytical concepts were used as a sensitising device to look for the different actors (present and distant, individual and institutional), interactions (face-to-face, online or more distantly – e.g. through TV) and histories of all actors or institutions that contribute to the image of the field and career choice. This resulted in an understanding of the web of the girls' everyday (school) life and its relation to their potential IT career choice, inductively emerging from the data. In the second phase of the analysis, we identified the factors behind the exclusion of girls from IT using the lens in Figure 1, considering how different individuals, structures and related historical bodies and interactions contribute to this phenomenon. We also looked for evidence of intentionality. All findings were discussed collaboratively to ensure all authors had the same understanding. The girls described similar discourses and while there was some variety in interaction orders and historical body related to family and interests, all described the high school setting similarly. Related to inclusion/exclusion dynamics, the findings were alike. The five GCs not only described matching observations from their work and interactions with their students but also provided new insights. The same general themes were identifiable from both girls' and GCs' interviews, as discussed below.

The last step of the analysis consisted of narrating the findings. Qualitative research always entails an enticing storyline for communicating the findings to the readers (cf. Clifford and Marcus, 1986). In doing so, we placed emphasis on direct citations from the empirical material.

4. Inclusion/exclusion of girls in information technology: literature review results

Next, we discuss our literature review results inspired by the nexus analytic lens: the prevailing discourses, background, history-related aspects and interaction-related issues that contribute to the inclusion/exclusion of girls in/from the IT field were identified.

4.1 Influence of different actors and interaction orders amongst them

Past research has identified the groups that influence girls' career choices: family, friends, peers, significant others, GCs, teachers from all levels and role models (Rommes, 2010; Zhang, 2007; Turner *et al.*, 2002). Adolescence is a time when career choices are heavily influenced by other people (Kindsiko and Turk, 2017). Although the studies rarely discussed the complex issues related to the interaction order amongst the actors, they pointed out the significant influence of these actors on girls' career choices. It has been indicated that actors can either encourage or discourage girls, and interestingly, the findings on who is a positive or a negative influence vary between the studies. For example, one study found that parents, friends or classmates rarely encourage women to choose or persist in computing and women in IT typically lack support throughout their education (Cohoon, 2002), while another study found parents and friends as mostly encouraging, suggesting the IT field as an option (Turner *et al.*, 2002). Hence, there are conflicting opinions about the type of social arrangements in our society around the IT field and how they shape girls' choices, creating

exclusion and inclusion, resulting in gendered occupations. There is also little evidence of intentionality in exclusion.

Parents creating inclusion/exclusion: In career choice, there is a consensus that family is significant in girls' decision-making. In addition to interest, family influence is the main reason for women to choose IT (Croasdell *et al.*, 2011). Students' career options and entry into technological fields are strongly influenced by their parents' opinions and encouragements and by exposure to technology (Lang, 2012; Wang *et al.*, 2015); furthermore, girls' perceptions of parents' support influence their beliefs of value and efficacy (Vekiri, 2010). Because parental involvement has a positive effect on choosing an IT career, parents need education about career possibilities (Adya and Kaiser, 2005).

Fathers' significance in affecting inclusion/exclusion: Researchers emphasise fathers, while the role of mothers, siblings or other family members is given less attention. Numerous women in IT have had a father in a technical job, and a majority of women identify men, especially fathers, as significant influences in their career choices (Adya and Kaiser, 2005; Lenox *et al.*, 2012; Smith, 2000; Turner *et al.*, 2002; Wang *et al.*, 2015). Fathers can encourage engagement in technical activities and be an example: using the computer, playing computer games, working in IT, etc. (Pau *et al.*, 2011). Mothers have mostly been in non-technical occupations, but they may be generally encouraging or set an example (Turner *et al.*, 2002). Few women with IT mention female influence (Serapiglia and Lenox, 2010). Educated mothers are more likely to have an influence on career choices, but fathers have been more significant when it comes to IT careers (Adya and Kaiser, 2005; Smith, 2000).

Brothers encouraging inclusion: Some studies addressed the role of siblings: brothers can influence their sisters to enter traditionally masculine fields, and girls who only have sisters often choose traditionally feminine fields (Adya and Kaiser, 2005). Male siblings tend to have a stronger influence on girls (Smith, 2000) and can encourage their sisters into masculine fields, such as IT (Crump *et al.*, 2007; Serapiglia and Lenox, 2010).

Male peers creating exclusion: One reason why women do not choose IT is their fellow students (Croasdell *et al.*, 2011). Male peers are described as negative influences on girls' career choice, and women have few female peers in IT studies or work life. The peers are mainly other students in schools or universities, friends from other social circles and co-workers. Women may be discouraged by male peers (Kahle and Schmidt, 2004).

Teachers are central actors in creating inclusion/exclusion: Teachers can be encouraging or discouraging, but they influence girls' choices to pursue IT careers. Teachers influence students' beliefs in their abilities (Vekiri, 2010). From elementary school to college, they affect women's choice to major in IT (Turner *et al.*, 2002; Zhang, 2007). Unintentional exclusion can happen through discouragement with thoughtless remarks or expectations based on gendered assumptions (Cohoon, 2002). To improve girls' participation in IT, education programmes must prepare teachers for reforms that challenge common explanations for girls' behaviour (Rowan and Lynch, 2011). We need to educate teachers about IT careers if we want students to be informed, improve programmes, provide training and enable interactions between universities and industry (Adya and Kaiser, 2005).

Career counselling creating inclusion/exclusion: Women's entry into IT education needs to take place before students choose their majors (Beyer *et al.*, 2004). Career education and guidance are included in the curriculum in many countries (Watts and Sultana, 2004). GCs can be weak influencers, but they can provide students with access to industry sources, reduce the emphasis of mathematics and inform about the interdisciplinarity in IT (Babin *et al.*, 2010). Earlier research shows, however, that women in IT have received discouragement from GCs (Turner *et al.*, 2002).

Female role models could increase inclusion: The discussion of IT role models for girls is focussed on their lack of existence (Blomqvist, 2010). The encouragement of role models and mentors could improve women's feelings towards IT and help in keeping them interested

(Kahle and Schmidt, 2004). High profile people in IT of either gender (Drury *et al.*, 2011), male (Serapiglia and Lenox, 2010) or gender-matched (Buck *et al.*, 2008), are considered significant or effective role models for women (Dee and Boyle, 2010). Mothers' influence may increase as women advance in their education and the number of women in higher positions and male-dominated fields increases (Adyaand Kaiser, 2005). Interestingly, women in IT may also reinforce the existing image of the field with the way they speak, not even necessarily coinciding with their actual experiences in the field (Nielsen *et al.*, 2003).

4.2 Influence of historical body in education and experiences

Lack of self-efficacy and experience creating exclusion: While there are few gender differences in IT skills, there are differences in attitudes, interest and self-confidence in computer use (Volman *et al.*, 2005). Perceived ability, self-efficacy and lack of confidence from having less experience have been found to inhibit girls from choosing IT careers, while boys seem to be in a better position in these aspects (He and Freeman, 2010; Michie and Nelson, 2006; Zarrett and Malanchuk, 2005). Yet, a study about psychological motivations found girls less likely to be motivated by improved skills and performance expectancy than boys and no significant gender difference in self-efficacy and perceived ease of use in the online learning platform (Shao, 2018).

Lack of knowledge creating exclusion: IT does not need to be presented to girls in a tailored manner; rather, the problem is the complete lack of information (Craig *et al.*, 2013). Misperceptions of IT professions and skills and having no exposure to the field before college can result in girls not even considering these careers (Adyaand Kaiser, 2005; Kahle and Schmidt, 2004). Students' knowledge of IT careers comes from school (Thomas and Allen, 2006) and yet, the possible career paths in IT are not familiar to many precollege students (Guthrie *et al.*, 2011). In high schools, the stereotypes of different fields seem intensified and the lack of education and misconceptions about IT work – as merely being on the computer – persist (Carter, 2006; Kindsiko and Turk, 2017). Consequently, high school curricula can reinforce the gender gap through the choices they offer to students (Abbiss, 2009). Age also plays a role as younger adolescents make more stereotypical choices (Rommes, 2010). Therefore, interventions need to take place early on, before biases and inaccurate impressions start to impact decisions (Anderson *et al.*, 2017; Zarrett and Malanchuk, 2005).

Personal interests and values creating self-exclusion: Interest is important for choosing an IT career, and it is affected by the image and stereotypes of IT (Stanko *et al.*, 2014). Actors from academia and industry could eliminate the misconceptions and emphasise the variety of career paths (Croasdell *et al.*, 2011; Zhang, 2007). A study indicated that girls can enjoy the subject if it resonates with them (Fisher *et al.*, 2015). The problem is that students do not think an IT career could fulfil their values: social interaction, work–family balance and job security. Informing students of less technical careers could change opinions (Jung *et al.*, 2017). At school, we can influence girls' interest in IT through the learning environment, role models, reinforcement and curricula (Fisher *et al.*, 2015). In addition to training and access to technology, it is important to consider the benefits IT can offer to the individual (Kvasny, 2006). If girls are not willing to work in IT, why take the necessary courses?

4.3 Influence of discourses around the information technology field

Society- and culture-related factors creating exclusion: Girls' career choices regarding IT are affected by traditional cultural norms, stereotypes and the image of the field (Beyer, 2014; Fisher *et al.*, 2015). A critical interpretive analysis of the international discourses about women in IT found that women attributed their underrepresentation to constant change (long workdays, stress and uncertainty), work–family balance (conflict with traditional roles), perceptions of industry (technical) and male-dominated environments (advancement and adapting issues) (Pretorius and de Villiers, 2009). There are gaps in our knowledge related to

the long-term consequences of this imbalance: we have no clear explanation for it and there has been little improvement of diversity in practice (Gorbacheva *et al.*, 2019). Halford and Savage (2010) saw a disconnection between the different approaches to the analysis and suggested that they need to work together to understand inequality in IT.

Gender-dominated environment creating exclusion: The male-dominant nature of IT is well known. Technical competence has been associated with masculine gender identity (Gill and Grint, 1995). Decades of unsuccessful efforts to diversify the IT field might cause the imbalance and women's exclusion to become the norm (Trauth, 2012). The male-dominated environments in IT make women feel unwelcome – i.e. they feel excluded and also exclude themselves (Dasguptaand Stout, 2014; Vainionpää *et al.*, 2019a). Gender-dominated environments should challenge their patterns, narratives and social and cultural orders (Vehviläinen, 1999). In unfavourable conditions, the weakly committed and unsupported – in IT, they are often women – leave. Furthermore, the few women in IT have few female peers for help and other students might consider them odd (Cohoon, 2002). At school, gendered classroom environments can influence girls' decisions to continue with IT studies (Master *et al.*, 2016).

Traditional gender roles create exclusion: Researchers have discussed the significance of traditional gender roles in girls' choices of occupation. Stereotypes and the social construction of IT as incompatible with women's gender roles cause unconscious gendered behaviour (Dasgupta and Stout, 2014; Trauth, 2013). Seeing men as inventors and designers and women as users and consumers of technology results in gender division in expectations, experiences and education (Bush, 2009). Programming is perceived as masculine, comparable to mathematical problem-solving (Boivie, 2010). This masculinisation creates barriers for women but does not stop them entirely (Ensmenger, 2010). Organisations must address gender role biases and create work environments that build self-efficacy expectations for both genders (Michie and Nelson, 2006). Gender identity is a significant factor in girls' choices (Serenko and Turel, 2016), which is corroborated by findings of digitally skilled adolescents still reproducing gendered discourses – e.g. computing is for men and creative career paths are for both genders (Wong and Kemp, 2018).

Stereotypes of IT creating exclusion: Girls' lack of interest in IT links to the image of the field as a male-gendered, boring, asocial, unfriendly, difficult and intimidating subject (Anderson *et al.*, 2008; Blomqvist, 2010; Kamberi, 2017). The stereotype is that IT is masculine, socially isolated and machinery-oriented and that it requires natural abilities or brilliance (Cheryan *et al.*, 2015). Despite their differences, different IT disciplines are affected by these stereotypes and prejudices (Joshi and Schmidt, 2006). Media paints and affects the culturally dominant images that influence social behaviour and choices of profession when adolescents are developing their identities (Blomqvist, 2010; Rommes, 2010). Changing the media depictions of IT workers could help change the field's image (Thomas and Allen, 2006).

Use of technology creating exclusion: The way technology is seen or used can be a source of exclusion. Earlier, gender differences were found in Internet use – e.g. women thought it affects social interaction, finding information, studying and shopping, while men saw the impact on finding careers, the sociopolitical effects and the negative aspects of technology (Colley and Maltby, 2008; Teo, 2001). Online behaviour can affect how we can reach people to inform them about IT careers. Women can be targeted via local campaigns and news media on Twitter, while men seem to follow more political and scientific information (Holmberg and Hellsten, 2015). These differences in IT use relate to IT identity – the way an individual sees the use of IT as a part of the self (Carter and Grover, 2015). These gender differences can result in different experiences and views of technology, contributing to the exclusion dynamics.

5. Inclusion/exclusion of girls in information technology: empirical results

5.1 Insight from high school girls

Exclusion of girls from the IT field: Despite our hopes, none of the girls we interviewed were going to choose an IT career because they did not know what IT jobs entail and had other interests. Some girls thought gender imbalance would not affect their choice, and some thought they might feel lonely or be excluded in a male-dominated field.

Although excluding themselves from the IT field, the girls thought it important that other women join the field and bring their perspective, "*so that we could get all kinds of thoughts out there, and like, women's perspectives on things*" (girl 1). The girls thought women should have equal chances to pursue IT careers: "*I think that if women do not want to go there, they should not, but I would not want that men can be like 'do not go there, it's our field*'" (girl 4). The girls pointed out that they should only choose IT if they are interested and that means there should be more technology made for their interests. "*You should not go there just because there are no women, you should go there if you like it*" (girl 10). The girls' sense that they lack representation in technology was also seen as a lack of women leaders in IT. The data showed that girls viewed gender differences related to ways of thinking and interests: "*It would be good that there would be some of both genders, since there are often little bit different points of view*" (girl 5). Ultimately, girls thought it was up to women to make the change and choose differently: "*I think it's up to the women themselves . . . it's useless to complain if you do not do anything about it*" (girl 3).

Different actors creating inclusion/exclusion: The girls saw family influencing their career choice: "*Well my mom, (. . .) she influences me and gives all kinds of good tips . . .*" (girl 7). Gendering was mentioned in upbringing and childhood activities: "*Boys play so much (. . .) probably because all games are some sort of war games and things like that*" (girl 6). When we look at interaction order, it is not just the actors present in the girls' everyday lives that influence them. Girls recognised the significance of short and less personal interactions: "*When you go to the city and look at what people are like, and all kinds of programs and series you watch shape your ideas*" (girl 6). Interestingly, teachers did not come up as influencers. Only after asking whether school reinforces occupational stereotypes were IT teachers recognised to shape ideas of IT and its connection to mathematics: "*yes if you look at our, who teach us these computer things, they always also teach mathematics, physics, or chemistry (laughs)*" (girl 6). GCs only came up when the girls were asked where they found information about careers.

Stereotypes of IT driving exclusion: The girls painted a uniform picture of IT professionals: "*Always really smart, with computer screens everywhere and stuff, or quiet boys with glasses*" (girl 6). Some thought of the schools' IT *guy*, who helps with technical issues. Many girls made the connection between IT and mathematics: "*Probably someone who has studied advanced mathematics, physics and chemistry*" (girl 10). This connection may come from IT teachers also teaching mathematics. These discourses related to IT reproduce the social construct of IT and its stereotypes, creating exclusion with images where IT professionals are men who are interested in computers, omitting the variety of qualities needed in the field. Work in the IT field was linked to computers and good employment but was otherwise unfamiliar: "*Well, they do things on the computer and then . . . I do not really know. Probably there are good salaries and employment*" (girl 10).

The lack of knowledge and interest creates exclusion: The girls thought education provides little experience or knowledge of IT careers: "*We have one compulsory IT course where we learn how to use Excel (. . .) learning basic skills*" (girl 2). Learning basic skills can be demotivational if students' skills are underestimated, and it does not educate students about career options in IT: "*Well I have not learned anything about IT image (. . .) it's like 'how to use Microsoft Word' and then we go through that for 5 h. And when you've learned it before, it's a bit boring*" (girl 4). This boredom may translate into seeing IT professions as just that. When

we asked how the IT field is talked about, it was seen as non-informative: "*They just talk about how you do a lot of work on the computer, and when they just bring that up it's what you remember, and then think, is that all it is?*" (girl 1). Lack of IT education in high schools results in lack of knowledge of the field as part of the girls' historical body, creating exclusion in the career choice in favour of more familiar options. Girls and boys are given the same information and opportunities, but they still make different choices. It seems girls do not choose IT without further encouragement and many have other interests. The girls in our data were not opposed to taking IT courses, but they had little time in their schedules: "*When you think about the matriculation exams, it will not fit there*" (girl 1). Yet, a genuine interest in the field was brought up as the most important factor in choice-making: "*I think sort of their own kind of perspective and what could interest women should be brought up a lot*" (girl 6).

When considering career options, the girls wanted to know about the regular workday in the field, about applying to higher education and the difficulty of the studies. They search for the information online or ask a GC once they find something interesting. "*I think it's firstly Google for everyone, and then the GC*" (girl 3). High schools provide information on different fields, but the information can be superficial: "*We do not get a lot of details about these professions, but they present fields*" (girl 5). There could be more concrete information about the everyday experience in the IT field: "*There could be some kind of vlogs about school days. Like more about what the studying is like and what the work is really like*" (girl 10). This shows the difficulty in picturing what IT professionals do, and some girls thought visual information would help. Advertisements were recognised as a source of ideas: "*youth can get interested in different professions if there's an advert about a profession*" (girl 2). Another possible source could be TV documentaries and series: "*I watched that documentary on Brexit, about how it happened, and I got interested in these data communications*" (girl 5). This suggests that we could tell more about interesting developments in technology to motivate girls to get involved.

Our data suggest that IT careers do not enter the list of options for high school girls, often due to educational structures and offerings and sociocultural factors. None of the interviewed girls had taken IT courses in high school, so we could not ask whether the courses provided information about the IT field or not.

5.2 Insight from study guidance counsellors

Different actors creating inclusion/exclusion: The GCs see themselves as objective guides to information and consider family the most important influence on students' career choices: "*Parents are a greater influence, definitely. If there has been some rejecting or encouraging comments, it has a clear impact*" (GC 1). Mothers were emphasised in girls' choices. The GCs have also seen how friends influence each other – e.g. when a group of students decides which professions they are going to hear about: "*the friends influence too (. . .) "If the friends go to hear about the social fields, then I will not go to see about that IT"*" (GC 6). The GCs ask for visiting speakers from different fields based on students' wishes and sometimes the speakers are sent by companies and universities – it goes both ways. Some GCs mentioned that a stereotypical representative of a field can reinforce stereotypes; therefore, the opposite can be done – e.g. having a male nurse or a female police officer come and talk about their work, thus changing the images just through representation.

A lack of knowledge and interest creates exclusion: The GCs estimated their own IT skills as low and some of them recognised that they are not encouraging women role models for girls to join technical fields. Furthermore, the GCs' understanding of IT disciplines varied, from no knowledge to some superficial definitions: "*Well this is a recurring question that we ponder together (. . .) I think CS is more technical and IS is closer to the user and the softer side*" (GC 2). The GCs were open about their difficulties in understanding the IT field. They are responsible for being informed about different fields, which they do by attending events and reading

online. GCs think students see IT as technical and that some associate it with mathematics. They said girls study mathematics but do not choose technical careers; they gravitate towards the "softer" – humanistic and social – professions: "*The majority (of our students) are girls and they study mathematics, physics, and chemistry, but when applying to fields, very typically they steer towards the softer values*" (GC 2). The GCs said students want secure employment in respected professions and traditional jobs are familiar to them. They agreed that career paths in IT are unclear to students who want to know where they will end up: "*IT professions do not have clear paths, that 'if you do this, you become this, and the work is like that, you can do it there'. The unclarity affects the students*" (GC 6). Considering career paths, few high schools even offer IT courses and when they are offered, they do not fit in students' schedules: "*Theoretical subjects and mathematics and languages, and the study period is filled with those*" (GC 5). This shows how structures and prioritising in high schools create exclusion.

Stereotypes of IT creating exclusion: In high schools, IT is known as a male-dominated and technical field and there are no visible women role models for girls. GCs highlighted girls' aversion to fields they deem technical and engineering oriented: "*some girls will probably say, or have said, that 'it's so technical, not there'*" (GC 1). Although it seems girls do venture into other technical fields, IT is not a choice for them: "*We do have a lot of girls who apply to technical fields, and medical school, but maybe the IT field is more unfamiliar*" (GC 3). The GCs thought that the technical and engineering sides of IT are considered negative by girls but they are also seen as the dominating attributes of the field. All GCs tell their students that IT needs more women, but it does not change girls' minds. Some GCs expressed surprise about girls applying to technical fields, saying that they are taking on quite a challenge. We assume that these attitudes may affect the girls as well, making them hesitate with their choice. The GCs thought that gender segregation is deep within our culture and that change needs to happen in how we raise children. Media was mentioned as a source of images as TV and movies highlight professions such as doctors and lawyers, while the IT field and professionals are shown stereotypically.

5.3 Information technology is not a real career choice for girls

Figure 2 summarises the factors that seem to be excluding girls from IT careers based on our empirical data.

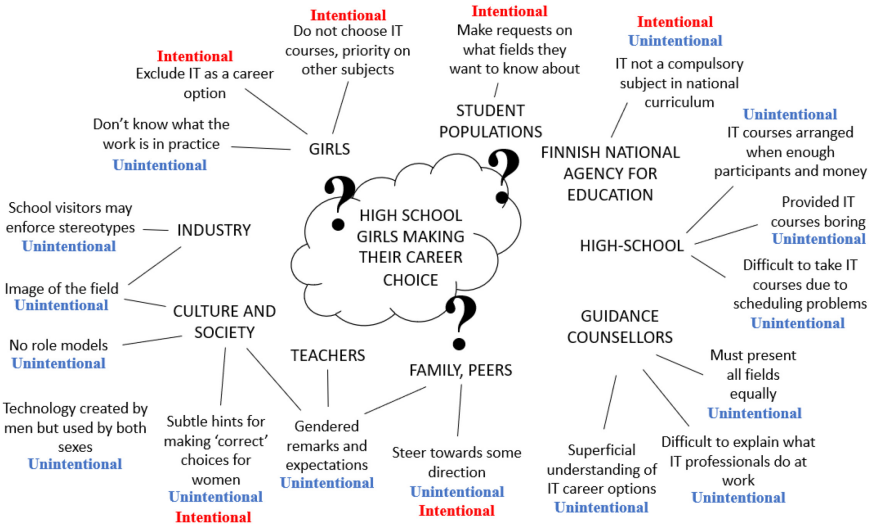

Figure 2.
Factors contributing to the exclusion of high school girls from information technology careers

To summarise, information – the lack of it, receiving it late and misinformation about IT work – seems to be a central factor affecting Finnish girls' choice to exclude themselves from IT careers. All students are provided roughly the same information, but it seems girls have ruled IT out. It is not the GCs' job to convince students to pick a specific career but to provide information. The girls say they look for information about careers online and discuss with the GCs if they find something interesting. The GCs have varying knowledge levels or often lack information about IT careers altogether, but they still try to encourage and inform girls about them. The students said they did not know what IT work is like. When high school students request their GCs for information about fields, they may not intentionally exclude themselves or others from the IT field but want information about their interests. The GCs thought it was difficult to change students' minds on IT careers. The school system does not support the development of interest in the field, and as IT courses are non-existent or non-compulsory, girls do not take part as they prioritise the courses for the matriculation exams, which provide points for applying to universities. Society and the gendered IT culture give us hints to make gender-appropriate choices.

Based on the data, the exclusion of girls from the IT field is mostly unintentional (see Figure 2), even if the girls intentionally exclude themselves from it. Many choose familiar, safe occupations instead of the alien, boring, men's world. There is some evidence that parents, peers, teachers and GCs may sometimes intentionally guide girls away from the IT field, although their actions seem mostly unintentional. Even when the actions are conscious choices, like the position of IT in the Finnish national curriculum, we interpret that the resulting exclusion was not intended. Behind this choice, there may be an assumption that it is enough to integrate IT education into other subjects through IT use. Unfortunately, this does not educate students on IT careers or empower them to take part as creators and developers; instead, students position themselves as passive users of IT. This leaves it up to the students to act. Based on the literature, girls are unlikely to end up considering an IT career without encouragement. In the literature and our empirical findings, the odds are stacked against girls giving it a go.

6. Discussion

The low number of women in IT is a concern for researchers and educators. This is a challenge for society and detrimental to the IT workforce; we need to focus on IT education. This study aimed to offer a fresh perspective on this topic by enquiring *what kinds of factors create the exclusion of girls from the IT field*? We addressed this question with a literature review and then complemented our results with exploratory data in the context of Finnish high school girls making their career choices. The participants we interviewed seemed to have either excluded themselves (the senior high school girls) or their female mentees (the GCs) from IT.

6.1 Summary of the results

Inspired by Iivari *et al.* (2018), we studied the issues at the individual and structural levels and those related to both historical body and interaction order that are behind the exclusion of girls from the IT field. We accounted for intentional and unintentional exclusion and exclusion as accomplished to or by someone. In the literature review, we identified actors, societal and cultural factors – gendered environments, stereotypes and gender roles – and the contributions of lack of self-efficacy, experience, knowledge, interest and education. The interview data provided corroborating and novel results.

In our literature review, the *discourse* lens of the nexus analysis helped show the significance of societal and *in situ* discourses circulating around the topic, many discouraging

girls from pursuing an IT career. Discourses on IT reproduce norms, stereotypes, gender roles and behaviour and gendered environments, which affect exclusion dynamics as it is easier to choose what is expected of us as adolescents. There is a contradiction in what is expected from women as feminine qualities are thought to be important for IT (e.g. Blomqvist, 2010), but the culture of the field has not supported or invited women (e.g. Dasgupta and Stout, 2014; Gill and Grint, 1995). Looking at existing research through the lens of *interaction order*, we found a variety of actors shaping girls' career choices, consciously and unconsciously. Existing research has provided conflicting evidence on the influence of different actors on girls pursuing an IT career. Finally, the lens of *historical body* directs attention to the cultural norms, assumptions and stereotypes that seem to hinder girls' interest in IT. Upbringing practices and the basic education of children are still gendered and have an impact and role models and positive media content are still lacking. Combined, these cause the girls' decision to exclude themselves.

In our empirical data, the girls and GCs identified numerous actors who intentionally or unintentionally contributed to their exclusion from IT (see Figure 2). The literature emphasises fathers' role in career choice (e.g. Lenox *et al.*, 2012; Wang *et al.*, 2015, etc.), but as Adya and Kaiser (2005) suggested, the GCs said mothers are important influences in girls' career choice. This may be culture dependent as Finnish women are well engaged in work life. Significantly, the girls unanimously and intentionally excluded themselves from the IT field. The data showed many issues related to education, society and culture shaping girls' choices. The girls and GCs discussed the stereotypes associated with IT and girls' lack of knowledge and interest contributing to exclusion, which are in line with the literature (Craig *et al.*, 2013). GCs seemed to be involved in reproducing the stereotypes. The lack of IT education also contributes to exclusion (Kindsiko and Turk, 2017) as the girls prioritise other courses related to their matriculation exams. The IT courses offered were few, with boring content and little information about the field.

Overall, this study paints a complex picture of inclusion/exclusion dynamics around girls and the IT field. We contribute to two streams of research, gender and IT and inclusion/exclusion dynamics, by viewing high schools as sites of exclusion, engendering a prevalent lack of information and education on the IT field.

6.2 Implications for research

This study has implications for research on gender and IT and inclusion/exclusion dynamics. High schools need to be approached as significant sites of exclusion considering girls and IT. We have not found this fully acknowledged in gender and IT literature; the focus tends to be more on the actors or factors (teachers, classrooms and approaches), instead of seeing high school as a complex microcosmos creating exclusions from IT. We know from psychology that students learn about gender from study materials, observation and gendered treatment (Basow, 2004). Sociology's concept of hidden curriculum teaches what is expected of us through unofficial rules, routines and structures of environments (Haidet *et al.*, 2020). Education and sociology have discussed the social reproduction of gender and high schools as sites of exclusion, where biased practices and structures – such as curricula – can be conscious or unconscious (see, e.g. Clark and Millard, 1998; Riddell, 2012; Parrillo, 2008). We have not found arguments for schools as sites of exclusion in the IT literature, although teachers and classroom environments have been shown to influence girls' sense of belonging (Master *et al.*, 2016; Rommes, 2010; Zhang, 2007; Turner *et al.*, 2002).

Our results corroborate some existing findings on gender and IT, such as different actors creating inclusion to and exclusion from the IT field, societal and cultural issues, including upbringing practices, education, stereotypes, gendered expectations and norms (see also Vainionpää *et al.*, 2019a, Vainionpää *et al.*, 2019b). Approaching high school as a site of exclusion addresses the problem of girls and IT from a somewhat novel angle. Although the

influence of curriculum has been noted (Carter, 2006; Fisher *et al.*, 2015), more explicit attention needs to be directed to schooling and curricula. In this study, the curriculum contained only a few IT courses, which were considered boring and non-informative on IT work. The matriculation exams directed students' attention to particular subjects, excluding IT courses. Because of this, IT teachers remained insignificant in this study (contrary to, e.g. Turner *et al.*, 2002; Vekiri, 2010): they were invisible as the students did not become espoused to their influence. This study underlines the importance of GCs in shaping students' choices, while earlier studies have considered them in a less positive light (see Babin *et al.*, 2010; Turner *et al.*, 2002). Our work indicates that GCs may be uneducated about the IT field and may even reproduce IT stereotypes. In looking for information about careers, the Internet emerged as important not only for the girls but also for their GCs. This was not addressed in the literature. Another issue that has not been studied is the discussion of IT courses in high schools. Plenty of articles focus on adopting IT in classrooms, but little can be found on IT courses or the role of IT subjects in the curricula. This indicates that not enough attention has been paid to high school IT education. Our data show that current and accurate information about IT is still not reaching girls. Overall, this study's findings highlight the lack of education and information as excluding girls from the IT field.

The nexus analysis helped us approach high school as a site that excludes girls from IT from multiple angles. This method enables a more comprehensive view of the problem and leads to examining a variety of different influences behind the social action in question. In this case, high school girls' career choice is influenced by historical, environmental, societal, structural, cultural, interpersonal and personal factors. We identified several discourses reproduced during several decades in academia and society, numerous actors and interaction orders amongst them and their historical bodies affecting girls' career choices. Many problematic discourses, interaction orders and historical bodies-related factors appeared to come together in the context of high school. The rich information we were able to extract makes the complexity of this problem tangible and concrete, enabling further action.

Regarding research on inclusion/exclusion dynamics in/from IT, this study emphasises, in line with Iivari *et al.* (2018), that exclusion can be intentional and unintentional and it can be done to and by people. The girls voluntarily and intentionally excluded themselves from the IT field, albeit under the influence of societal and cultural issues. This indicates a lack of free informed choice as structural-level issues are heavily at play, even if a person's right of not being included also needs to be respected (cf. Iivari *et al.*, 2018, see also Andrade and Doolin 2016; Edwards *et al.*, 2001; Mariën and Prodnik, 2014; Taket *et al.*, 2009). The data show that families, friends and peers may contribute – intentionally or unintentionally – to the exclusion of girls from IT. This study emphasises the role of high schools as sites of exclusion, enmeshed with the curricula created by national agencies of education, actors responsible for the education in schools, their historical bodies and the information available for the educators and the girls provided by various actors, including higher education institutions. We assume none of the adult actors identified were intentionally excluding girls from the IT field but their contribution was identifiable in our study. There seems to be a gap between the conceptual space of the adults and the lived experience of the girls. Despite the good intentions of educators, girls seem to be excluded by themselves and others.

Figure 3 captures our main findings on the factors excluding girls from the IT field. For research on inclusion/exclusion dynamics in/from IT, the figure corroborates prior results (Iivari *et al.*, 2018) on the factors excluding children from IT development. We identify novel issues at the structural and individual levels and historical body- and interaction order-related aspects (see Scollon and Scollon, 2004). Research on inclusion/exclusion dynamics around IT has mostly concentrated on the access and use of IT. While the exclusion of younger children has been examined (Iivari *et al.*, 2018), this study contributes to the literature on the social inclusion/exclusion of high school students. The present work revealed the

many forces working against the inclusion of girls and underscored how they come together in the context of high school. The novelty of our work lies in the emphasis on curricula, which lacks suitable content and shapes students' schedules and choices, leading to a neglect of IT education. Considering historical body and interaction order, curricula are significant (cf. Scollon and Scollon, 2004): they capture and act as aggregates of what a society considers important and shape interactions in schools: amongst the staff, students and between them all. They shape the work of GCs, who have so far been weakly acknowledged as an actor group in IT research. GCs are expected to guide students towards suitable careers, but due to their own limited background and knowledge, their help is insufficient regarding IT. This shows how various historical body- and interaction order-related factors associated with the GCs cause the exclusion of girls from the IT field.

We invite researchers interested in inclusion/exclusion dynamics around IT to start identifying these types of sites of exclusion, where a variety of problematic factors come together. Considering the exclusion of girls from the IT field, we invite researchers to approach high schools as such a site: embedding and reproducing problematic discourses on IT and IT careers, prioritising particular subjects and choices while downplaying others, joining together a variety of actors and generations that tend to have similar kinds of historical bodies (e.g. men and mathematics) associated with IT. High school should be viewed as a "complex microcosmos: as a multifaceted constellation of people, objects, tools, relationships, discourses, as a stage with particular performances" (Iivari *et al.*, 2020) that requires careful study before considering any interventions. We emphasise a participatory approach for the study and interventions in such a microcosmos. The nexus analysis is helpful for seeing the broader picture and its complex factors, while also advocating change in close collaboration with the research participants – i.e. not as something to be done to them but by them. This method also supports giving agency in the inclusion and exclusion of girls (Scollon and Scollon , 2004). While girls' career choices are not purely free informed ones, it is important to respect the choice to not be included (Iivari *et al.*, 2018). We can be actively involved in shaping and making our digital future or just live it. We hope more girls choose to start shaping and making the future.

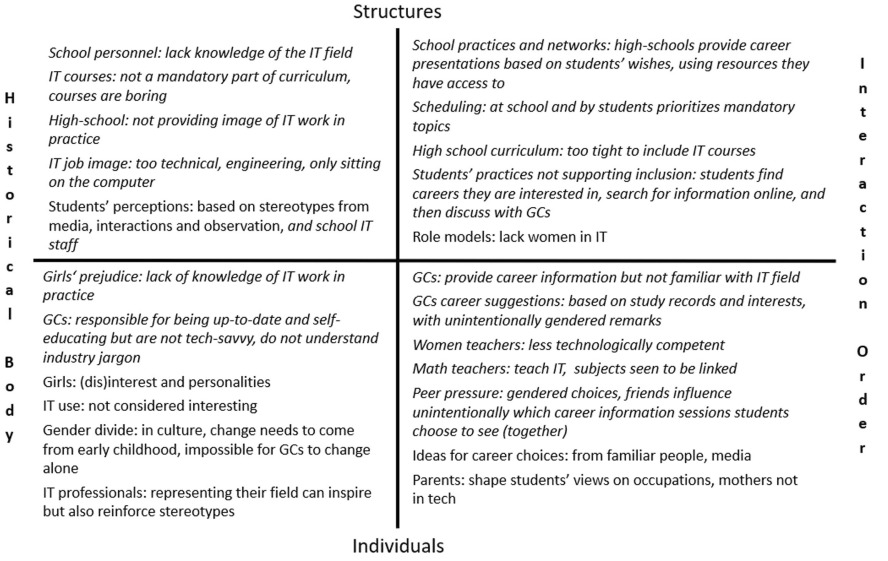

Figure 3.
The factors behind the exclusion of girls from information technology. Text in italics: findings on high school as a site of exclusion; regular text: corroboration of previous findings

6.3 Practical implications

We need fresh viewpoints to act against the barriers for girls to enter the IT field. As *in situ* actors, we need to make sustainable improvements for the future and raise awareness. We can be sensitive to the unintentional and intentional exclusion around us (Cohoon, 2002) and consider avenues for increasing inclusion. We can ask ourselves how we can encourage girls to consider themselves capable shapers of society. Our results have an impact on society as we identify the reasons behind girls' exclusion from IT. The findings can be used for curriculum development and awareness campaigns for IT education. This paper highlights three possible solutions: early IT education in children's basic education; marketing to arouse girls' interest; IT education and curriculum in higher education to sustain girls' interest and motivation. Additionally, the education of parents, teachers and GCs is also important as they pass on their ideas about IT careers.

We need to engage in shaping children's basic education (Iivari *et al.*, 2016) and act early, at the latest in high school. We should also make the variety of IT disciplines visible and showcase the social, organisational and business aspects of the field. Research suggests such aspects can interest girls (Carter, 2006; Guthrie *et al.*, 2011; Jung *et al.*, 2017). Currently, the integration of IT education into other subjects is making it invisible as a career option. IT education needs to be proactive with campaigns and interventions that address the young generation and spark girls' interest. We can show how they can make a difference in people's lives, instead of developing technology just for the sake of it. Early interventions may prevent misperceptions about IT (Anderson *et al.*, 2017; Zarrett and Malanchuk, 2005). Yet, high school is the last stage of education in many countries to influence girls before they make their choice. Although we speak of girls in general, different things appeal to different individuals (Trauth *et al.*, 2004), so we suggest emphasising the diversity of the field and speaking in terms that have meaning to 18-year olds (see Kvasny, 2006 on expected gains).

IT research should consider how national curricula could be developed to better integrate IT-related aspects into different levels of education. The literature has pointed out a lack of IT education (Craig *et al.*, 2013; Guthrie *et al.*, 2011), and we found that current high school education in Finland offers little incentive for students to consider careers in IT – the topic has rather been excluded from the curriculum. Students use IT daily but have no time for IT courses – if they are even offered. Such courses offer the opportunity to become familiar with the different disciplines of IT – i.e. besides programming, organisational, business, design and user-related aspects could be introduced.

The literature and our empirical data show that the lack of girls in IT is connected with student marketing, which concerns GCs rather than high schoolers. We know the image of IT work is not appealing to young girls (Blomqvist, 2010). A major problem is that students do not have opportunities to see what IT work entails before they make their career choices. The options need to be visible to girls so they can make informed decisions. The Internet is an important avenue for marketing IT careers. This begs the following question: should something be changed if the information does not reach girls or GCs (Colley and Maltby, 2008; Holmberg and Hellsten, 2015 on gender differences online)? We need to consider whether we are using the Internet effectively – that is, what can we do as individuals, as representatives of the field, with our online presence? Positive role models from the industry need to be visible. Are our organisations providing enough information in an understandable format to the right people (Adya and Kaiser, 2005; Babin *et al.*, 2010) – i.e. the girls, their parents and teachers? Just because the information is online, it does not mean it reaches the right people or that they understand it. There is only so much the GCs can do if the girls' minds are made up and the GCs' own understanding of IT careers is limited. As high schools have insufficient opportunities for familiarising oneself with a specific field, higher education can be active in offering information. Media could also pay more attention to how they portray IT professionals.

At the university level, IT education can make a difference in girls' career choices. Courses can encourage girls to continue their studies and pique their interest. Gender-sensitive education, which considers subtle issues, such as the circulating discourses, norms and stereotypes, is needed. The curriculum can be designed in a way that sustains the girls' interest that was aroused in student marketing. The aspects emphasised in campaigns should also be at the forefront of current education. If girls are genuinely not interested in IT, once they gain a realistic image of what the industry has to offer, they should not be pushed. However, we can show how IT skills are valuable in most fields these days and as such, a viable option as a minor subject. Researchers agree that girls need to be supported by family, peers, educators and employers if they are to join the male-dominated workforce (Rommes, 2010; Zhang, 2007; Turner *et al.*, 2002). Studies have also shown that girls fare well in IT subjects and positive experiences can show them they can succeed in this field and that there are various positions available in IT or other industries (Fisher *et al.*, 2015; Volman *et al.*, 2005).

The future of IT depends on the research studies and interventions finding what works and for whom, addressing the needs of underrepresented or excluded groups and generating theoretical inferences and practical applications for policymakers (Zarrett and Malanchuk, 2005). IT has a strong influence on who benefits, gains, loses, creates or accommodates opportunities. For women to transform technology, it is important to assess the equity implications of technological development and strategies for changing social relationships (Bush, 2009).

6.4 Limitations and future research

Due to the amount of research on the topic, some areas – such as studies addressing STEM and gender – were excluded. Regarding terminology, different cultures and countries might have varying ideas of what counts as IS, IT or CS. We tried to account for this variety in the analysis. While some of our findings seem applicable to many fields, our research relies on articles addressing the IT context. As for the empirical research, our study is limited by the participants: we interviewed students and GCs in one city in Finland, which surely influences our results (see, e.g. Hyde, 2014; on choice of occupation). As the GCs see a large number of students in their work, our data give a general picture of five different schools in the same area. The GCs had similar views on the phenomenon.

Despite our efforts to find girls for the interviews, few volunteered and none of them were planning to choose a career in IT. We take this as a sign of girls' general disinterest in the field and assume that with these interviews, we managed to gain a general understanding of the challenges and exclusion dynamics involved. Since the girls live in a welfare country, the employment or salary potential in IT might not provide them enough of an incentive. We know that locally, 10–20% of the applicants in the IT fields are women and that it is not amongst the popular choices for male applicants either. The volume of empirical data is relatively small, but it was intended as an exploratory extension of the literature review and our aim was not to generalise but to gain in-depth information. The interviews were conducted and analysed by a researcher with a background in a local high school, which may have created bias but also provided a more contextual understanding of the interviews.

In the future, we need to provide timely information about the IT field to girls and all actors affecting their career choice. The girls we interviewed engage with technology daily but none of them intended to study IT. While the decision is theirs, our ideas of gender and technology seem to be deeply engraved in us, repeating the cycle of exclusion. GCs strive for gender-neutral advice but seem to have little chance of convincing girls of IT careers as viable options. Moreover, GCs cannot highlight IT careers over others as they are expected to give an overview of different fields; therefore, universities need to be active in collaboration and providing information. As the girls consistently said their first source of information about careers is the Internet, we need to consider how well we are utilising this channel.

7. Conclusions

Despite different actors' efforts to entice young women to consider IT as a career choice, the decreasing number of women in the field indicates the situation is not improving. IT disciplines are in a worrying situation in many European countries. We contribute to this discussion with a literature review, where we identified exclusion and inclusion dynamics, a review which we complemented with exploratory empirical data from interviews with ten senior high school girls and six GCs. Using the nexus analysis helped us paint a broader picture of the issue and its complex factors. Although our empirical findings agree with many earlier studies, there were inconsistencies (e.g. mothers' influence and the use of the Internet). We also show how the good intentions of educators do not necessarily yield the expected result. Our data brought forth the importance of the Internet in providing information to both the students and those who guide them in finding suitable careers. We need to link our efforts to young people's lives to reach them and arouse interest. For example, social media seems to be an underutilised opportunity. It is an open question how today's girls, who live "on the web", are always online and use technology all the time, are influenced by the gendered division of labour or the masculine picture of IT.

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