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GIRLS' CHOICE - WHY WON'T THEY PICK IT?

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Research paper

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Abstract

The low number of women in the Information Technology (IT) field is a concern of European Information Systems (IS) research, among other disciplines. Despite a vast body of research generated during decades, the problem persists. That is a challenge for the society and detrimental from the viewpoint of IS workforce. It is an issue that needs attention from IS education as well. This narrative literature review aims at offering a fresh perspective on this old yet current topic by inquiring what seems to affect whether senior high school girls end up studying in the IT field. We consider IT education and career as important choices to build young women's capabilities to leave their marks and take powerful actions in the digital society. Using nexus analysis as our theoretical lens we focus our analysis of literature on discourses, different actors and interaction between them, and histories; all of those affecting the girls' choice of career. Our results show that various cultural norms and assumptions still influence the choices. Based on our findings, we call for in-depth qualitative analyses on girls' life world and targeting girls, their parents, and teachers, as well as better linking our efforts to girls' everyday life.

Keywords: IS, Girls' choice, Gender imbalance, IT education, Historical body, Interaction order.

1 Introduction

Reasons for the low number of women in the Information Technology (IT) field have been studied for decades but the solution for motivating women into this male dominated field is yet to be found. The statistics tell a clear story: girls do not see the IT field as a career option. Across all OECD countries only 20% of new students in the IT field 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 the European Union, 83,3% of employees in the IT field were men in 2016 and the gender difference has been steadily increasing in the last ten years (Eurostat 2018). This is worrying information. On the one hand, we know that due to the digital transformation of society jobs in the IT field will increase in the future and we already see headlines of companies struggling to find enough workers for IT jobs[1]. Women could help fill in these positions. On the other hand, segregation impairs the overall economic efficiency of a country (Melkas and Anker, 1997) and affects companies' competitiveness around the world (Ahuja 2002) – it is bad for business if mostly men plan, design, and develop IT as it is not only men who use

[1] In Finland, one of the high-tech countries in Europe, the acuteness and significance of this problem is illustrated, e.g., by a newspaper opinion piece signed by top level managers e.g. from Supercell, F-Secure, Nokia, Google, Reaktor, Finnair, and Rovio that underscores the shortage of skilled IT workforce: https://www.hs.fi/mielipide/art-2000005867532.html

it; more viewpoints are needed for developing compelling and useful products. Our digital environments are currently largely constructed by men and, as the significance and effect of digitalisation in our lives grows all the time, we are in a dire need of more diverse views to what kind of 'digital life' we could and should have. The cross-domain nature of the IT field in general would most definitely benefit from women's perspective, not to mention gender equality. Promotion of gender equality is seen as necessary within European Union countries for ensuring a democratic society (European Commission, 2018). Lowering the gender divide on the occupational level is one important step towards that direction. There is a rather unanimous view that the situation should change – for societal relevance and impact of the entire field, women need to get more involved and need to gain equal capabilities and opportunities for controlling the digitalisation of their lives.

For Information Systems (IS) education and enrolment, this is an acute issue that requires action even though IS represents a softer side in IT education and globally it is often associated with business schools and business-oriented careers where gender balance tends to be better (see e.g. Mandviwalla et al. 2017 for a report on IS industry in the USA). In many European countries the distinction between IS and IT education and careers remain very fuzzy: IS education is often offered in the faculty of IT or natural sciences. Separation between the disciplines of IS, IT and computer science (CS) is far from clear (consider e.g. Informatics or IS education in Nordic countries or Germany). Particularly for girls making their career choices, IS is almost unknown or closely connected with IT (Jung et al., 2017).

A large base of research from various fields addresses this question: why girls do not enter the IT field and how can we change this situation. Disciplines such as IT, CS and IS, but also engineering, science, education, gender studies, anthropology, psychology, and social sciences have all brought in different theories and perspectives to study the same issue (for literature reviews see e.g. Butler, 2000; Volman and van Eck, 2001; Ahuja, 2002; Adya and Kaiser, 2005; Sanders, 2005; Pretorius and de Villiers, 2009; Trauth, 2013; Rogers, 2015; Oehlhorn, 2017; Main and Schimpf, 2017). In IS research, there has been an on-going concern for this topic for long (e.g. Joshi and Schmidt, 2006; Oehlhorn, 2017; Trauth, 2013; Croasdell et al., 2011; Serapiglia and Lenox, 2010). However, recent studies (e.g. Oehlhorn, 2017) show that the problem persists, similarly to other IT related fields, despite the more feminine nature of the IS discipline due to its greater perceived social component (Joshi and Schmidt 2006). Even after decades of research on this topic, it seems that we still do not know enough about the reasons behind this imbalance, as the problem has remained unchanged over the decades. Because the topic of women's underrepresentation in the IT field has accumulated a large body of research, an analysis and synthesis is needed (Webster and Watson, 2002). We thus intentionally conducted yet another literature review on this topic in the IT education field. We aimed to find a fresh viewpoint to this old yet current topic, to increase our understanding of this persisting problem.

We are specifically interested in understanding the career choice of high school girls. We acknowledge that probably many of the issues originate from girls' life experiences, but we see high school as a significant phase of life to influence girls' choice to join the IT field. We see choice as a dynamic and multidimensional process, in which systemic and emergent choice processes should be focused upon, rather than static factors correlating with some expected outcomes (Jung and Lyytinen, 2014). As our research question we ask, *what seems to shape high school girls' career choices as regards IT field.* In this study, we also aim to understand how we can help girls see the IT field as a viable career option. We approach the topic using 'nexus analysis' (e.g. Scollon and Scollon, 2004) as our theoretical lens. Nexus analysis offers a suitable lens to study complex topics in depth, such as racism (Scollon and Scollon, 2007) or societal multi-lingualism (Hult and Pietikäinen, 2014), while it has also been utilized to understand various kinds of complex IT related phenomena (see e.g. Iivari et al. 2014, Iivari et al. 2018, Molin-Juustila et al. 2015). It enables to analyse the existing research qualitatively from multiple perspectives, acknowledging various kinds of historical and social aspects shaping our choices as well as discourses at different level affecting us (see, e.g. Scollon and Scollon, 2004). We hope that by gaining nexus-analytical understanding of the existing research to this complex topic we find new directions for making sustainable improvements in the future.

The structure of the paper is as follows: The next section introduces nexus analysis used as our theo-

retical lens for making sense of the literature on senior high school girls' career choice as regards the IT field. Next, the methodology for the literature review is presented. The fourth section discusses our findings, and the fifth section considers their implications for the IS research community.

2 Nexus Analysis as a Theoretical Lens

Inspired by Molin-Juustila et al. (Molin-Juustila et al. 2015) we use some core concepts from 'nexus analysis', developed by Scollon and Scollon (2004), as our theoretical lens. Nexus analysis has its roots in 'mediated discourse analysis' and is meant to address complex social situations (Scollon and De Saint-Georges 2013). Methodologically, nexus analysis also has ethnographical stance with participant observation and discourse analysis (Pan 2014). In nexus analysis, *social action* is the central focus of analysis. It is seen as being 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: 19). One of the general concerns of nexus analysis is how "discourses of our social life are engaged" in the "social actions of social actors" (Scollon, 2001: 139). In other words, nexus analysis guides us to study the complex social action of high school girls making their career choice as regards the IT field as always tied to both its social and historical context as well as the relationships between actors (see e.g. Molin-Juustila et al., 2015). The notion of *discourses in place* means that all social actions are mediated by cultural tools or mediational means, the most salient being language (Scollon 2001: 141). Discourses are heterogeneous, non-hierarchical and complexly networked (Honan 2007, Honan 2010) and they can be observed in terms of flow and dis/connections (Pietikäinen 2015). The concept of discourses in place emphasizes also the social space into which people have become accustomed (Blommaert and Huang, 2009: 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. A mother working in the IT field may, e.g., affect her daughter's interest towards the field in significant ways. More distant actors shape the social action as well, e.g., role models. Finally, life experiences of social actors are referred to as their *historical body*. This concept comes from Nishida's work (1958) while Bourdieu's (1990) concept of 'habitus' is closely related. 'Historical body' is, however, more closely tied with participants' concrete embodied actions (Scollon and Scollon, 2004: 13). In the context of our study, historical body shows, e.g., as stereotypes girls might have encountered about the IT field.

In this study, similarly to Molin-Juustila et al. (Molin-Juustila et al. 2015) we use these nexus analytical concepts to make sense of the existing research. As for discourses in place, we do not have access to real-life discourses in place but examine them as they are displayed in the published academic papers addressing the topic. We focus our analysis to the discourses of the authors as experts on the topic: how they position and motivate their studies and talk about making career choices. As for the concepts of historical body and interaction order, we search for traces of them reported in the papers. This analysis enables us to provide some fresh perspective on the social action of high school girls making their career choice as regards IT: what kind of prevailing discourses, background and history related aspects, and interaction related issues are shaping and involved in their choice. It is important to note, however, that the three concepts introduced are analytically intertwining. 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: 14). Yet, one can use these concepts heuristically as analytical lenses to the social action under scrutiny (see e.g. Molin-Juustila et al. 2015).

3 Methodology

The literature search was executed 11/2017-4/2018 using the information services of ACM, Google Scholar, IEEE, and EBSCO. Search words used included variations of 'girls', 'women', 'females', and 'gender', together with terms such as 'Information Systems', 'Information Technology', 'Technology', 'ICT', 'Programming', 'STEM' (Science, Technology, Engineering, Mathematics), and 'Computer Science'. This resulted in 325 articles, which were included if they were published on a peer-

reviewed forum and if they discussed gender, women, or girls in IT education or work, including both empirical studies and literature reviews. The focus of this literature review is on the choice of high school girls (one third of the papers in this review), so papers focusing on younger children were excluded. Papers related to women in various stages of their careers in IT occupations or studying in universities were included if they discussed how they chose to pursue an IT career (rest of the papers in this review). In these papers, it was often mentioned only that the job was in the IT or ICT field. Thus, it was very difficult to distinguish between different fields of IT in the review. Articles that only discussed women as users of technology were excluded as well as ones providing only highly theoretical accounts, addressing some specific technology, or describing how an inclusion project was done but not contributing to the knowledge of factors behind girls' career choice. Due to the large number of articles on the topic, we also decided to aim at generating a picture of the situation in the Western and European world, hence excluding studies that were related to very specific and different cultural contexts (~10). In the end, it was also necessary to exclude papers related to STEM (~25), partly because of a large volume of papers directly related to IT, but also because most 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 of the topic, but the emphasis was on the newer publications, which narrowed the selection further. The final dataset included 68 articles of which approximately one third of the articles were from IS, one third from IT/ICT, and one third from CS.

The articles were gathered in Mendeley, and abstracts or key findings from the articles were included in a separate text document. This document was coded into themes as they emerged, such as "Girls and technology", "Girls in IT education", "Women in IT", "How do women end up in IT", and "How to get girls in IT". Next, the themes were analysed using the nexus analytical concepts of discourses in place, interaction order and historical body as a sensitizing device. The focus was on searching for traces of 1) what kind of discourses can be identified in the literature addressing high school girls' choices of career in the IT field; 2) who are the actors involved and how girls' career choices are considered to be shaped by interactions between different actors, and 3) how life histories and experiences are considered to shape high school girls' decisions to enter the IT field. Afterwards, the authors collaboratively discussed the findings, and outlined their implications. Finally, a subset of papers was selected for presenting the results and for preparing a narrative synthesis, with the aim to report what existing research tells us about this phenomenon (Boell and Cecez-Kecmanovic, 2015).

4 Nexus Analysis of Girls' Career Choices as Regards IT

In the following, we discuss our nexus-analytic inquiry on the existing research.

4.1 Discourses in Place

Many studies discuss women, since it is women, not girls, who enter the working life. To understand the gender roles in the IT field, these papers cannot be left out. Pretorius and de Villiers (2009) have made here an interesting effort. Because of the declining participation of women in IT education and profession, they conducted a critical interpretive analysis of the international discourse about women in IT, identifying factors that women in the IT industry have attributed to cause the underrepresentation of women. The root causes experienced by women were constant change (causing long working hours, high stress levels, and uncertainty), work-family life balance (not accommodating women's traditional domestic responsibilities), women's perceptions of the industry (very technical), and the male-dominated environment (difficulties in advancement and in adapting to work environments).

The male-dominant nature of IT has been discussed by others as well, and it has been considered a cultural norm. The fatigue from decades of unsuccessful efforts to diversify the IT field might be the cause for this imbalance to become a norm, which then sends the message that there are enough women in IT and there is no need for more of them (Trauth, 2012). Absence of women in the Western cyberspace says more about the technology and culture made by men than about women – men got there first and the longer it takes for women to enter the field the harder it will be to take part in shaping

new technologies and culture (Spender, 1997). Discourses in our society are seen as gendered: men are associated with thought, intellect, and reason and women with body, emotion, and intuition (Halberstam, 1991). Technology and masculinity are thought to be linked, which is why technical competence is associated with the masculine gender identity – and masculinity has become central to the definition of technology (Gill and Grint, 1995).

While the field seems incompatible with the traditional female identity, there is also a demand for feminine qualities. User and need values are feminine, so increasing the number of women in design communities could change technologies towards more user-oriented perspectives. This would change the current tradition of using technologies for excitement and adventure, and designing technologies for their own sake. (Oudshoorn et al., 2004). Increasing women's participation in the field has been considered beneficial for the society in general. The fast expansion of IT use has resulted in a need to recruit more people to the IT workforce, which means that employers need to consider the entire labour pool, including women and other minorities (Ross and Thomas, 2008). The lack of women is making the labour shortage more prominent, affecting companies' competitiveness around the world (Ahuja, 2002), while motivating women into IT careers would help to solve the shortage of skilled technical professionals (Jepsen, 2001). A stronger representation of women in IT would help address the deficit of employees, but it could also modify and expand the range of technological applications, products, standards, and practices, benefitting the society in general (Fountain, 2000). Women participating in developing new technology means that technology serves both women and men; attracting women to high paying fields could also help narrow the gender pay gap (Lehman et al., 2016).

However, women in the IT field may enforce the existing image of the field with the way they speak, and thus reinforce existing impressions of the IT industry - even though their actual experiences might be different (Nielsen et al., 2003). Then again, women can feel empowered and gain confidence from succeeding in a male-dominated field and feel special or admired when they are involved in IT, while other motivating factors to work in the field include practical and emotional motivations (Turner et al., 2002). At the same time, there is literature about women being outsiders and feeling like they are not welcome in the field. (e.g. Trauth, Quesenberry, and Yeo, 2008; Stepulevage and Plumeridge, 1998).

Technology is also an equity issue. 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). While the absence of women in IT education remains, there is little research on women actually partaking in IT education (Blomqvist, 2010). Women's entry into IT education needs to take place before students make their major choices (Beyer et al., 2004). An important task is to make IT jobs more attractive through recruitment and retention strategies (Ross and Thomas, 2008). In fact, most of the research on women and IT has been focused on the absence of women, rather than their presence (Blomqvist, 2010). The future of IT is dependent on the research and interventions that aim to find out what works and for whom, addressing the needs of underrepresented groups and generating theoretical inferences and practical applications for policy makers (Zarrett and Malanchik, 2005). Important is also to understand and appreciate individual differences. Different theories have been used to explain women's part in IT: the essentialist perspective focuses on biological gender differences; the social construction perspective focuses on IT as a male domain, incompatible with female identity; there is also a newer theory focusing on individual differences between women (Trauth et al., 2004).

4.2 Interaction Order

When it comes to interaction order, research has found various influencers for girls' career choice: family, friends, peers, significant others, guidance counsellors, teachers from all levels, and role models (Rommes, 2010; Zhang, 2007; Turner et al. 2002). These actors can influence girls in their homes, at all levels of educational systems, and organizations where women work. Attitudes of family and friends create social pressure (Scragg and Smith, 1998). Actors can be encouraging or discouraging; there is variance in the studies in who is a positive or negative influence on girls. For example, one

study indicated that parents, friends, or classmates rarely encourage women to choose or persist in computing, and the women who do make the choice typically lack support through their education (Cohoon, 2002). However, another found that parents and friends were mostly encouraging (Turner et al., 2002). This shows that the studies have controversial findings on what type of social arrangements exist in our societies and how they shape girls' choices.

Researchers have long discussed how the male-dominated environments in IT treat women; on one hand women do not feel welcome, and on the other they refuse to join the "techies". (Cockburn, 1983). Gender-dominated environments should reflect and challenge their patterns, narratives, and social and cultural orders of technology. If women are to enter the IT field, they cannot change this alone; the discussion and change must come from men. (Vehviläinen, 1999). Fathers, male peers, and male siblings have a significant influence in motivating women to take part in tinkering activities and providing scaffolding (Smith, 2000). In unfavourable conditions, the weakly committed and unsupported leave, in IT they are often women because they do not tend to receive the same level of support than men do (Cohoon, 2002). Researchers seem to agree that men need to play their part in welcoming women into technological fields.

Some women have entered scientific and technical fields despite gender dissonance, and paid a social price for choosing to be unique (Martin, 1999). Women employed in masculine environments need to keep proving themselves as women in order to keep their identity, which can be difficult while being professional and "one of the guys" (Boivie, 2010). Women are often masculinized when they become technologically competent; they are no longer viewed as social and people-oriented, heterosexual, sexually attractive to the opposite sex, or good for society in general (Rommes, 2010). Women may disregard IT careers because they would not be taken seriously and they would lose the society of other women (Cockburn, 1983). Women can, though, gain self-confidence and professional pride from working in a profession that is thought to be difficult for women, and being involved in IT can make women feel special or admired (Rommes, 2010; Turner et al., 2002). Women in masculine domains may also take various positions, instead of a position solely based on gender-specific patterns.

When it comes to family influence on career choice, the consensus is that family is a significant factor in girls' decision-making. In addition to genuine interest in IS, family influence is the main reason for women to choose the major (Croasdell et al., 2011). Students' career options and entry into technological fields are strongly influenced by their parents' opinions, encouragement and exposure to technology (Lang, 2012; Wang et al., 2015), and their perceptions of parents' support influences beliefs of value and efficacy (Vekiri, 2010). Because parental involvement has a positive effect on choosing an IT career, parents need education in career possibilities (Adya and Kaiser, 2006).

Researchers often discuss family influence as a unit, or concentrate on the role of fathers, while the role of mothers, siblings, or other family members is given less attention. A significant number of women in the IT field have had a father in a technical occupation, and a majority of women identify males, especially fathers, as significant influence in their career choices. (Adya and Kaiser, 2005, 2006; Crombie, 1999; Lenox et al., 2012; Smith, 2000; Turner et al., 2002; Wang et al., 2015). Fathers can influence their daughters by encouraging girls to engage in technical activities; by playing computer games, introducing new things on the computer, encouraging to set up computers and to consider computing careers, and leading by example by working in technical jobs (Pau et al., 2011). When it comes to mothers, they are mostly in non-technical occupations and the influence is described as generally encouraging or as setting an example (Turner et al., 2002). In fact, few women with IS degrees mention female influence (Serapiglia and Lenox, 2010). Educated mothers are more likely to have an influence on career choices, but fathers are still more significant when it comes to computing careers (Adya and Kaiser, 2005; Smith, 2000). Some studies address the role of siblings in particular: 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).

Teachers from different levels of educational systems can be encouraging or discouraging and there is

a consensus that educators have a significant impact on girls' choice to pursue IT careers. Teachers influence students' beliefs in their own abilities (Vekiri, 2010). Teachers from elementary school to college are important influencers in women's choice to major in IT; the most discouragement that women had received was from guidance counsellors and male professors (Turner et al., 2002). In post-high school studies, undergraduate students' professors are an important factor influencing major choice in IS (Zhang, 2007). Faculty can discourage women with thoughtless remarks or expectations based on assumptions that men's behaviour and experience are needed to succeed in IT (Cohoon, 2002). The low numbers of women in IT should motivate educators and policy makers to improve their programs, give teachers counselling, technological training, information about career options, and enable interaction between universities and industry (Adya and Kaiser, 2006). Improving girls' participation rates will not be possible if education programs do not prepare teachers for educational reforms that challenge the common explanations for girls' behaviour (Rowan and Lynch, 2011).

A study about role models found that encouragement could improve feelings toward the field, and particularly women felt that role models and mentors help keep them interested (Kahle and Schmidt, 2004). Meeting high profile role models could work as inspiration for women students in IT (Dee and Boyle, 2010). While role models are described as important influences on girls' career choices, studies offer different ideas of what type of role models are most effective. A study indicated that while female role models can be effective in retention of women, role models of either gender can be effective in recruitment (Drury et al., 2011). Another study found that influence of male role models is significant in the major selection and completing a degree (Serapiglia and Lenox, 2010). Students are more likely to choose careers in which they have role models they can identify with, and gender-matched role models are more effective, however (Buck et al., 2008). It may be that the influence of fathers and peers as role models will remain the same, but mothers' influence will increase as women achieve higher levels of education – and the number of women in higher positions and male-dominated fields increases (Adya and Kaiser, 2005).

The discussion about role models for girls seems to focus on discussing their general lack of existence in IT. The way IT professionals are represented in media (entertainment and news) is one issue in creating and enforcing stereotypes. Media (movies, television series, music, and commercials) constructs social reality and affects the construction of culturally dominant images that affect social behaviour - soap operas can influence behaviour as well as choices of profession when adolescents are developing their identities and looking for role models (Rommes, 2010). Changing the way computer personnel are depicted in media could help change the image of IT; girls' magazines could be used to alter the image of technology so it would be seen as fun and worthwhile – and a career option (Thomas and Allen, 2006). It seems that women in the industry are not visible, and thus they cannot be seen as role models. Their contributions may not be well documented, but women have played an important role in designing and programming the first electronic computers and languages. (Gürer, 2002).

Male peers are described as negative influencers on girls' career choice, and girls have few female peers in studies or work in IT. The peers mentioned are mainly other students in schools or universities, friends from other social circles, and co-workers. Most women are not encouraged to pursue an IT career; they may even be discouraged by male peers (Kahle and Schmidt, 2004). The main reasons why women do not choose an IS majors are job related factors and the influence of fellow students (Croasdell et al., 2011). The few women who choose IT education and careers have few female peers for help, and other students might consider them odd (Cohoon, 2002).

4.3 Historical Body

Aspects related to historical body can also be found from existing research, such as experiences with IT, traditional and cultural norms and stereotypes, and the image of the IT field that influence high school girls' career choices regarding the IT field (Beyer, 2014; Fisher et al., 2015; Halberstam, 1991; Sackrowitz and Parelius, 1996; Silverman and Pritchard, 1996). Research in women's underrepresentation in the field shows that there are gender differences in computer self-efficacy, stereotypes, inter-

ests, values, interpersonal orientation, and personality (Beyer, 2014).

Traditionally men have been inventors and designers, and women have been users and consumers of technology, and this Western division of labour results in gender division in expectations, experiences, and education (Bush, 2009). Women's contribution to the development of IT through design and programming has not been well documented (Gürer, 2002). Programming is seen as masculine as it is compared to mathematical problem solving (Boivie, 2010). This masculinization creates barriers for women, but does not eliminate their participation (Ensmenger, 2010). Gender identity is a significant factor in female students' choice of majoring in IT (Serenko and Turel, 2016): in general, men find more positives in choosing IT as their major than women, and primary influence for men tends to be interest in computer games, whereas women intend to use IT on other fields (Carter, 2006).

Researchers have discussed the significance of gender roles in major choice and occupation, and traditional roles seem to have a significant influence on girls. Traditional gender divisions reinforce models of gendered labour where men write programs and women process words (Halberstam, 1991). Women's underrepresentation in IT is caused by unconscious behaviour, which occurs in the gendered ways that children are raised, female stereotypes, biases women face, problems working in male-dominated environments, and sexual biases in language (Spertus, 1991). Domestic responsibilities can constrain women's possibilities to achieve high-level positions, since managerial work requires long hours (Melkas and Anker, 1997). Traditional work role expectations in women's efficacy persist in IT, and if organizations want to attract and retain women, they must address gender role biases and create work environments that build self-efficacy expectations for both genders (Michie and Nelson, 2006).

Stereotypes of IT jobs affect high school students' decisions to enrol into IT education. Girls' lack of interest stems from stereotypes of the field; the field and computing subjects are seen as boring (Anderson et al., 2008; Blomqvist, 2010; Graham and Latulipe, 2003), and girls show an aversion to computers in general (N. Anderson et al., 2008). They also believe that women are not treated well in the industry (Blomqvist, 2010). Only girls willing to be "pathbreakers" who challenge stereotypes choose IT (Silverman and Pritchard, 1996). The stereotype of the IT field as male-oriented, socially isolated, machinery-oriented, and requiring natural abilities or brilliance can be altered by broadening the image of the people, work, and the environments, and by increasing girls' sense of belonging (Cheryan et al., 2015). More women in work and leadership positions should reduce the problems that arise from gender stereotypes (Adya and Kaiser, 2005). While the IS discipline can be considered to be more feminine (due to the perception of a greater social component), the stereotypes and educational prejudices exist in the IS field as well (Joshi and Schmidt, 2006).

Values, perceived ability, and expectancies are reasons for why women do not get into computing (Zarrett and Malanchuk, 2005). With an absence of IT experiences, girls feel they lack abilities and self-efficacy, and assume they cannot succeed in the field. Hands-on learning, exposure to technology, and an interest in a technological career are motivating factors for both genders (Silverman and Pritchard, 1996). Girls feel less confident and more anxious with computers, due to less experience and practise than boys (He and Freeman, 2010). Positive introduction to IT in homes and schools influences career choice (Serapiglia and Lenox, 2010). Positive experiences and perceiving learning activities as meaningful and creative can increase interest in computing. (Beyer, 2014; Vekiri, 2010). Researchers agree that girls need more information and experiences related to IT early on.

Another reason why girls might not choose IT related fields is misperceptions of what professionals in the field do and what skills they need (Adya and Kaiser, 2005). Most women are not exposed to the field until college, and unfamiliarity may be a reason why girls do not consider enrolling in IT (Kahle and Schmidt, 2004). The diversity and career paths of the IT field are not familiar to many pre-college students if their parents are not employed by the industry (Guthrie et al., 2011). Students' perceptions of IT jobs are incorrect or non-existent, they assume jobs consist of sitting in front of a computer all day, and the lack of knowledge affects career choice. The ignorance stems from a lack of education in high schools, which could show IT's applicability in other fields. (Carter, 2006).

Recruiting and encouraging girls into IT in high schools is important, but computer education is not a

compulsory subject in most curricula (Craig et al., 2014). To be more effective, interventions need take place early on, before biases and inaccurate impressions impact major choice; middle and high school students are less likely to have committed to a major than college students (Anderson et al., 2017; Zarrett and Malanchuk, 2005). Students' knowledge of IT careers comes from school, so it is important to determine if the representation of the industry is suitable for both sexes (Thomas and Allen, 2006). Encouraging girls to use computers may help overcome the biases in society that are visible already in children's toys and computer games (Spertus, 1991). Age affects career choices; younger adolescents make more stereotypical choices, and as we mature, our identities become stronger and sexuality or fitting in are not as important (Rommes, 2010). The main problem is that girls are not interested in IT, largely because of the image of the field. Television and newspapers paint that image as they produce a social reality with gender relations (Blomqvist, 2010).

Uniqueness and adventurousness have been used to interest girls in IT careers. The problem is that this ignores the young women's internal needs when they are self-conscious, and they think that entering the IT field would make women less feminine (Thom et al., 2002). Attempts to inspire girls to study IT showed that girls do not need to have the subject presented in a tailored manner; the problem is that the information has not been given to girls at all (Craig et al., 2013). A long-term intervention program in secondary schools was able to increase girls' interest and confidence in IT, and found that girls enjoy the subject if it is presented in a way that resonates with them (Fisher et al., 2015). The reason students do not choose IS careers is that they do not think that they could fulfil work values: social interaction, work-family balance, and job security. Informing students that IS careers are not technological in nature and offer leadership opportunities to the business minded could change opinions. (L. Jung et al., 2017). Genuine interest is an important reason for women to enter the IS field, and academic institutions and employers could support it by addressing misconceptions about IT and emphasizing various career paths (Croasdell et al., 2011; Zhang, 2007).

5 Concluding Discussion

The low number of women in IT is a concern for European IS researchers and educators, among others. Despite a vast body of research generated during decades, the problem persists. This is a challenge for the society in general and detrimental from the viewpoint of IS workforce; it needs attention from IS education. This literature review aimed at offering a fresh perspective on this old yet current topic by inquiring *what seems to shape high school girls' career choices as regards IT field*.

5.1 Summary of the results

We maintain that use of the nexus-analytical concepts – discourses in place, interaction order, and historical body – enabled us to get a fresh view to the issue at hand. These concepts enabled to systematically map significant issues affecting girls career choices. The *discourse* lens helped make visible the significance of both societal and *in situ* discourses circulating around the topic, many of them discouraging girls to pursue a career in IT. We also made visible how researchers engage in constructing this topic, attaching particular meanings to it and legitimizing their studies. The central discourses (Table 1) draw a picture of the IT field as unsecure, stressful, and unwelcoming to women (see Pretorius and de Villiers, 2009): work-family balance is problematic to women who have traditionally had domestic roles and may still choose to prioritize family issues high; the field is seen as male dominant in preferring technical skills to people skills, which have traditionally been considered as feminine qualities, whether that is true or not (see Halberstam, 1991); and it is a norm that the field is male-dominated and does not support female identity. When looking at the existing research through the lens of *interaction order*, a variety of actors could be identified to shape girls career choices, both consciously and unconsciously (Table 1). Family, especially fathers were positioned as significant, but teachers and peers played an important role, too. The existing research also provides conflicting evidence on the influence of these actors: sometimes they have been seen as encouraging, other times discouraging girls in the IT field. There is a contradiction in what is expected from women: on one hand, female

qualities are seen important for the field (e.g. Blomqvist, 2010; Oudshoorn et al., 2004), on the other hand, the culture of the IT field does not support them or invite women to the field (e.g. Gill and Grint, 1995; Grint and Woolgar, 1995; Turbin and Johnston, 2013). The lens of *historical body* specifically directs attention to existing cultural norms, assumptions and stereotypes that still seem to hinder girls' interest in IT (Table 1). Toys and upbringing practices together with basic education of children are still quite gendered and definitely make an impact. Role models and positive media content are still lacking. Instead of renewing the history with persisting findings on cultural norms and assumptions we encourage the IS community to take transformative actions of spurring and engaging – right now.

Discourses	Interaction order	Historical body
The field dominated by men, requires technical rather than people skills Imbalance a cultural norm (men got there first) The field incompatible with women's identity Industry changes fast and continuously, leading to unsecure job situation and stress Work-family balance does not accommodate women's traditional domestic roles	Different actors influence girls' choice subconsciously, through subtle remarks and expectations Controversial findings on whether families, teachers, peers and classmates encourage or discourage girls into IT Family – mostly positive influences, attitudes and examples from home. Fathers a significant influence. Mothers or siblings not spoken of much. Women do not feel welcomed in technological working environments – men in significant position affecting this Peers - boys can discourage girls, but girls may also be admired and receive positive attention; few girls in the field to rely on for support; girls in IT may be isolated from their female peers Girls not willing to join the 'techies' Teachers from all levels of the educational system increase or decrease girls' interest and confidence in pursuing a career in IT Role models (women or any gender) significant influence; seeing someone one can relate to important – however, women in IT may also enforce existing image of the field	Traditional gender roles and stereotypes: traditional work role expectations prevent women from pursuing IT career; women traditionally seen as users only Assumptions and stereotypes about IT: girls' negative associations with IT; technology perceived as masculine Lack of role models Image portrayed by media negative and gendered Experiences with IT: girls' limited experiences with IT and perceived lack of abilities and self-efficacy discourages them to pursue an IT career Interest in IT: girls' lack of interest in IT; IT perceived negatively

Table 1. Findings from nexus analysis of aspects affecting girls' career choice as regards IT

5.2 Implications for IS Research

From an IS research point of view this paper has interesting implications for future research, both topic and method wise. Overall, we need fresh viewpoints to better fight against the already too visible cultural barriers for girls to enter the field. The longer it takes the harder it gets (Spender, 1997); time seems to be the enemy in this. As actors *in situ*, we need to do more. Making sustainable improvements for the future is needed. As authorities in the IS field, we need to arouse awareness that each of us needs to look in the mirror and ask ourselves: what can we do to have girls and young women really consider themselves both having equal capabilities and opportunities to control the digitalisation of their lives as well as being important shapers of this society, perhaps making it more caring as well.

We have identified a number of discourses prevailing for decades, numerous actors, and historical body affecting girls' career choices. All our findings come from literature addressing the IT field. However, many of the findings apply in other fields as well: girls career choices in general are shaped by their backgrounds, life experiences, education, friends and families, and discourses circulating around. Then again, there are issues that might be specific for the IT/IS field, such as societal discourses that paint a negative picture of the field for women, the strong male influence on the career choice, and the girls' lack of interest, experience, and self-efficacy. We think a systematic and rich appreciation of aspects shaping girls career choices as regards IT is valuable right now. The rich and wide texture shaping up from these findings makes the complexity of this issue more tangible and concrete. Previous literature reviews have focused more narrowly on, for example, the effect of school

environment (Volman and van Eck, 2001) or different life stages of women (Oehlhorn, 2017), while we provide a comprehensive view of different influences in high school girls' choices, showing the wide array of historical, environmental, societal, structural, cultural, interpersonal, and personal factors behind their choice. Noteworthy from our analysis is that there is plenty of research on this topic, yet with questionable impact so far. However, we believe our new way of organizing this literature, using the concepts from nexus analysis as our analytical lens, takes a valuable step forward regarding this complex issue.

Nexus analysis leads us to consider both intentional and unintentional issues affecting the choice processes. In the literature we reviewed, it seems that the older sources talk about alienation and exclusion of women in IT in a more explicit, direct or intentional sense, while newer literature discusses the culture and environment as unintentionally unhospitable to women. Along these lines, the concepts of discourses in place, interaction order, and historical body all indicate that there are many factors looming in the background, influencing the social action in question in very subtle ways, without anyone intentionally aiming at excluding women in IT, quite the opposite. The existing literature has acknowledged these subtle influences, to an extent (Cohoon, 2002; Gill and Grint, 1995; Rommes, 2010; Scragg and Smith, 1998; Silverman and Pritchard, 1996), while we see a lot of interesting research opportunities ahead along this path: we need to study our contemporary discourses – at societal level as well as *in situ* in schools and at homes – that position girls in relation to the IT/IS field in particular ways. We need to study the variety of actors shaping the choice processes and how their presence encourages or discourages girls in subtle ways. We need to examine girls' lifeworld more broadly and experiences within, in which attitudes, expectations, and understandings of IT and the IT field as well as particularly of the IS field have been and are continuously forming. We need to scrutinize the IT related education offered for girls in their basic education as well as the profound influence of leisure time activities and activities at home. The stereotypes, norms, assumptions, and role models given by teachers need to be critically reviewed. Usually teachers do not have an in-depth understanding of the IT field and they do not have a clear understanding of how IS differs from IT. Educating them would be significant. More importantly still, we need to focus on girls themselves: we need to gain an in-depth understanding of their technology-rich everyday life and meanings making around IT and the IT field. We see a lot of interesting opportunities for future IS studies. We encourage new data collection: e.g. interview data about either the actual life stories behind women already studying the field or the school girls making their career plans (when, what, why, etc.). Observational data supplemented with reflective *in situ* questions in the school context might enrich our understanding of the different contexts in which girls' career choices emerge and evolve. Supported with further interviews, these findings might lead to more focused future interventions with better impact.

A noteworthy observation was that male influence was emphasized as regards the actors shaping girls' career choices. Fathers and male peers were discussed a lot, while mothers' role was less acknowledged. Peers and role models were seen as lacking, and girls were seen as being alienated from their female peers if choosing an IT career. We invite IS research particularly addressing the female actors' contribution in girls' career choice – considering if and how other females can encourage girls into IS. Future research is also warranted to address the conflicting findings of the current research. There was unclarity as regards the different actors' influence. Some of this unclarity might be due to time difference between the studies, but we also assume that with such a complex topic, unclarity still prevails. Historical, social, societal, and cultural issues all play a role, and their significance needs to be examined in more depth. Individual and contextual differences need to be acknowledged – girls for sure are not all the same and even Europe actually includes a variety of cultural contexts with differing educational systems, family situations, job markets, and societal arrangements. Nexus analytic studies on particular constellations are warranted – showing how all this shapes girls' career choices in certain time and place. However, also quantitative studies addressing the population more broadly are valuable for the purpose of helping explain the conflicting findings.

We also call for IS researchers to do qualitative, interpretive investigations as well as design-based interventions into children's and young women's career trajectories in the context of their everyday

life, before they make up their minds about the first subject of their occupational education. As an alternative for searching for even more new static factors encouraging or discouraging girls into the field or making IS curricula more attractive, we should link the processes of girls' identity making with the urgent need of human touch in the increasingly technology-rich environment and society. We suggest viewing young women's career choice as a dynamic, emergent and multidimensional process (see Jung and Lyytinen, 2014), within which the influence of discourses circulating around, the variety of actors involved in the process and the prevalent as well as continuously accumulating historical body of the participants (Scollon and Scollon, 2004) should all be considered. We also encourage more concrete design-based interventions to be experimented with by IS researchers. The nexus analytic concepts of discourse in place, interaction order and historical body are valuable when planning and implementing such interventions targeting girls but also when reflecting on and analysing the results (Molin-Juustila et al. 2015). Inspired by cultural probes (Gaver et al. 1999) and critical design (e.g. Iivari and Kuutti 2018) approaches, IS researchers could try to address the discourse in place, interaction order and historical body related issues shaping girls' career choices in collaboration with girls. In those interventions, we should try to encourage them to reflect on the aspects shaping their choices as well as to consider alternatives and potentially challenge some of the aspects. Our interventions should make future opportunities in the IT field more visible for girls, arouse their interest and self-reflection – encourage them to reflect on their assumptions, practices, values, and worldviews as well as to potentially question or challenge those – and generally invite girls to explore, envision and construct speculative futures and alternative presents for women in IT (see Iivari and Kuutti 2018).

5.3 Implications for IS Education

From IS education point of view, this paper introduces three significant issues to be tackled: early IS education to be offered during children's basic education; student marketing to arouse girls' interest to enrol; and IS education and curriculum to sustain girls' interest and motivation.

IS research has not considered children's education as a concern of us (see also Iivari et al. 2016). It is clear that action needs to be taken with high school students at the latest, if not even earlier. IS discipline and profession need to be made visible for children, among other IT related fields. Children should become aware of the social, organizational, and business aspects that are significant in IS, in addition to pure technology. Especially for girls, such aspects seem to arouse interest (Carter, 2006; Guthrie et al., 2011; L. Jung et al., 2017). So far, IS education has let STEM education to address schools and children, but due to this, IS remains invisible as a career choice for children. IS education should be proactive here: we should develop campaigns and interventions addressing the young generations and specifically arousing girls' interest in this fascinating profession and discipline in which a true difference in people's lives can be made, instead of developing technology just for the sake of it. Interventions need to take place early on, to prevent misperceptions about the studies and career options in IT from setting in. High school is the last stage of education in many countries to influence girls before they make their choice and commit to a major in university studies.

This issue is strongly connected with student marketing, which should address high schoolers in particular. In the marketing, it should be kept in mind that the image of IT work is certainly not appealing to young girls. A major problem is that students do not have an opportunity to see what IT work entails before they make their career choices. It is important that different career options are presented to girls early on, so that they see the variety of options. IT industry should be invited to contribute, too. If the industry wants to increase the number of women, the industry needs to become involved in showing girls the enticing aspects of IT career, including the fact that there are people- and business-oriented jobs in IT, within which it is possible to truly help people and communities. Families and teachers should also be educated in IT career possibilities. Positive role models from industry are needed as well as IS institutions, who are to take the lead in this work. Media could also pay more attention in how they portray IT professionals.

IS education at the university level, moreover, can make a great difference as regards girls' career

choice. The courses offered need to be such that they encourage girls to continue their studies as well as arouse further interest. Gender sensitive education is needed – considering the very subtle issues such as discourses circulating around and norms and stereotypes looming in the background. The curriculum needs to be designed in a way that sustains girls' interest that has been aroused during the student marketing. Not all girls are motivated by people and business aspects, there surely is a lot of individual variation, but if such aspects are emphasized in the campaigns targeting high schools, those should be in the forefront in the actual education, too. Then again, if girls are genuinely not interested in IT even after they gain a realistic image of what the industry has to offer, they should not be pushed to choose IT careers, of course. Skills and competencies in IT will be valuable almost in any field these days, as IT is everywhere, and hence the benefits of IS as a minor subject should also be made visible for girls. In any case, researchers agree that girls need to be given support from family, peers, educators, and employers if they are to join the male dominated workforce. Studies have shown that when girls are given the opportunity to gain experience in IT subjects, they fare as well as males, and if the experiences are positive they can show the girls that you do not need to be a male to succeed in this field, and that there are various positions to take in the industry (or other industries).

6 Conclusion

As a summary, it can be said that despite all good work of different actors to entice young women to consider the IT field as a welcoming career choice, the situation seems to be going to even worse direction as the decreasing number of women working in the IT field shows. Clearly, we need to do something else to change the situation. It is important to understand and address these issues, so that half of the population are not discarding a field they may excel at, only because of their gender. It is also important to have diversity in the construction of our increasingly digital realities to ensure equality or we end living our digital lives in the world almost fully constructed from the viewpoint of one sex only. IT and related fields are indeed in a worse situation than other STEM fields, and their reputation has an impact on IS as well, at least in many European countries. Finding a solution for companies' increasing need for skilled employees is also important for economies all over the world. There have been qualitative efforts to study this topic, but we call for even more in-depth qualitative and design-based inquiries. We need to link our efforts to children's life world better to reach them and to arouse their interest. Current significance of social media in children's lives seem to be an underutilized opportunity. It is an open question are today's young girls, who live 'in the web', are always online, and use technology all the time, influenced by the gendered division of labour or the masculine picture of IT anymore. Technology is definitely a part of their everyday lives. We also put our hope to the increasing lack of workforce in the IT field as well as to the increasing consciousness within companies and the whole society that it is just smart to have women working in the IT field, wishing that these factors push the change forward in different fronts and we will finally gain some real results.

As to the limitations of the study, due to the high amount of previous research on the topic we have excluded certain areas of research, e.g. the influence of cultural issues, from our analysis. It also needs to be noted that different authors may use the same terminology, but because different cultures and countries might have different ideas of what counts as IS, IT, or CS, the studies can be very different. We have tried to take this variety into account in our analysis. Moreover, while many of our findings seem to be applicable to other fields than IT as well, our research solely relies on articles addressing the IT context.

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