PROGRAMMED OUT:
THE GENDER GAP IN TECHNOLOGY IN SCANDINAVIA

WHAT ARE SUCCESSFUL WAYS
TO GET MORE GIRLS INTO TECH IN SCANDINAVIA?

INDEX

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FOREWORD

No country in the world has so far succeeded in achieving gender equality. With the current development, we will not see a world with equal rights for men and women in our lifetime. Gender inequality is especially apparent within the field of digital technology. Technology has arguably never been more influential than it is today. Half of the global population is online, and almost every aspect of our economic, political and social existence is digitalized. The creators of digital technologies are overwhelmingly male. Across the world, women are underrepresented in Science, Technology, Engineering and Mathematics (STEM) and computing classes and careers. In the Scandinavian context, we are experiencing one of the highest technology gender gaps in the world.

Plan International is the leading girls' rights organization globally. We are experts on gender equality, sustainability and reaching out to the most marginalized children in the world. Telenor's core competence is mobile communication and technology. Together, we can use technology to close the digital gender gap for girls and break down barriers that prevent poor children reaching their potential. As mentioned above, there is a severe gender imbalance in the creation of technology in Scandinavia. Through our partnership, we are working to reduce the imbalance so that technology becomes a driver for gender equality.

With the support from Telenor, Plan International has commissioned this report in order to identify successful ways of getting more girls into technology in Scandinavia. The report identifies barriers that limit girls and young women in relation to technology and maps out successful initiatives that can support girls and women to pursue careers in technology in Sweden, Norway and Denmark. Plan International sees tech companies as powerful allies in addressing gender biases in our society. It is our goal, that the report will provide evidence and guidance for the tech industry so it can support equal opportunities for young women. Our hope is that it motivates tech companies to join in our mission to create gender equality!

Kari Helene Partapuoli

Kari Helene Partapuoli
National Director, Plan International Norway

1. WHAT:

AN INTRODUCTION TO THE GENDER DIVIDE IN TECH

FRAMING THE STUDY

Fewer young women in Scandinavia are choosing to study STEM subjects and pursue careers in tech than young men. As a result of this gender divide, the recruitment pool of qualified tech workers here isn't large enough to keep up with rising demand, and Scandi-created digital technologies risk being gender-biased. The number of initiatives seeking to build girls' digital skills to ensure a more equal technological future are growing. However, there is a lack of in-depth analysis of «what works» in addressing the digital gender divide in Scandinavia. This report maps existing evidence, identifies evidence gaps and presents new insights gained from speaking to experts and girls engaging in science and technology in Scandinavia. To conclude this report provides recommendations for tech companies wishing to help get girls further engaged in technologically relevant education and careers in Norway, Sweden and Denmark.

STUDY AIM

This research focuses specifically on Norway, Sweden and Denmark, and seeks to find out «what works» in terms of getting girls into tech in these national contexts. The aim is to fathom how tech companies in particular can best support diverse girls and women to study STEM in these countries, including computing and programming, and ultimately build long-lasting careers as «creators» in the digital technology sector.

Whilst overcoming the gender divide in digital technology creation in Scandinavia will require the co-operative efforts of multiple stakeholders, including of course various players in the education sector, the role that tech companies can play has hitherto been comparatively neglected. This is surprising, as tech companies have a unique role to play in this movement to equalise digital technology, and also stand to gain a great deal from doing so. As discussed in more detail in Section 2.1, diverse teams create technologies that are less biased and better serve the needs of the wider population, and they do so in a more efficient, innovative and profitable manner. There is also a growing skills shortage in Scandinavia - the tech sector continues to expand, but there simply aren't enough workers to fill available vacancies. Tech companies could do more to support young women to pursue further study in STEM and become successful technology creators, bringing big benefits to all involved. It is for these reasons that Plan International sees tech companies as powerful allies in addressing gender bias in the technology sector. The commissioning of this report demonstrates Plan's commitment to working with the Scandinavian tech industry, providing evidence and guidance as to how the sector can best support equal opportunities for young women.

METHODOLOGY

The research conducted for this report combines primary and secondary data collection and analysis. Initially, a comprehensive desk review was conducted involving the examination of relevant qualitative and quantitative data, including both academic and grey literature, to identify key characteristics of the gender divide in Scandinavia and key drivers of, and tested solutions to, the issue. Where possible case-studies from Scandinavia were utilised, but at times studies from elsewhere had to be drawn upon. The literature review identified numerous gaps in knowledge (See box below for more detail).

Key themes highlighted in the literature were then drawn upon to construct the interview and survey questions for the next stage of the research. During this primary data collection stage, 15 interviews were conducted with experts within the field (five each from Norway, Sweden and Denmark). These experts were identified from the key literature, web-searches, and «snowball sampling» – i.e. one expert recommends another two experts, who recommend another four experts etc. 15 in-depth interviews were also conducted with girls and young women (five from each of the three target countries) who have been part of different tech events, or are undertaking STEM education in Scandinavia, to get a sense of their experiences and reflections on what it means to be a young woman in tech. Lastly, an online survey was constructed, drawing on the literature reviewed and key themes highlighted in the interviews. This was circulated within networks spanning all three countries of focus to get further wide-scale insights into how best to address the gender digital divide in Scandinavia . This data strengthens the conclusions drawn from the interviews.

1 *Science, Technology, Engineering and Mathematics*

GIRLS AND TECH IN SCANDINAVIA - WHAT DON'T WE KNOW?

Whilst there is a vast amount of literature on girls and technology globally, and a growing pool of Scandinavia-specific research, the desk review conducted for this report revealed a lack of rigorous evidence as to «what works» in recruiting, retaining and advancing women in technology studies and careers. Studies exploring «why» girls are less likely to follow a technological path are growing in number, and some evaluations of initiatives designed to address the barriers girls face can be found. However, large-scale, longitudinal studies that track the effectiveness of, for example, technological mentoring programmes for girls are in short supply. For the gender divide in technology in Scandinavia to be overcome it will be necessary to invest in strategic research to test proposed solutions to the issue. Another key gap identified was the lack of literature examining how gender intersects with other identities, such as economic status and ethnic background, to further compound disadvantage in tech. Whilst this report aimed to take an intersectional approach to gender and technology in Scandinavia, it was challenging to do so based on current evidence. This is an area of research that is greatly needed if the technology sector here is to enable all, rather than some, women to flourish within it.

REPORT STRUCTURE

Section 1 of this report has introduced the overall framing, aims and methodology of this study, including a brief discussion of «what» the gender digital divide is. Section 2 then establishes «where» this study is focused, going into more detail regarding the gender digital divide in Scandinavia specifically. Next, section 3 explores «**why**» the divide in technology education and careers for Scandinavian men and women has come about, focusing on the barriers young women face in this sector. Section 4 then moves on to discuss «**how**» we might overcome these barriers through establishing the evidence as to «**what works**» in supporting young women in STEM. Finally, Section 5 concludes by responding to the initial study aim of identifying how tech companies can best support young women in STEM through outlining the main recommendations drawn from the findings.

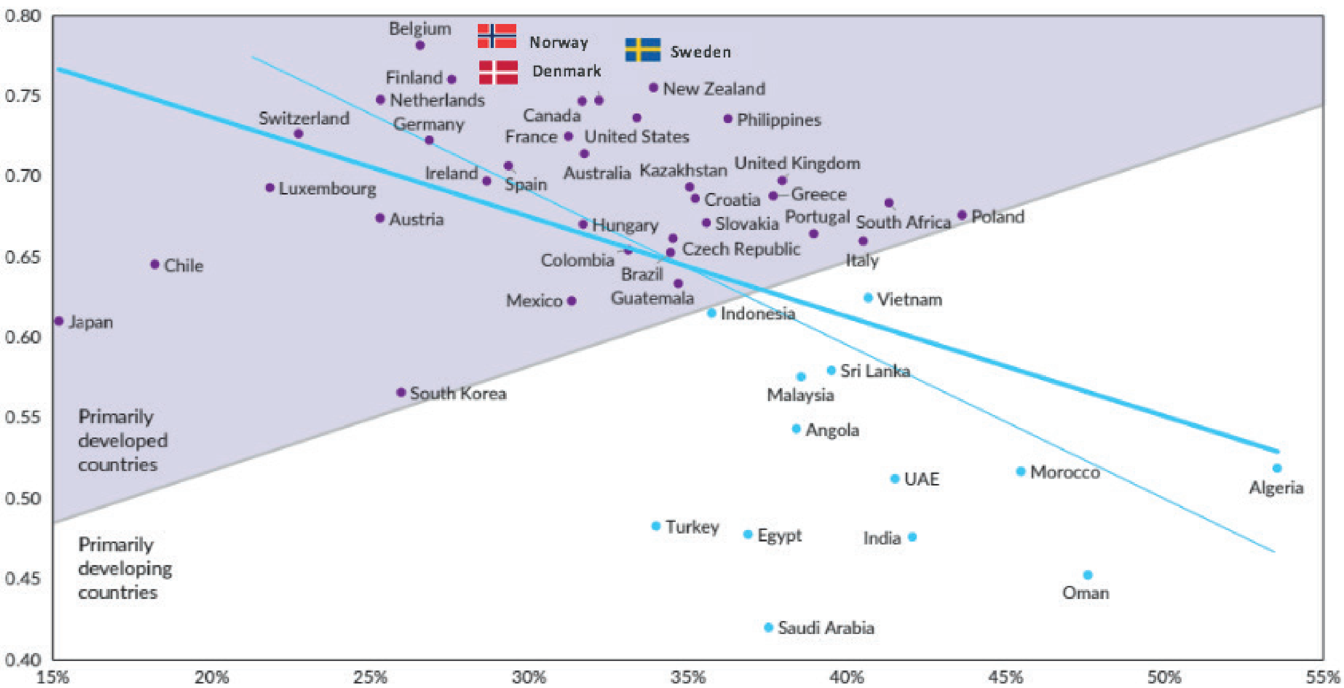
2 In total the survey had 172 respondents, 50 from Denmark, 61 from Sweden and 54 from Norway

2. WHERE:

THE SCANDINAVIAN CASE

The gender gap in technology is not solely a Scandinavian phenomenon. When comparing data across 35 European countries we can see that only 1 in 5 computer science graduates are women (OECD Gender Data Portal, 2018). And yet, the gap in Norway, Sweden and Denmark is particularly wide. The Relevance of Science Education (ROSE) project, based at the University of Oslo, found through surveying 40,000 students in 40 countries that the gender gap in positive attitudes towards science and technology is greater in higher income North-European countries such as the Nordics (Sjøberg and Schreiner, 2010). More recently, Stoet and Geary's (2018) paper on the «gender equality paradox» demonstrated that, perhaps surprisingly, the more «gender equal» a country is, the larger the gender gap in STEM education and careers. Norway, Sweden and Denmark are exemplary of this phenomenon. As the graph below demonstrates, from a global perspective the gender gap in technology is roughly split between «developed» and «developing» countries. Japan, Chile, Luxembourg, Switzerland, Austria and South Korea are all countries with lower rates of female STEM graduates than Scandinavia. Yet whilst Norway, Sweden and Denmark average a 30-35% female share of STEM graduates, in Algeria over 50% are women, and Oman and Morocco are not too far behind. Stoet and Geary (2018) argue that the reason lower-income countries have a higher rate of female STEM students is that there is more of a financial incentive for parents to direct girls down this route due to the high financial return and income security careers in this sector bring. This need for financial stability is less prominent in high-income countries such as Norway, Denmark and Sweden, hence their lower rates of female STEM graduates. This is only one theory, however, and further research is needed in each setting to deduce the exact drivers behind the gender imbalance in technology in each location, taking into account gender and income, but also class, race and ethnicity, and other intersecting aspects of identity.

Global Gender Parity Score: Gender equality (parity = 1.00)[1], index



Share of female STEM graduates, Percent[2]

Graph 2.1. Gender equality and women among STEM graduates. Source: McKinsey & Company (2018) The Talent Gap. Original source: McKinsey Global Institute, 2015; UNESCO Institute for Statistics, 2018; OECD, 2018; Stoet & Geary, 2018

1 *Science, Technology, Engineering and Mathematics*

The widespread perception that Norway, Sweden and Denmark have already reached peak gender equality is likely part of the reason that the gender divide in tech here is yet to be overcome. Initiatives directly seeking to address the disparity between men and women in technological fields here are often met with confusion, disbelief and, sometimes, anger. In the survey conducted for this study, for example, one participant remarked:

«Are you guys serious about this? It is as if you think there's a problem or something? People can do exactly what they want. If more boys want to be e.g. engineers than girls, that is just fine»

The interviews carried out as part of this project yielded similar findings. Isabelle Ringnes, a Norwegian expert who is deeply engaged in various projects and networks with the objective of getting more girls to pursue a technological path, shared that:

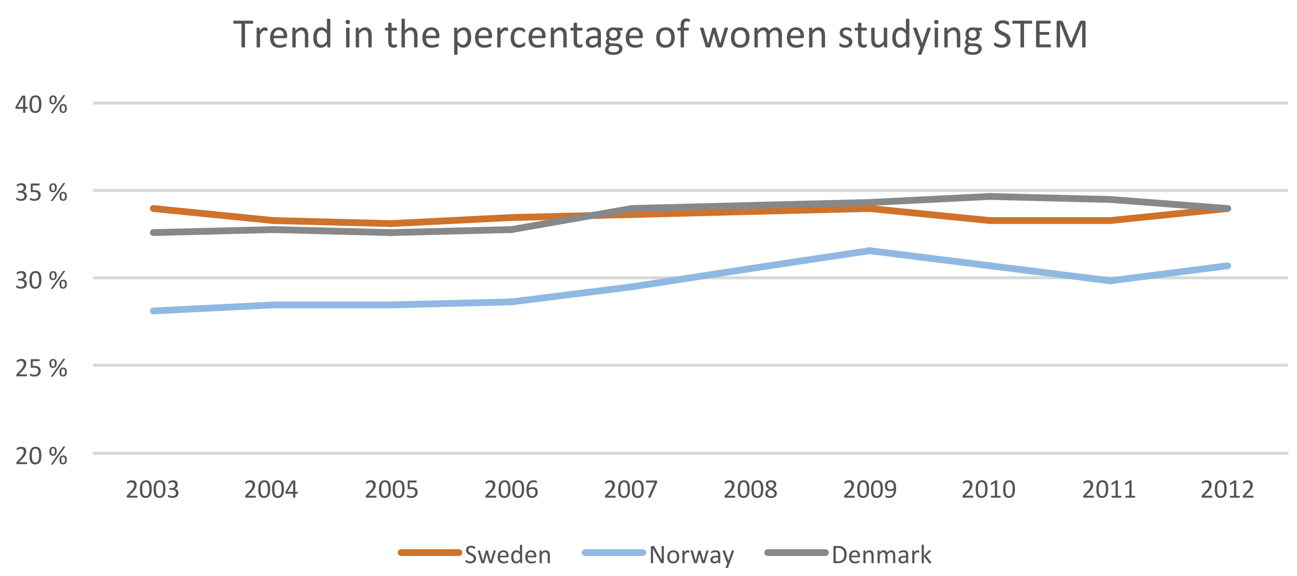
«In the beginning, there was a lot of questions about why we had specific initiatives for girls, in an equal society as Norway. So there was a barrier getting by that, getting accepted for doing what we were doing»

THE WIDESPREAD PERCEPTION THAT NORWAY, SWEDEN AND DENMARK HAVE ALREADY REACHED PEAK GENDER EQUALITY IS LIKELY PART OF THE REASON THAT THE GENDER DIVIDE IN TECH HERE IS YET TO BE OVERCOME.

Eva Fog, a Danish expert working on digital learning workshops for young women also remarked that when she first began she was told:

«You can't do that, that is gender separation!! And it's not equality, we already have equality, and you're destroying it". Then I had to tell people that well, equality requires us to be at the same level at the same time and right now we're not even at the same level. So I can't destroy something that isn't really there»

Despite the belief that Norway, Sweden and Denmark have «achieved» gender equality, and pushback against programmes seeking to tackle the lack of girls in technology here, statistics clearly demonstrate the existence of the divide.



Graph 2.2. Trend in the percentage of women studying STEM. Graph adapted from Eurostat (ISCED levels 5a, 5b and 6, and comprises the sub-groups: Engineering, Manufacturing and Construction, Life Sciences, Physical Sciences, Computing and Mathematics, and Statistics (Nordic Councils of Ministers 2016). Data available up until 2012.

As the graph above shows, the proportion of women studying STEM at University level in Sweden, Denmark and Norway remains low in comparison to the proportion of men, despite subtle fluctuations over the last decade or so.

In relation to IT studies specifically, the number of women applying for IT courses in higher education may have risen, but overall remains low. In 2015 17% of applicants to IT studies in Norway identified as women, whereas in 2019 this had risen to 26%, according to Samordna opptak (NRK 2019). Similarly, in Sweden the share of women undertaking IT education underwent only a small increase from 20% in 2008 to 23.3% in 2014 (Digitaliseringskommissionen, 2015). In 2016 this rose to 26%, a sign of some progress but also of much work still to be done to ensure equality for all in tech (Digitaliseringsrådet, 2018). In Denmark, the share of women studying IT has stagnated at approximately 27% since 2008 (Børne- og Undervisningsministeriet, 2018). The gender gap in IT education at this higher level is evidently still an issue, and directly impacts the lack of equal gender representation in the technology sector in Scandinavia.

The reasons for the pervasive nature of the gender gap in tech will be explored in more detail in Chapter 3.

WHY DOES THIS MATTER?

Whilst it's clear, then, that a gender technology divide does exist in Sweden, Denmark and Norway, proving that this is the case is only half the battle. Some may question why this matters - aren't young women free to follow the path they choose? Why does it matter if boys prefer STEM and girls the social sciences?

Yet there is a strong case as to why gender equality in the technological sector matters, and is worth investing in.

1. GENDER EQUAL TEAMS PRODUCE BETTER TECHNOLOGIES

The more diverse a team, the better it is able to solve problems, maintain high levels of productivity, think outside the box and generate increased revenue (Diaz-Garcia et al., 2013; Ellison and Mullin, 2014; Levine et al., 2014; Phillips et al., 2009). Different perspectives drive innovation, and ensure that technologies cater to the needs of a larger share of the population (McKinsey, 2018 citing Sethi et al., 2001; Egan, 2005; Woolley, et al., 2010).

Natasha Friis Saxberg, a Danish expert interviewed for this report, agreed that there is a need for diverse technology creators:

«It is also important to highlight that we need women to design this digital world because it's primarily designed by men for men, and imagine if we had diversity in the way we design IT what value that would bring to us»

One of the young Danish informants spoken to also noted that when women aren't included in technology creation this can lead to glaring omissions in final products:

«Apple has this health app and when it launched, there wasn't a function where you could keep track of your period. And it's so stupid that you don't think about that. I hear that in some debate, that it was because there weren't any women on the team. So they just forgot»

2. GENDER EQUALITY IN THE TECH SECTOR ENSURES SCANDINAVIAN COMPETITIVENESS

The talent pool for technology workers in Scandinavia is not growing quickly enough to match demand from the sector. For example, Denmark alone faces a future scarcity of an estimated 19,000 ICT specialists by 2030 (Højbjerre Brauer Schultz, 2016). In Sweden the situation appears to be even more alarming, with the country facing a deficit of 70,000 people with IT or digital related competences by 2022 (IT och Telekombranchen, 2017). Lack of IT competencies is also reflected in the Norwegian industries, where the IKT Norges annual competencies survey of 2017 revealed that 38 per cent of Norwegian companies stated that they have vacant IT positions which they have not been able to fill over the last 12 months. As many as 60% of their respondents stated that the lack of the right IT skills is the biggest obstacle to growth (IKT Norge, 2017). In Europe more broadly a shortage of up to 900,000 skilled ICT workers is expected by 2020 (European Commission, 2014).

If more young women were supported to join the sector, then this would greatly contribute to filling the technological talent gap. However, beyond initial recruitment it is also vital to retain women within the tech sector by ensuring that they are able to thrive, not just survive, so that the gender gap in digital technological creation does not re-open further up the career ladder.

Liv Freihow of IKT Norway is a strong advocate for the need for more female technologists to ensure future competitiveness:

«Contrary to Sweden, Norwegian companies have difficulties to grow large and become international and get an international position. We have a lot of startups, a good entrepreneurial environment and so on. But we are not able to create any unicorns - access to capital, access to people and human capital are the most important»

3. GENDER EQUALITY IN TECHNOLOGY IS A MATTER OF SOCIAL JUSTICE

As the technology sector continues to grow in Scandinavia, an ever greater number of well paid, stimulating and impactful roles are opening up. In Denmark for example, 6,500 engineers and 3,500 science graduates are estimated to be needed as early as 2025 (Engineer the future, 2018). In 2013, Statistics Sweden (SCB) estimated a shortage of approximately 30,000 people with a formal engineering education by 2030.

It is vital that women have just as much opportunity as men to be able to take up these opportunities, otherwise social inequalities will only widen.

In addition to this, society is becoming increasingly digitalised, and digital technologies are playing an ever bigger role in driving societal shifts. If women and girls aren't able to partake in this process as technologically able citizens then the world will be shaped in ways that may not reflect the interests of half of the population. This would be undemocratic and unjust (Utbildningsdepartementet 2017; Sultan 2018; Sjøberg and Schreiner, 2010). In the words of Boe et al., (2011: p. 41) «involvement in STEM gives people literacy, empowerment and economic freedom to shape their world and everyday life» - «women and other underrepresented groups need STEM to be empowered to influence their own lives and the development of the world».

A Norwegian expert in gender and technology shared during her interview that:

«Reaching equality takes a very long time! But we can't afford it if we are to solve the problems ahead that our society is facing, both globally and at the national level. We can't recruit from only half of the population»

3. WHY:

BARRIERS TO GIRLS IN TECH

As outlined in Chapter 2, women and girls in Scandinavia are still underrepresented in STEM education courses and the digital technology workforce. But why has this gender divide in technology come about, despite Scandinavia's track-record of achieving relatively high levels of gender equality in other areas? The desk review conducted for this research revealed some of the barriers that young women face here to advancing along a technological path. The barriers identified were incorporated into a quantitative survey which enabled women and men in Scandinavia to suggest which factors they felt were most significant in driving the gender technological divide (see Fig 3.1 below). In-depth qualitative interviews with Scandinavian young women currently engaging in tech, and experts in the field, also allowed for these barriers to be explored in greater depth.

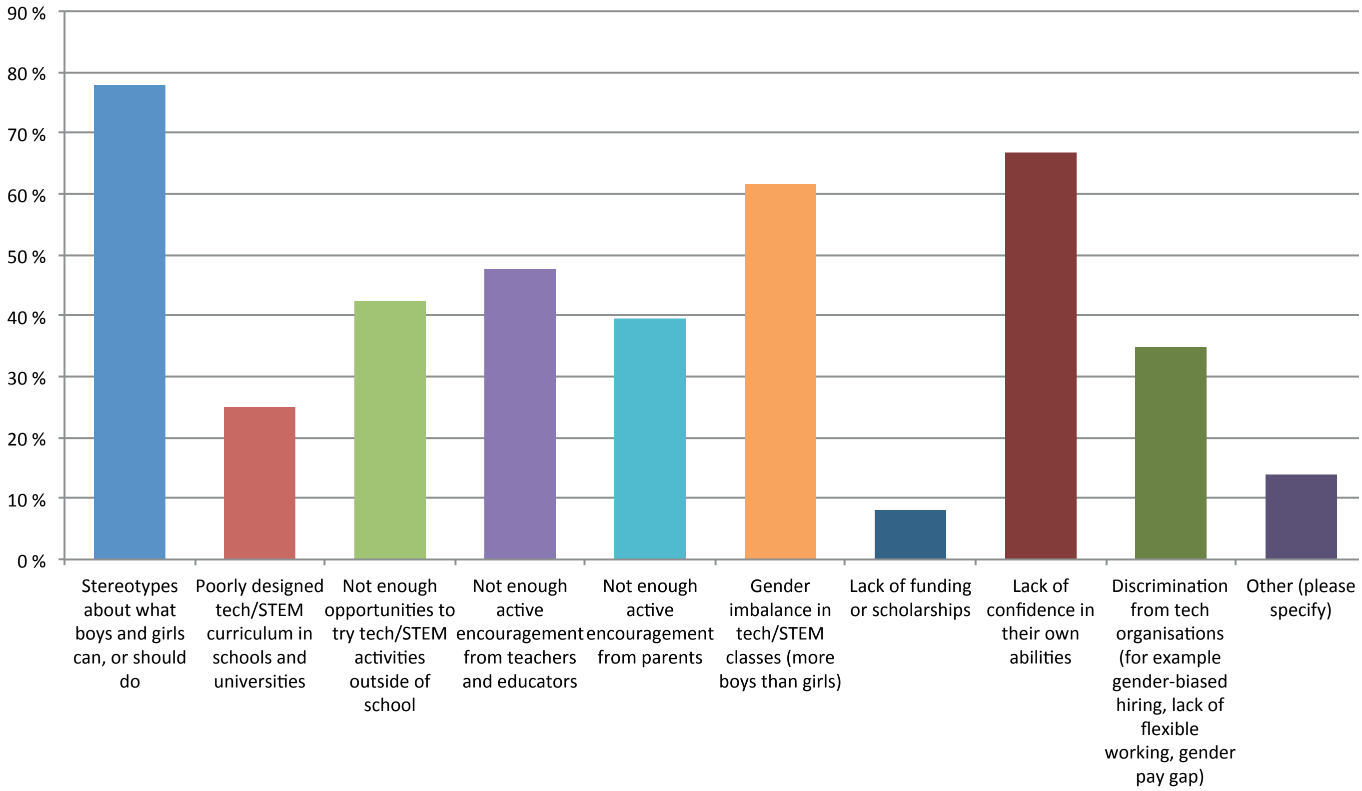


Figure 3.1. What challenges do girls and young women in your country face if they want to have an education or career in tech/STEM. Online survey, 2019, multiple choice, N=172

3.1 GENDERED STEREOTYPES ABOUT «WHAT GIRLS CAN DO», AND «WHAT TECH IS»

As Figure 3.1 above shows, «Stereotypes about what girls and boys can, or should do» was the most frequently selected challenge facing girls and young women when pursuing an education or a career in tech and STEM. This was also a common theme in the interviews conducted for this study:

«Girls somehow learn that they can't do tech. That could partly be due to the stereotypical image of who is doing tech. And what tech is, how it is communicated in school»
(Ulrika Sultan, Swedish Expert)

«People don't understand what it is. They can have stereotypical views like «How can you programme when you're a woman, that is for men», or «It is hard for women to comprehend the abstract levels of software because their IQ levels are generally lower», or «Females are better with humans, the humanities, and men are better at comprehending abstract levels and logical reasoning». Constantly hearing that you as a girl are good at looking after people or languages - you start to believe it! Because why wouldn't you? And then if you know that you aren't expected to be good at math, then why should you try doing it?»
(Danish Young informant)

Children begin to internalise gender stereotypes from a very young age - by the time they reach the end of infant school, they have already developed a clear sense of what is expected of boys and girls and how they are supposed to behave (Bian and Cimpian, 2017). This includes stereotypes that STEM is a «masculine» field (Schreiner, 2008; Wikberg-Nilsson, 2008; Ryder, Ulriksen & Bøe, 2015). Several studies across multiple countries have shown that when children are asked to draw a mathematician or scientist, girls are much more likely to draw men than women, whilst boys almost universally draw men too, often in a lab coat (Aguilar et al., 2016; Picker and Berry, 2000; Miller et al., 2018). Sjøberg (2002) found this to be the case in Norway specifically. Miller et al. (2018), whose study was focused on the USA, in particular found that female depictions occur less often among older children, indicating that stereotypes are strengthened over time.

One of the young women in STEM that we interviewed for this study told us that these «norms» and structures about what men and women can do, including the influence of language, have played a key role in shaping the idea that STEM is a male activity:

«STEREOTYPES ABOUT WHAT GIRLS AND BOYS CAN, OR SHOULD DO» WAS THE MOST FREQUENTLY SELECTED CHALLENGE FACING GIRLS AND YOUNG WOMEN WHEN PURSUING AN EDUCATION OR A CAREER IN TECH AND STEM.

«Well you know, the structures in our society. It has been all about men, so it's not that strange to think about a programmer as a man, that knows physics, like, it's called vetenskapsMÄN! (Swedish, Norwegian and Danish equivalent of a scientist refers specifically to the masculine sex). They are the ones that have done it in the past, all the discoveries that you read about in school. Teachers in tech-subjects are also men. Sometimes I've been pulled into a class just to have a girl there, to have a girl talk about tech to put another face on it.»

Toys that are specifically marketed as being «for boys» or «for girls' also promote conventional stereotypes, as well as facilitating different types of play and development (Spinner et al., 2018). Studies have shown that traditional «boys» toys, such as cars and video games, facilitate the development of spatial skills and an agentic, active self-image which may in turn promote success in engineering (De Lisi and Wolford, 2002; Jirout and Newcombe, 2015), whilst conventional «girls» toys on the other hand, such as dolls and Disney princesses, facilitate the development of caring, empathic skills and a communal, appearance-focused orientation (Dittmar et al., 2006; Li and Wong, 2016). The UK Institution of Engineering and Technology found that boys are almost three times more likely to receive a STEM toy for Christmas than girls, as 31% of science, technology, engineering and maths (STEM) toys are listed for boys, whilst only 11% are listed for girls on international shopping websites like Amazon (Nareissa, 2015). One of the informants interviewed for this report agreed that toys can have a strong influence, stating that:

«I think it (gender segregation) starts from a very young age. We look up to people, mirror ourselves in them. I think it comes down to how we play, and what kind of toys we give our kids»

The young women and experts interviewed for this report also reported having to face stereotypical associations of «masculinity» with «technology» from a young age. Eva Fog, a Danish expert on learning and IT, for example, said whilst recalling her first interaction with a computer and the Internet in the early 1990's that:

«I learned about technology when I was about ten, and it was love at first sight (...) My parents are really open minded, but nobody thought about me as somebody that could use technology for anything. I was alone in that»

The interviewees also felt that as well as being associated with men and boys, technology is also regarded as «nerdy». Whilst «nerd» is seen by some to be a negative term, closely related to being «uncool», for some young women the term has positive connotations and provides a sense of belonging.

«A lot of people think that if you are a girl in tech then you are nerdy … but the definition of nerdiness changes throughout time. Now it's kind of cool to be a nerd»

«All my people are here. The nerdy people, basically. So personally I think I fit in better here»

However, for some young women, and young men, who do not identify as a «nerd» this association could be off-putting, as Wikberg-Nilsson (2008) found in their study of female engineers at Luleå Tekniska Universitet.

3.2. LACK OF ACTIVE ENCOURAGEMENT FROM PARENTS AND TEACHERS

A lack of active encouragement from teachers and educators, and from parents were also both fairly highly rated by the survey respondents as key challenges facing women and girls interested in technology, with just under 47.67% selecting the former, and just under 39.53% the latter.

Studies have shown that teachers interact with children differently depending on their gender, reinforcing gender stereotypes. For example, teachers have been noted to engage in mathematical talk more often with boys in pre-school settings (Simpson and Linder, 2016). Research carried out in Sweden found that negative attitudes towards science subjects are common amongst pre-service teachers, particularly if they are women (Sundberg and Ottander, 2013). A one-year longitudinal study involving 91 teachers and 1822 students from the higher years of Dutch primary schools found that female teachers showed less positive attitudes towards teaching about science and technology than male teachers (Denessen et al., 2015). Girls appeared to be susceptible of their teacher's attitudes and developed less positive attitudes when their female teacher showed less enthusiasm for teaching science and technology. One of the young informants (aged 20) interviewed for this report told us that whilst she hadn't heard it said outwardly that STEM isn't for girls, she hadn't felt as encouraged by her teachers as her male peers had been:

«In my experience, it is not something that has been communicated overtly. But in terms of encouragement, I think we're pretty bad encouraging pupils in general. When I was younger I definitely felt that it was assumed that I didn't like maths for example. I never got asked to participate in math competitions while my male peers did»

Parents are also key role models for young children. However, they too are affected by gender stereotypes. DEA's (2019) survey of Danish children and their parents illustrated that young people showing interest in STEM tend, to a larger extent, to have parents with an interest in STEM. However, it also revealed that 54% of the parents of boys and only 26% of the parents of girls thought that their child should opt for a technology and IT related programme. 70% of the parents believed boys to be more interested in technology and IT than girls, while less than 1% replied that girls were more interested in technology and IT than boys. The young people surveyed agreed with their parents' views, unanimously explaining that boys' interest in IT is likely to be due to their interest in computer games.

One of the experts interviewed agreed that parents have a significant influence over their children's interests:

«Children and youth tend to be very influenced by parents. If you're a kid with parents with low educational background, chances are that you yourself lose interest in pursuing higher education. That is why I think it is so important with role models to look up to. Because if you don't have it at home, you need to find it elsewhere. And it can't be up to the girls themselves to find these role models. We have to provide this for them»
(Norwegian expert)

3.3. LOW SELF-CONFIDENCE

Previous research has identified that boys have greater confidence in their ability to solve math and technical problems than girls, even when they lack prior experience with tech (Sultan, 2018). Studies worldwide have found girls' self-efficacy to be much lower than that of boys in relation to STEM subjects, even at a young age (Bian et al., 2017; Devine et al., 2012; Lindberg et al., 2013). In Scandinavia specifically, Tellhed, Bäckström and Björklund's (2017) study of 1327 Swedish 17-year old high-school students found self-efficacy to be a crucial mediator of gender differences in STEM. This research confirmed that high-school girls' low self-efficacy in STEM greatly reduces their interest in pursuing a STEM career. In the survey conducted for this report, 74.3% of the 25-34 years old respondents (n=78) viewed «Lack of confidence in girls abilities» as a major barrier, compared to 66.8% of respondents over all.

This gender gap in technological confidence carries through until later in life. For example, when surveying new students in STEM higher education courses in Norway, Project Lily found that young women expected their studies to be more demanding and were less confident that they would succeed. Girls were also found to have greater demands for teaching and for the general quality of educational programs (Loken et al., 2010).

This lack of confidence in one's own abilities in STEM is reflected in the interview with one of the young female informants spoken to for this report:

«I'm fairly good at math, or I AM good at math. But I've also had my doubts. Like I've thought that if you're good at math then you constantly think about math, you write formulas on your window etc. And where did I get those thoughts? I have no idea!»

One of the survey respondents also stated that a key issue in the gender divide in tech and STEM is that:

«Girls don't know or understand that they are so good and capable»

3.4. POORLY DESIGNED TECH AND STEM CURRICULUM IN SCHOOL

Ensuring that computing (including programming/coding, computational thinking and broader digital competences) is taught in schools is vital for giving girls and boys equal opportunities to

BOYS HAVE GREATER CONFIDENCE IN THEIR ABILITY TO SOLVE MATH AND TECHNICAL PROBLEMS THAN GIRLS, EVEN WHEN THEY LACK PRIOR EXPERIENCE WITH TECH.

gain experience and confidence in tech. Sweden, in particular, has taken steps towards achieving this goal through the 2017 Digital Strategy, which states that programming and digital source criticism should be integrated into the curriculum as early as elementary school (for more details see box on policy on page 30).

Whilst Sweden's Digital Strategy is a step forward, and signals the importance of computer science skills, the interviews with experts conducted for this report revealed that, on the ground, there is a lack of resources, cohesion and comprehension as to how best to implement these guidelines.

«I think it is good to have a strategy, but we had enough demands before it was implemented. It is extremely challenging because thus far there has been no extra money allocated to implement it. We are expected to make things out of thin air» (Swedish expert)

«We do not yet know how to teach, and learn programming in the best way. We're in this vacuum of not knowing» (Ulrika Sultan, Swedish expert)

It will be necessary to undertake in-depth research with educators and policy-makers involved in the Digital Strategy in Sweden to understand how to ensure that all young people receive the high-quality digital education required so that the gender gap in technology can be closed.

While the Norwegian national curriculum is undergoing revision, the strategy from 2017 states the importance of integrating computational thinking and programming in the curriculum for primary, secondary and vocational education. Yet how exactly this integration should be carried out is still up for debate. As such, the strategy does not describe how these subjects should be taught, and which other subjects are affected. However, in 2017 the Norwegian government did initiate a three-year pilot project, offering programming as an elective in lower secondary schools (Kunnskapsdepartementet, 2017). The results of this pilot are forthcoming, however, as of July 2019 the Norwegian government announced an allocated NOK 20 million to programming in school, along with a statement that programming will be included

3 Further explained in chapter 4.2.1

in the new curricula for mathematics and science from Autumn 2020 (Regjeringen, 2019). In Denmark, digital competences, including «IT and media», are integrated in all subjects. Like Norway, programming is yet to be implemented in the curriculum and pilot projects are currently being carried out (Bocconi et al., 2018).

The table below summarises the rationale of the respective countries for including computational thinking (CT) and programming in the broader curriculum based on current policy documents. Currently the main focus is on these subjects as a means for developing learners' problem-solving and logical thinking skills, which can then be applied more broadly, and as a way of ensuring that students can participate fully in the digital world as both critical users and creators of digital products. But the link between these skills and employability is not being made so strongly in Denmark and Norway in comparison to Sweden. The possibility that computing could inspire disaffected students through providing a practical and «real world» application for mathematics skills is also not currently a key rationale for integrating CT and programming in any of the three countries (Bocconi et al. 2018).

	SWEDEN	DENMARK	NORWAY
FOSTERING EMPLOYABILITY IN THE ICT SECTOR	■		
FOSTERING CODING AND PROGRAMMING SKILLS	■		
FOSTERING PROBLEM-SOLVING SKILLS	■		
FOSTERING LOGICAL THINKING SKILLS	■	■	■
FOSTERING OTHER KEY COMPETENCES	■	■	■
STRENGTHEN PUPILS' MOTIVATION TO STUDY MATHEMATICS			■
DEVELOPING DIGITAL CITIZENSHIP	■	■	
UNDERSTANDING SOCIETY AND THE ROLE OF TECHNOLOGY IN SOCIETY	■	■	■

Table 3.1. «Rationale for integrating computer thinking in the curriculum, as emerging from the survey of MoEs» Derived from Bocconi, S., Chioccariello, A. and Earp, J. (2018). The Nordic approach to introducing Computational Thinking and programming in compulsory education. Report prepared for the Nordic@BETT2018 Steering Group. https://doi.org/10.17471/54007

Aside from computing education, at ungdomsskole and högstadie-level «technology» is generally introduced as its own subject in school. However, technology is commonly taught earlier under the category of «science» (NO-ämne). In Sweden's updated educational time plan for year 1-7 students of 2019, elementary school students will get 47 hours allocated to «technology», increasing to 65 hours in middle school and 88 hours in high school (Skolverket, 2019). According to the syllabus, these hours include providing opportunities for students to develop a technical awareness and technical knowhow to give them skills to address technical challenges in a conscious and innovative way (Skolverket, n.d). Alongside science classes, this increases the opportunities for young women and men to gain technical skills that could lead to an interest in becoming a creator of digital technologies.

However, the interviews carried out for this report revealed that the way that tech and STEM are taught in schools is not well designed to appeal to young women, or indeed many young men:

«I think schools (in Norway) need to be structured in a different way. We tend to separate the subjects within STEM. Chemistry is chemistry, math is math, physics is physics and so on. But the subjects are intertwined, and you need to understand each part. It can be hard to understand physics unless you understand chemistry. And it is really hard to grasp any of them unless you know the mathematics. So I think we need to stop making such separations of the subjects. Let the students understand the connection between the subjects. And to work creatively with the subjects. You learn science by doing science, but far too often we teach the theory of it. If the students are lucky they get one, two or three lab experiments. And then the rest they need to read up on in the books. That doesn't create interest, and it doesn't foster and understanding of what you can do with the subjects!»

One of the survey respondents similarly wrote:

«I think the curriculum in Sweden for the tech subjects are more biased towards boys and their interests while the definition of stem/tech is much wider»

This frustration with the rigidity and lack of hands-on experience that characterises STEM teaching in schools in Scandinavia was also found in Holmegaard et al.'s (2014) study of Danish students' decision making process around studying STEM at higher education level. They found that students who did not choose STEM perceived it as stable, rigid and fixed, and, hence, too narrow a platform for developing and constructing desirable identities. This corroborates Krogh's (2006) study of upper secondary school physics in Denmark - students reported wanting autonomy and self-reliance, but found their physics classes consisted instead of closed and determined content and teacher-centred teaching without much student influence. DEA's (2019) survey of Danish pupils also found that girls have difficulty in imagining a career and a future within STEM occupations, especially IT and technology, because they find it difficult to reconcile these subjects with looking after people (a stereotypical «female» preoccupation linked to the influence of gender stereotypes as discussed in 3.1). There is a lack of connection between technology and STEM and real-world issues, which has been found to be of great importance in engaging young women in digital tech and STEM (Jensen, Sjaastad & Henriksen 2011).

3.5. NOT ENOUGH OPPORTUNITIES TO TRY TECH AND STEM OUTSIDE OF SCHOOL

The number of clubs, activity groups, programmes and classes seeking to provide accessible opportunities for girls to explore digital technology and STEM outside of school in Scandinavia are increasing. However, this was not always the case. In general, less is known about girls' learning experiences of technology outside of school than in school (Hallström et al., 2018).

Several of the survey respondents pointed this out in their responses:

«There is not so many projects - IKT Norge have a network - but it's not reaching out to the rest of the country. And the role-model here is rather different from the girls you meet out in schools with good programming skills etc.»

«I haven't been in direct contact with any project. Projects for supporting girls and young women are a fairly new thing. I had no access to any. We had a group of girls that studied the same as me in the University which would contact and arrange meetings with the newcomers so they knew they weren't alone»

This isn't to say that there haven't been after school computing clubs in Scandinavia for some time. The issue is that these groups have often failed to adequately address the gender imbalance within their attendees. For example, Corneliussen and Proitz (2015) conducted an in-depth study of a Kids Code afterschool club in Norway. They found that far fewer girls attended than boys (7–8 girls and 30 boys). But as this report has discussed in previous sections, girls are less likely to attend a club like this due to gendered stereotypes about who should «do» tech, the influence of parents and teachers, and resultant lower technical self-confidence. Unsurprisingly, then, they also found that the parents of the children attending made stereotypical assumptions, stating that «boys were more into computers and computer games, that boys had more of a technical interest and that they were more independent and fearless in dealing with technology». They also found that the leaders had not made any effort to recruit girls specifically, arguing that «perhaps because we have been used to» a gender imbalance in IT and that «it's about culture». Corneliussen and Proitz conclude that «code clubs need an explicit recruitment strategy targeting girls in order to become an arena where girls can develop interest and competence in digital technologies".

Part of encouraging girls to engage in extracurricular tech and STEM activities might be ensuring that they involve creativity. Sultan (2018), based on her experience at KomTek (a Swedish municipal technology school which offers out of school courses and projects for children and young people), argues that technology has been characterised as a field that negates creativity and creative expression. She encountered plenty of girls that saw themselves as crafty, or creative – but not technical per se due to this conventional image of what counts as «technical». This corroborates the findings of the Swedish Youth Barometer study (Ungdomsbarometer, 2015) commissioned by trade association Teknikföretagen, which surveyed 8,000 young people's self-image in technology and found that only 7% of the technology-interested girls describe themselves as technical, compared with 36% of the technology-interested boys, but that 23% of the technology-interested girls describe themselves as creative, which was more than the technology-interested boys. Sultan (2018) points out that creativity is a key part of problem solving - and that «creating» digital technologies is by its very nature a «creative» process. In her own words «programming can be dance, and natural materials can be used in the construction of solid structures». The lack of creative learning experiences outside of school, and within schools too, particularly for coding and programming can be considered a key barrier to girls' engagement with computing studies.

3.6. GENDER IMBALANCE IN TECH/STEM ACTIVITIES

Due to all the other barriers listed in this report it is hardly surprising that women and girls are the minority in technology and STEM classes and extracurricular activities. But this can leave girls who do want to pursue these initiatives feeling very alone and at odds with their peer group. The effect of «stereotype threat», which is when «the fear»… that our actions will confirm negative stereotypes about our «group» or about ourselves as members of a group» greatly reduces performance, confidence and risk-taking behavior, is greater for young women in gender imbalanced groups too (Ashcraft et al. 2012: p.35).

The findings from the interviews and surveys carried out for this report suggest that worries about being «the only girl in the group» are particularly strong in Denmark, where the hesitant approach of girls could be traced to the opinions of their peer group (for more on intra-Scandinavian differences see box page 21). In the words of Eva Fog:

«It is difficult for the girls, because they go more like why should I be doing this, what is the point? is it good for me? My friends? The world? What will people think of me when I do this? Are my friends also interested in it? If no, then oh, I'm going to be the odd one out and I won't do it, even from a very young age. Girls need to be prepared to be themselves and have somebody to show them the way, and kind of move the boys aside»

Another interviewee agreed that a lack of supportive STEM peers can have a negative impact on young women's lives. In her case her talent and interest for STEM had served as the basis for bullying from her fellow pupils:

«I really liked STEM subjects in elementary school. And since I was really good at it, girls in my class started teasing me about it»

Wikberg-Nilsson's (2008) study on female engineers at Luleå Tekniska Universitet indicates that studying STEM subjects is associated with socially normative negative connotations, for example being a «nerd». Similar results are found in the Swedish Insight Intelligence report (2016), which found slightly more positive attitudes, but still noted that the IT industry is associated with adjectives such as «boring» and «complicated». Moreover, out of the women surveyed, 22% stated that they would not be interested working within IT, due to the expected male-dominated environment. Being informed of the low share of women in the tech industry may thus have a deterrent effect.

A young Swedish informant interviewed for this report remarked that if she had known in advance how few women would be taking her university course alongside her then she may not have chosen it:

«I think it can have an opposite effect if you, to a large extent say that there are too few women… had I known that it was as skewed as it was, maybe I would have thought differently, or taken that into account when choosing»

Similarly, a young Danish informant was concerned that talking too much about the current imbalance would hinder positive change:

«The focus should be on how to appeal to women, not say we need women.»

DIFFERENCES BETWEEN SWEDEN, NORWAY AND DENMARK

Over all, the research carried out for this report did not reveal any significant differences in response from the participants from the three different countries. However, the survey did yield some slight variations that may be worthy of note. For example, the Swedish respondents were the most likely to say that 'Girls and young women in their country face challenges if they want to have an education or career in tech/STEM (67.2%) compared to those from Norway (53%) and Denmark (62%). Conversely, Norwegian respondents were the most likely to say that girls and young women in their country do not face challenges (37%), with 9.2% stating that they are uncertain. For those answering that they do think that women and girls are facing barriers in their respective countries, the barriers selected seem to be quite similar across the board, with a few small deviations. In Norway, for example, 55% reported that there are 'Not enough opportunities to try tech/STEM activities outside of school', compared to 32% of Swedish respondents answering the same question. Norwegians appear to view 'Stereotypes about what boys and girls can, or should, do' as a larger barrier than others as well, with 83.3% of respondents from here selecting this option, compared to 77% and 74% of the Danish and Swedish respondents respectively. It is difficult to say whether these observed patterns reveal any inherent 'truths' about the situation of girls and technology in each of the countries as a whole due to the relatively small sample size of this research. Further research is needed, that combines quantitative surveying with a more ethnographic, longitudinal and in-depth approach to studying the issue of gender and technology across the three countries, to enable any firm or robust conclusions to be drawn.

3.7. LACK OF FUNDING OR SCHOLARSHIPS

In the online survey conducted for this report 8.14% selected «lack of scholarships or funds» as a key barrier for girls looking to obtain an education or a career in tech/STEM. This is interesting to note, as this concern was not reflected in the literature found as part of the desk review.

A concern about «lack of scholarships or funds» could refer to several different issues. Firstly, it could refer to the current lack of funding provided by Scandinavian governments to schools in order to realise the bold targets made by the various government strategies on digital education. A Swedish expert interviewed for this report said that she had noticed this to be an issue within her daughters' school education. She shared that technology teachers had to resort to activities such as:

«Building a spaghetti bridge, or a space rocket with empty toilet rolls»

Her daughters had also been asked to bring a technological artefact to school with them to present in front of the class:

«I have questioned this style of teaching at my daughters' parent-teacher meetings (kvartssamtal). And she … opened the door to the teaching materials in the classroom and showed

me paper, color pencils and a bit of tape. This whole thing is a big problem. Lack of teachers, education materials. The technology subject gets the least allocated funds of the budget» (Swedish Expert)

If we want young women, and men, to get excited about future technologies so that they want to play a part in creating them, these current makeshift approaches, borne out of low budgets, may not do the trick.

Another aspect of what a lack of funding could entail is the low share of venture capital to female startups. In Swedish newspaper Dagens Industri's review of investments of Swedish tech companies, a mere 0.7 per cent out of the total SEK 11.4 billion went to companies with female founders (Dagens Industri Digital 2018). This is an issue outside of Scandinavia too - in Silicon Valley in 2018 female founders raised $2.88 billion, which is only 2.2% of the $130 billion total in venture capital money invested over the year (Hinchcliffe, 2019). Perhaps it is this worrying trend that led one of the respondents for the survey conducted for this report to write that they would like to see:

«More scholarships for women in STEM subjects and financial support generally. Also funding for women's tech startups. VC (Venture capitalists) only want to fund projects of wealthy white young men. Leaving little money for initiatives from women»

3.8. GENDER BASED DISCRIMINATION IN TECH ORGANISATIONS

A significant number of survey respondents (34.88%) noted «gender based discrimination in tech organisations» as a key factor that limits young women from pursuing a future in tech. One of the respondents wrote that:

«The career path may have some challenges. For example, women often get asked during interviews for new jobs about family life and if there are any plans about having children in the near future, while men usually do not get asked these questions»

One of the young women interviewed for this report also told us that her friends had told her to expect an unwelcoming environment at tech companies that she might want to work at:

«My friends that already have experience working at companies say that there are a few negative comments here and there that you just have to tolerate. So they told me that I probably had to endure some of that. But then again I'm not the kind of person that shuts up»

ACCORDING TO THE STATE OF EUROPEAN TECHNOLOGIES (2018), AS MANY AS 46% OF THE WOMEN SURVEYED RPORTED TO HAVE EXPERIENCED DISCRIMINATION IN THE TECH SECTOR

Harassment and discrimination within the tech industry is not a problem isolated to the Scandinavian tech industries. According to the State of European Technologies (2018), as many as 46% of the women surveyed reported to have experienced discrimination in the tech sector. In Scandinavia, such discrimination was increasingly debated during the rise of the #metoo movement of 2017. In Norway, the specific discrimination experienced by women in the tech industry went under the hashtag #systemdown (Sletteland, 2018). In Sweden, the petition #tekniskfel was signed by 1947 women (Teknisktfel, 2019). Many of the testimonies found under the hashtag and within the petition describe the issues related to being a woman in a male-dominated environment. Due to the many testimonies of sexual harassment in connection to #Metoo, the Swedish Equality Ombudsman launched an inspection of the IT-industry, among others, to document to which extent the guidelines and procedures for sexual harassment and retaliation were followed (Diskrimineringsombudsmannen 2018)

While none of the informants for this report stated to have experienced harassment of this sort themselves, the gender imbalance at the workplace appeared to still pose some uncomfortable situations. A young Norwegian woman told us about a team-building day at her company, where the traditional Scandinavian sauna event had made her feel a bit awkward:

«You know, it is perhaps not the most fun situation to be the lone girl in a sauna full of guys»

It is worth noting, too, that gender-based discrimination is an issue in academic workplaces as well. A study combining recruitment statistics and interviews with department heads at a Danish university found that of the vacancies for associate and full professorships, 19% were announced using closed procedures, with such circumstances serving to perpetuate an existing male-dominated gender distribution (Nielsen, 2016).

4. HOW:

«WHAT WORKS» TO GET GIRLS INTO TECH

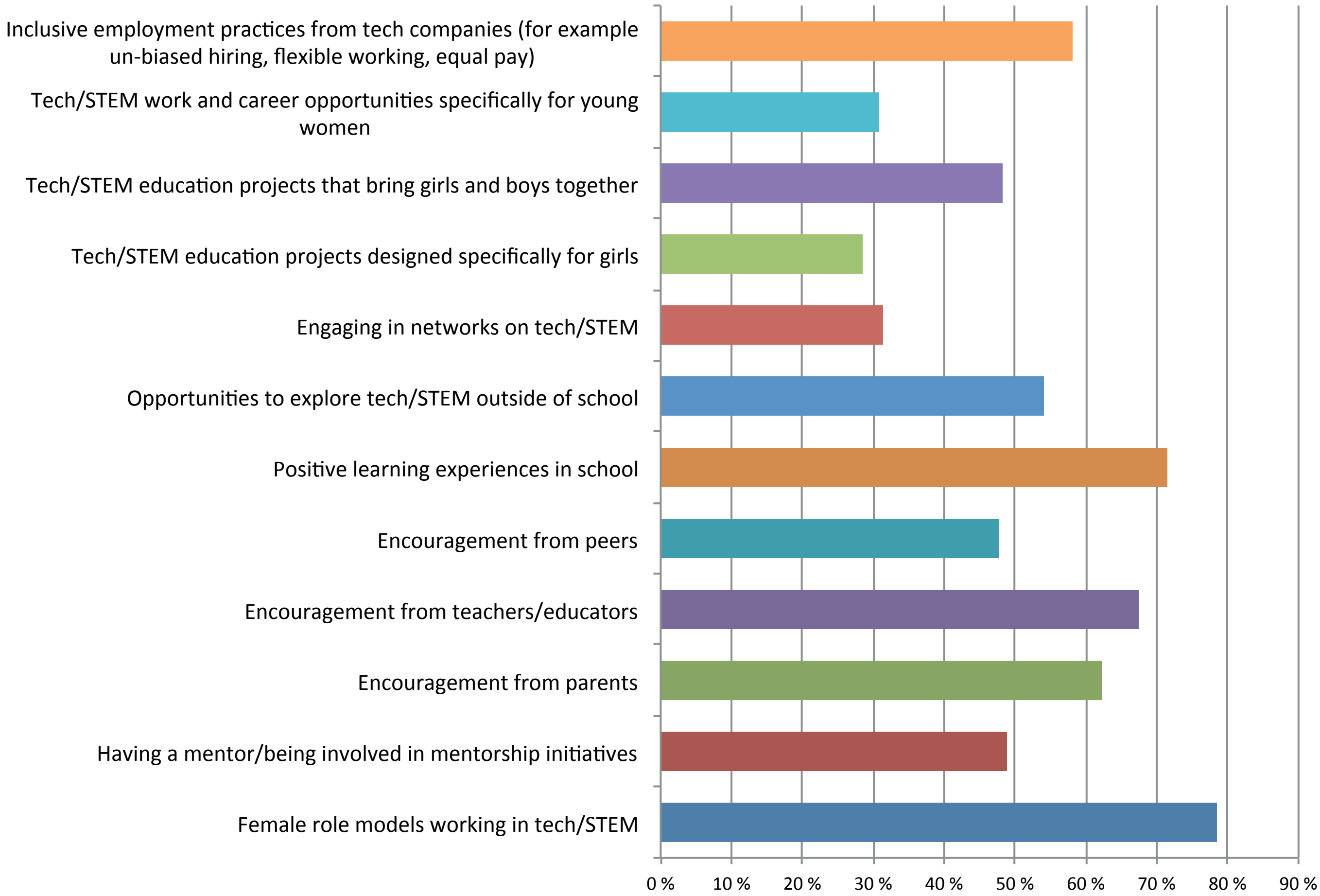
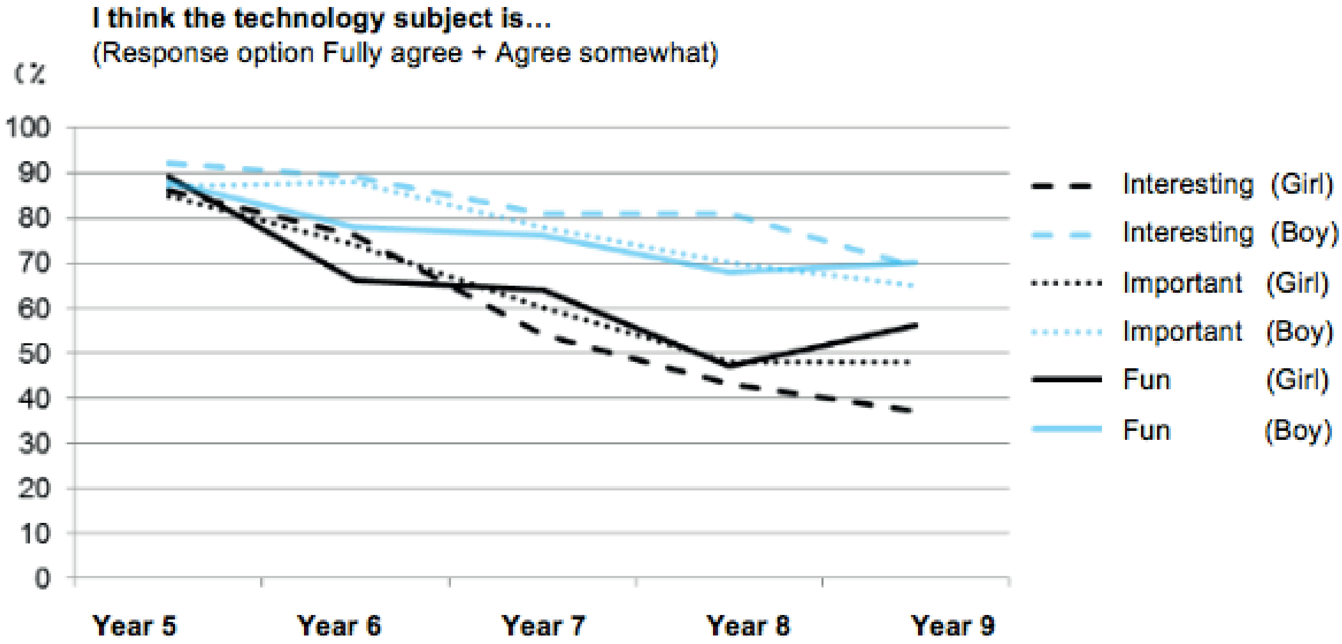


Figure 4.1 What helps girls and young women to study or work in tech/STEM in your country? (Online Survey, 2019, Multiple choice, N=172)

4.1 PRE AND PRIMARY SCHOOL

There is some debate as to the best age to begin interventions to increase girls' participation in STEM. Microsoft and KTC's (2018) survey of 11,500 young women in Europe discovered that most girls become attracted to science, technology, engineering and math between the ages of 11 and 12, but that interest then drops off significantly between 15 and 16, with limited recovery. In comparison, however, DEA's (2019) survey of Danish 10-11 year old's and 15-16 year old's found that whilst STEM interest drops by a fourth between these two age groups, many girls have already started to lose interest in STEM by the time they reach lower secondary level. For Sweden, the decreasing interest in tech is illustrated in the graph below.



Graph 4.2 View on the technology subject (Skolinspektionen 2014). Own translation.

Stoeger et al. (2017) argue that «as girls' interest in STEM subjects decreases during adolescence... support programs need to be offered already during primary and secondary schooling» to pre-emptively address the barriers girls face to engaging with STEM before they begin.

An interview with a representative from the Talentsenter i realfag education program in Norway, an education program providing STEM education for particularly talented students, corroborated these other studies. They said that up until the age of 12, the share of interested applicants appear to be equally distributed between boys and girls, whereas their older age group applicants tend to be overrepresented by boys. They felt that this pattern could be partly explained by girls internalised perceptions of themselves not being gifted in the STEM subjects.

4.1.1 COUNTERING STEREOTYPES

Gender stereotypes are at the heart of the gender divide in technology in Scandinavia. Many of the other barriers that young women face on the path to achieving in tech stem from the fundamental issue that society expects different things from boys and girls, and shapes them to be different as a result of these expectations. This then affects how teachers and parents interact with girls, how confident young women feel in pursuing tech and STEM, and so on:

«If it's biology that determines how good you are at programming, why fight it? But it's not! I think it's the more societal view on many gender dialogues that I've heard - they say that girls CHOOSE not to do it, but I think it's the society that pressures them to not choose that line»
(Danish Young informant)

A survey respondent also wrote that a key barrier facing girls in pursuing tech and STEM is:

«Peer-pressure around what girls are «supposed» to be interested in from an early age. Already in pre-school»

Studies that have tested the best approaches to challenging gender stereotypes with the aim of encouraging girls in tech are lacking. Some promising findings are emerging from studies of gender-neutral pre-schools in Sweden - however, more research is needed into how teaching children in a gender-neutral environment from an early age impacts upon their life choices later on.
'What works': Gender neutral pre-schools in Sweden

Shutts et al. (2017) found that 3-to-6 year old's enrolled in gender-neutral preschool programs in the central district of a large Swedish city were more interested in playing with unfamiliar other-gender children. In addition, children attending the gender-neutral preschool scored lower on a gender stereotyping measure than children attending typical preschools. One of the authors suggested that "as children develop through play and through interactions with peers, and that many play activities (like playing with blocks) that promote development are traditionally gendered, then it would be reasonable to assume that this is likely to improve these children's development and future success" (MacLellan, 2017).

4.1.2 TEACHERS

67.44% of respondents for the survey conducted for this report selected «Encouragement from teachers and educators» as a factor that helps girls to study or work in tech/STEM. Similarly, Sjaastad's (2012) study on sources of inspiration for Norwegian STEM students in their educational choices found that teachers are key role-models in students' lives, especially for female students. In their role as disseminators of STEM subjects, teachers can increase young students' curiosity in the subjects and show their variety. In Sjaastad's (2012) open-ended questions on significant persons in their lives, women were twice as likely to mention teachers than men. This resonates with Sultan's (2018) study, which highlighted the power of teachers in broadening students', and particularly girls', perspective of what technology entails and providing an inclusive teaching environment where technology is something girls can more easily relate to.

One of the survey respondents attested to the significant role that teachers can play, even within a challenging educational environment:

«Without the amazing, female, math teacher I had when I was 16, I would never have thought about getting into programming and tech. At that point, I didn't know what programming was, and I knew less about hardware. Which says a lot about the state of our school system»

Providing training opportunities for teachers to improve their ability to support girls in STEM more effectively is therefore a key area to explore.

«What works» : Seminars on gender, science and tech with teachers K-6, Sweden

Andersson's (2012) study describes how since 2005, a group of teachers (K-6) in Sweden have met approximately once a month in two-hour seminars to discuss and develop their instruction in science and technology based on a gender perspective. These seminars enabled the teachers to observe video-recordings of their science instruction with students, which revealed their biased interactions with girls during the classes. When the teachers were able to read their own statements about the girls, they got «a glimpse of themselves», and their condescending ideas about girls were made visible. In this way, the teachers were able to begin active work towards change, which may lead to new outlooks on and attitudes towards students.

4.1.3 PARENTS

In Sjaastad's (2012) study, parents were also listed alongside teachers as important sources of inspiration in young Norwegian students' lives. 62.21% of respondents taking part in the survey conducted for this report also selected 'Encouragement from parents' as a key factor in encouraging girls to pursue tech/STEM. Interestingly, Sjaastad found that fathers were mentioned three times as frequently as mothers for the female respondents. He notes that this may be due to the segregated labour market, where the majority of the STEM workforce consists of men.

A DAMVAD (2016) report which maps gender equality and education in the Nordic countries finds, through quantitative analysis, that girls list their mothers (28 %) as the most important parent when asked who had been significant in choosing their education. However, their qualitative interviews indicate that females to a large extent describe their fathers to be of most importance in determining their choice of education.

Project Lily (Schreiner et al., 2010), which surveyed 7540 new students at Norwegian public universities and university colleges, found parents rated highest as 'persons who had inspired and motivated their choice', and that girls expressed that persons generally had had a greater impact on their educational choices than boys.

This resonates with the interviewees involved in this study. For example, a young Swedish woman (aged 20) reported to have faced difficulties in reconciling her interest in computer games with her identity as a young woman as her female peers did not share her interests. Had it not been for her father's encouragement, she speculated that she probably would have abandoned gaming to "fit in" with the image of what a girl's interests should entail:

«There was one time in primary school when I remember that I ran home and cried, because I thought something was wrong with me. I didn't have any female friends that liked the same things that I did. I liked gaming and I thought I should have been born a boy. Not that I wanted to change gender but I couldn't connect my interests with my gender, because it felt so weird»

There is a lack of evidence as to how best to engage parents in Scandinavia in their children's STEM/tech education. However, the below example from the USA suggests that this could be an approach worth exploring further.

«What works» : Three-part intervention to help parents motivate adolescents in mathematics and science, USA

Harackiewicz et al. (2009) conducted a field experiment testing whether a theory-based intervention, that was designed to help parents convey the importance of mathematics and science courses to their high school–aged children, would lead the children to take more mathematics and science courses in high school. The three-part intervention consisted of two brochures mailed to parents and a website, all highlighting the usefulness of STEM courses. This relatively simple intervention led students whose parents were in the experimental group to take, on average, nearly one semester more of science and mathematics in the last two years of high school, compared with the control group. Parents are an untapped resource for increasing STEM motivation in adolescents, and the results demonstrate that motivational theory can be applied to this important pipeline problem.

ENSURING THAT ALL YOUNG PEOPLE, GIRLS AND BOYS, HAVE THE OPPORTUNITY TO EXPERIENCE STEM IS ESSENTIAL FOR LEVELING THE PLAYING FIELD.

4.1.4 EARLY STEM EXPERIENCES

Ensuring that all young people, girls and boys, have the opportunity to experience STEM is essential for leveling the playing field. Research with girls aged 7-12 years in Sweden showed that girls who did have the opportunity to experience technical education in primary school had higher technological self-confidence and a better idea of what technology 'is' (Skogh, 2001). A study in Germany also found that following an intervention of teaching technology in an elementary school, girls' interests in tech raised to match those of their male peers (Mammes, 2004). 'Positive learning experiences in school' was also selected by over 70% of respondents in the survey conducted for this report as a factor that helps more young women to pursue a future in tech/STEM. But which kinds of STEM activities are most likely to engage girls, and boys, in STEM at a young age? Björkholm (2010) surveyed 256 elementary school pupils in Sweden taking technology lessons implemented by teacher trainees in technology during the teaching practice section of their teacher training programme. She found that when asked what was «fun» about the lessons, 40% of the boys and girls described some type of practical work;

«It was fun that we could build something, and that we did not just read as in ordinary science lessons»
(Girl, Grade 6).

Such recommendations are found across our interviews, for both young informants and experts. For example, one of our expert respondents told us that:

«Girls have technology thirst (...) But rather than saying «come do tech, come do computing, come do engineering» we say "come here and do what you like! (..) Technology that is there needs to be a part of the girl's world, it is what works, because they finally feel like they can be themselves, instead of being put in a box.»

One of the survey respondents also shared that:

«As a child I built robots and cars instead of playing with barbies. Today I know building robots are fun and you don't have to be a genius (trial and error and try again - it's okay not to be smart and interested in STEM). We need to be introduced to STEM in a way that isn't filled with hard work but with fun and creativity. I also did coding as a child - and today I'm not afraid of programming»

Again, more research is needed to ascertain the most effective teaching styles for engaging younger girls in technology and STEM. However, the below case-study suggests creativity is key.

«What works» : Creative computer science workshops with young children Norway

A group of researchers and artists designed and implemented two 2-day creative computer science workshops involving a total of 29 students aged 12, exploring their experiences with the program (Giannakos et al., 2017). The workshops were based on the open source software Scratch, as well as the creative use of recycled materials. The results showed that: (a) the participants regarded the workshop as an overall positive experience, (b) creativity is an excellent means to promote and teach programming, and (c) a workshop approach raises interest in computer science among female students in particular.

BREAKING THE BINARY CODE - BOYS AND GIRLS WORKING TOGETHER ON STEM

Research suggests young adolescents, across cultural settings, commonly express stereotypical or inequitable gender attitudes (Saewyc et al., 2017). But interviews with 10-11 year old boys and girls attending a Kids Code coding club in Norway found that whilst they noticed that there were more boys than girls at the sessions, none of them could think of a reason why girls would attend less than boys. They stated that boys' and girls' coding is equally good (Corneliussen and Proitz, 2016). A study in the US that brought boys and girls together to work on e-textile projects that combined crafting and computing found that this process opened up the young participants' perceptions of what constitutes 'feminine' and 'masculine' activities and identities (Kafai et al., 2014). 48.26% of respondents taking part in the survey conducted for this report selected tech/STEM projects that bring girls and boys together as helpful for supporting girls into this sector, which was a greater number than those selecting tech/STEM projects designed specifically for girls (28.49%). Further research is needed, but this small-scale case study suggests that it could be fruitful to engage young boys and girls simultaneously in STEM activities that challenge gender norms. If successful, then specific recruitment initiatives only for girls may not be needed at a later stage.

4.2 GYMNASIUM/VIDEREGÅENDE SKOLE

At the secondary level young people make their first decision about taking non-compulsory subjects around the age of 15–16 years. Boe et al (2011) therefore argue that experiences of junior high school science can have a significant influence as to whether girls continue on in STEM, since decisions to forgo science subjects generally put an end to any formal science education.

4.2.1 PEERS

As young people reach adolescence peers take on an increasingly significant influencing role in their lives. This is true in relation to STEM as well - in a survey of middle school girls in the USA, Denner (2011) found that perceived support from school peers (and teachers) had a direct effect on girls' interest in computing classes and careers, more so than support from parents. Kessels et al. (2014) argue that same-age role models are particularly effective in changing the perception of STEM fields as unfeminine. Schoon and Eccles (2014) also note that peer support is particularly important for high-achieving girls' willingness to persist in STEM fields into college. «Encouragement from peers» was also a popular response in the survey conducted for this report on 'what helps girls and young women to study or work in tech/ STEM', receiving a vote from 47.67% of respondents.

The educators interviewed for this report agree that the role of peers is vital. For instance, educators in Denmark have noticed different attitudes in boys and girls in out-of-school tech workshops. As mentioned earlier, young girls commonly have a rather hesitant, or questioned approach when introduced to new technologies, tuning in with their peers to see if it is of interest to them and how their friends react. This supports the literature on the importance of peer support and the importance of creating a space which catches female students' interests as a group.

Another informant told us:

«It's very important to have female friends in your class that you can turn to. Back each other, support each other, believe in one other. We have to stand together. It's very common to call each other 'brother'. I think we need to be sisters for each other»

And another expert added that, in relation to girls:

«If you give them the means and a supportive community, they will love technology»

THE IMPORTANCE OF POLICY AND GOOD GOVERNANCE

Much of 'what works' to engage young women in STEM in Scandinavia involves educational changes, whether that means improved teacher or professor training, altering the curriculum itself, or the education of parents or carers on the importance of STEM. Teachers and educational institutions won't be able to achieve these changes on their own - policy change and increased funding is required. This will drive real impact, as a young Swedish informant aged 20, engaged in an organisation which seeks to encourage more girls in STEM, told us during her interview. She has seen first-hand the early effects of the Swedish IT strategy of 2017 through her experience as a sub-teacher at a Swedish school:

«I almost get jealous when I get to see how much they (first-graders) get to code! I can't help but think where I'd be today if I had been given such opportunity»

NATIONAL IT STRATEGIES

SWEDEN - In October 2017, the Swedish Government adopted a national Digital Strategy with three focus areas to be implemented until the year 2022. «Digital competences for everyone», «equal access», and «research and monitoring on the possibilities of digitalisation» are outlined as crucial in reaching the goals of becoming a leading nation in digital competences (Utbildningsdepartementet 2017). Important elements in the strategy include integrating programming and digital source criticism in the elementary school curriculum, as well as digitalization of national exams.

NORWAY - The Norwegian Government's policy document Digital agenda for Norge includes five main priorities, all of which are central for the digital development of the education system. More education opportunities in programming and technology throughout school system, an increased focus on teachers' digital competence and improved digital equipment are a few of the necessary steps highlighted to ensure that the current and future needs of the individual, society and industry are catered for (Kunnskapsdepartementet 2017).

DENMARK - Denmark´s fællesoffentlige Digitaliseringsstrategi 2016-2020 (public digitalisation strategy 2016-2020) includes the importance of digital learning materials and tools. In continuation of the joint Danish public digitization strategy, the recent publication «Digitalisering med omtanke og udsyn» (Digitization with care and vision) includes the themes of technology in teaching, technology as profession, technology and children's wellbeing, and technology in school as central to the upcoming digitalization strategy for the education sector (Undervisningsministeriet 2019).

4.2.2 STEM IN SCHOOL

Klepaker et al.'s (2007) survey of 2900 Norwegian boys and girls in grade 7 revealed that girls express a higher preference for working in smaller groups, project work and drama/role play in STEM classes, whilst boys prefer practical activities, like excursions and doing experiments, and whole class lecturing and discussions. The girls were particularly keen on drama/role play in science, a teaching technique not often used in science lessons. However, an earlier study (Tveita, 1993) that dramatised the kinetic particle found that whilst girls expressed a more positive attitude to drama prior to the study, afterwards the boys became equally positive.

Jidesjö and Danielsson (2016) analysed data from the ROSE study (global Relevance of Science Education) in Sweden and concluded that connecting STEM education to students' outside interests, such as everyday technology and body and health, is vital for ensuring young people's interest in STEM. They also found gender differences in young people's interests in technology - girls reported being more interested in body and health and boys in building and repairing. Looking at the ROSE data for Norway, Sjøberg and Schreiner (2010) similarly found that girls were more interested in health topics and environmental issues, while boys were more interested in technology, mechanics, and electronics.

When the National Academy of Engineering (2008) asked young people in the US if they wanted to be engineers, girls were twice as likely as boys to say no. However, if they asked the same respondents if they would like to design a safe water system, save the rainforest, or use DNA to solve crimes, the girls answered yes.

The importance of anchoring tech's relevance to everyday life and providing environments which promote hands on, creative learning has been a recurring theme in the interviews conducted thus far. Lack of these important elements are believed to be one of the factors for the cooled interest in STEM subjects. A young female informant (aged 20) expressed this in the following way:

«I think interest is lost partly when «technology» is introduced as a subject in school. You lose the connection to «reality» - when in fact, technology is all the things that are around you! Your snapchat filter you use each day is AI, improving an app, facilitating being a blogger (...) it is all technology! This, in combination with all the stereotypes you have, makes the discouragement larger»

One of the survey respondents also wrote that what is needed is:

«A broader perspective on what tech is. Connect STEM topics to «saving the world», girls/women are often interested in making lasting positive change, but they have no clue that's what engineers do»

More research is needed into the best approaches to teaching tech and STEM in schools in a way that inspires young women, and men, in Scandinavia. The below case-study from the UK provides inspiration for a study that could be replicated in the Scandinavian context. It rigorously measured the outcomes of different teaching and learning strategies on girls' engagement with physics to identify specific tactics that could be implemented elsewhere.

«What works» : Girls Into Physics: Action Research, UK

100 schools in the UK participated in an action research project in 2008 to build understanding of how teaching and learning strategies based on gender research can be used to engage girls with physics (Daly et al., 2009). This project found that effective teaching styles to engage girls included more discussion time; posters and presentations; increased practical, group and project work; and «girl-friendly» examples, focusing on applications of physics that girls found more interesting and engaging.

However, DAMVAD's (2016) study of girls and young women who choose STEM in Scandinavia found that some young women find the single-sex approach patronising and too restrictive - for example, focusing girls' initiatives on «design» rather than algorithms and programming. Giving girls a supportive environment in which to explore technology and computing is positive, but «girls only» initiatives must not fall back on tired gender stereotypes in their choice of language or activities.

This sentiment was shared by the respondents involved in the project survey. One wrote, for example, that they would be put off by «Girl-tech projects that only contribute to stereotypical gender biases».

GIRLS ONLY - SINGLE SEX INITIATIVES TO ATTRACT GIRLS INTO STEM

Whilst it could be argued that bringing boys and girls together to work on STEM initiatives is the best way to challenge the gender binary in the early years, later on in young people's lives, when gender stereotypes have become more entrenched, some have argued that a 'girls-only' approach is the best way to address the gender digital divide. Crombie et al. (2002) found that all-female computer environments in secondary school enabled girls to be more vocal, gave them more confidence and raised the level of girls' perceived support from teachers. Another study found that all-girl environments with girl-only peers helped build community and increased girls' self-reported amount of learning. Girls felt they could do computing because there were other girls doing it around them (Jenson, de Castell, & Fisher, 2007).

4.2.3 STEM OUT OF SCHOOL

Alongside positive experiences in the classroom, opportunities to explore technology and science outside of school can also inspire more young women to pursue a future in this area – 54% of respondents engaging in the survey carried out for this report selected this category as helpful for encouraging more girls to pursue this path. Henriksen et al. (2015) collected questionnaire data from 5,007 Norwegian first-year students in all STEM higher-education disciplines to understand the influence of out-of-school experiences and targeted recruitment efforts in Norwegian Science and Technology Students' educational choices. They found that popular science as well as leisure-time activities and experiences in nature were rated as highly inspirational, with fiction or drama with a science component rated particularly highly by girls. Visits to or from a higher-education institution were rated fairly highly too, and so the authors concluded that stakeholders wishing to improve STEM participation might consider partnerships with educational institutions, popular science, the media and organisations offering outdoor activities for children and adolescents, in designing information and outreach to improve STEM participation.

Including programming in out-of-school programmes at so called «fritidssentre» (youth recreation centers) was proposed by a young Norwegian informant from the interviews conducted for this report as a good way of reaching young girls, especially in socioeconomically challenged areas. She described it the following way;

«Well you don't really do much at fritidssentre anyways, you kind of just hang out... I think it would be great if you had the ability to learn some coding there, that would be very useful»

Engaging in tech/STEM outside of school also provides girls with the opportunity to meet role-models studying or working in this field – a key factor selected by 78.49% of respondents taking the survey conducted for this report as helpful in getting girls and young women to pursue this path.

«What works»: The Girls' Day at the Norwegian University of Science and Technology

The Girls' Day (TGD) is a two-day event at the Norwegian University of Science and Technology (NTNU) aimed at girls who have chosen specialisation in mathematics and physics in their last years of upper secondary school. During the 2011 TGD event, 251 participants attended a science show, a lecture about privacy and data security, a «motivational» lecture, and a lecture where they received information about the study programmes and everyday life as a student at NTNU. They were divided into five groups based on what study programmes they had expressed interest in, took part in a guided tour around the campus where they visited different departments and laboratories, met university students and participated in hands-on activities. The university covered all expenses for participants who travelled from all parts of Norway (Jensen and Boe, 2013).

The event influenced the participants' STEM motivations by affecting their expectations of success and subjective value of STEM tertiary education. Meeting university STEM students was emphasised as the most important factor. These students provided «trustworthy» information, and served as achievable role models helping the participants to see themselves as future STEM students. The majority of the participants rated the costs (in terms of required effort) of studying STEM higher after the event than they did before, but this did not weaken their expectation of success. While learning about the difficulty and required effort, the participants were also introduced to strategies for coping with these costs: study groups, tutor support, and «it is tough for everyone» attitudes.

«What works»: IT Camp for Girls at the IT University of Copenhagen in Denmark (ITU)

This IT camp was a free three-day workshop for about 50 high school girls. It was taught by male and female teachers and it introduced data science and programming concepts through a series of lectures and hands on exercises. Female students were supporting the activities and acting as role models for the high school students. The camp was successful in inspiring and motivating some of the participants in choosing computer science education, with 11 of the 50 participants among the female students admitted to the bachelor in software development in the fall of 2017. Following this intervention alongside others (the introduction of BootIT, Live Coding, Study Lab, IT Camp for Girls) the percentage of female students admitted to the bachelor in Software Development doubled in one year – from 11% in 2016 to 22% in 2017. This was the steepest raise in percentage of women admitted over the past seven years (Borsotti, 2018).

4.2.4 MENTORS AND ROLE-MODELS

The popularity of STEM mentoring has grown, but the research on what makes these programs effective, either in isolation or in combination with other supports, has lagged behind (Kupersmidt et al., 2018). Very few STEM mentoring programs have been formally evaluated using any kind of experimental or quasi experimental design. Nevertheless, a study in Denmark, which looked at the reasons for choosing a career in engineering, found that men were more influenced by intrinsic and financial reasons but women were far more influenced by mentoring (Kolmos et al., 2013). Stoeger et al. (2017) argue that female mentors can have a positive effect similar to the peer benefits already discussed above (i.e seeing female mentors reduces stereotype threat, girls feel less alone etc.). 48.84% of respondents taking the survey conducted for this report selected 'Having a mentor/being involved in mentorship initiatives' as helpful for getting girls and young women into STEM/tech. But having female mentors alone isn't enough - other studies show that other essential characteristics of mentoring are one-on-one mentoring relationships, high-frequency mentor–mentee communication, program durations of at least several months, and a high degree of compatibility between mentor and mentee (DuBois et al., 2002; Eby et al., 2008; Underhill, 2006).

One of the young women in STEM that we interviewed for this report told us about how much she had gained from having a female mentor:

«I was looking everywhere for female role models to do my internship with. It proved to be very difficult, but after a while I found this woman, who I still keep in touch with. And I was surprised by how similar we were! She was just normal, and she had reached so far in her career! She's researching the most up-to-date physics and had received plenty of stipends and such. But she was so normal, liked dancing, had a family, she had her feet on the ground. She wasn't anything like I thought you had to be to be successful as a woman in STEM. I was 16 when I met her, in the end of högstadiet. She has helped me a lot, and we still keep in touch. She was relatable, perhaps that is a better word than «normal» (laughs), if she can do it, so can I! She is definitely my biggest role model»

Another young woman that we spoke with reiterated the importance of having relatable female role models in STEM:

«It's important to know that completely ordinary girls and women, can also be in science. Like you can be completely obsessed with makeup and spending WAY too much time watching trash TV and still be interested in doing a good job, and interested in doing well in school just as well as a man. You don't need to be put in a box»

«What works»: DigiPippi, Denmark

One of the interviews conducted for this report was held with an expert from DigiPippi. This Danish initiative seeks to encourage young girls' interest in tech in girls-only learning environments with female teachers who also act as role-models and mentors. The initiative appears to be successful in multiple aspects:

First, by having female teachers leading the classes, and encouraging the participation of mothers and grandmothers of the young women involved, the project aims to break gender-stereotypes of what females are good at. Using constant encouragement alongside this approach has created a positive impact on the girls and their self-belief.

Second, the teaching is carried out in a safe and open space. Before introducing any tech project or task, the facilitators listen to the young girls' own interests and ideas and find ways to incorporate this into the classes. The girls are also encouraged to use technology in a way which aligns with their interests and identity. This increases their sense of belonging and self-efficacy.

«What works» : CyberMentor for girls in high-achiever track secondary schools, Germany

Stoeger et al. (2017) examined the Germany-wide e-mentoring program CyberMentor. The program provides female students between the ages of 12 and 18 with at least one year of one-on-one interaction with a personal female mentor who has a college degree in a STEM subject and is currently working in a STEM field. The program gives as many as 1600 mentors and mentees per year the chance to communicate about STEM subjects and careers via a members-only online platform using internal e-mail, chat, and forum functions. Program participation affected positive changes in certainty about career goals (independent of STEM) and in the number of STEM activities. E-mentoring can overcome limitations of recruitment, geography, and scheduling that apply to offline programs. In e-mentoring programs, mentor and mentee need not live in close proximity to one another or share similar daily schedules or even time zones. These flexibilities of time and space also allow e-mentoring to offer participants more chances for interaction with program participants beyond their immediate mentoring dyad.

4.3 UNIVERSITY

Despite all the challenges that they face, some young women in Scandinavia make it through to studying STEM within higher education (albeit at consistently lower rates than their male counterparts). But this does not mean that there are no challenges for them to face at this stage.

Some universities have developed initiatives to build young women's confidence and ability to succeed in STEM courses. As the case-studies below show, some of these focus on changing girls' perceptions and strengthening their resilience. However, other programmes have sought to instead change the nature of STEM education itself, by integrating gender into teaching and course content, or addressing gender bias in the department and thus hiring more female professors.

It seems that interventions early on in university that seek to provide those with less prior experience with computing extra support are especially beneficial for young women in higher education. This is not surprising, as young women in Scandinavia are less likely to have engaged with computer science to the extent

EFFECT OF THE MEDIA AND ENVIRONMENT

A randomized controlled trial among female ninth and tenth grade students in the USA found that the girls showed higher comprehension in a chemistry lesson when the images in their textbooks included female scientists (Good et al., 2010). Another study tested the effect of classroom environments on female interest in STEM (Cheryan et al., 2009 & 2011). When entering a room with insufficient lighting, cables, drinks cans littered around and posters with Star Trek on the wall, women participating reported feeling dissuaded from pursuing computer science at university level. However, the other group of women in the study, who were introduced to a computer classroom with art posters, books, plants, and water bottles, expressed more interest in doing so. Neither environment had any effect on the interest level of the male participants.

Henriksen et al. (2014) found in their survey of Norwegian students in all STEM higher-education disciplines that females reported a higher degree of inspiration from television drama series with scientific elements than did males. Other researchers have pointed out that the public image of scientists remains as a whole highly gendered (Christidou, 2011), and that increasing the positive images of female scientists on television might be effective for increasing girls' motivation for STEM studies (Long et al., 2010). Henriksen et al. (2014) also found that whilst the web pages of universities and colleges were rated as an important source of inspiration by STEM higher-education students (both female and male) the multitude of campaign websites established by STEM business organizations, professional organizations and so on are visited by a small minority and are not rated as influential by those few who have visited.

that boys have prior to starting university, due to all the barriers already discussed (Borsotti, 2018).

«What works» : CareerWISE, resilience training website for Women in STEM Doctoral Programs, USA

Bekki et al. (2013) tested the potential for an online resource to increase resilience and persistence among women in STEM doctoral programs. The study recruited 133 women in at least their second year of a PhD program from 23 universities studying chemical engineering, civil engineering, electrical engineering, materials science, mechanical engineering, computer science, applied physics, applied math, physics, astronomy, math, chemistry, or geological sciences. The authors examined the effects of 5 hours of independent exploration on the CareerWISE website on problem-solving knowledge, resilience, and coping self-efficacy among women pursuing PhDs in engineering and physical sciences. Women who used the CareerWISE resilience training website for at least 5 hours demonstrated significantly greater problem-solving knowledge, resilience, and confidence in their self-efficacy to cope when considering common challenges in their STEM PhD programs.

«What works» : Integrating gender perspectives on teaching and subject content at the Swedish University of Agricultural Sciences

A study by Powell et al. (2013) looked at an intervention project with the aim of introducing gender and norm critical perspectives in teaching at a natural science university. The purpose of the project was to establish new ways of working towards more gender equal education by offering a course for university teachers. The course evaluation and follow-up interviews show that the project increased awareness of gender perspectives in teaching, supported individual teachers who were or had become engaged in these questions, and provided a platform to discuss issues relating to teaching overall. However, the fact that the project was externally funded affected the prospects of long-term effects, given the uncertainty of funding.

«What works» : Gender bias workshop for university STEM departments, USA

Gender bias, particularly unconscious and unintentional bias held by individuals, persists across academic fields including science, medicine, and engineering. Devine et al., (2017) developed a 2.5-hour workshop that treated gender bias as a deeply ingrained habit that could be countered using a habit-breaking approach: increasing awareness of the habit, generating willingness and confidence to change the habit, and practicing new behaviors to replace the habit. They offered the workshop at a large public university, across departments housing faculty in science, medicine, and engineering, and found that the intervention improved individual self-reports of gender bias awareness and departmental climate.

In a follow-up study, the authors further assessed real, institutional-level outcomes from the habit-breaking intervention. Tracking faculty composition over the two years before and the two years following the workshop offerings, they compared the gender balance of departmental hiring and attrition between departments that participated in the workshop and departments that did not receive the intervention. Over the two years following a 2.5-hour departmental-level workshop that presented gender bias as a changeable habit, departments reached gender parity in hiring new faculty.

«What works» : **BootIT, ITU Study Lab, Live Coding Sessions, ITU Computer Science Department, Denmark**

Since females are less likely than males to have extensive previous coding experience, and the bachelor in the ITU Computer Science Department was not geared enough towards absolute beginners in coding, the introduction of support learning activities like BootIT, Live Coding and Study Lab has been an important first step in leveling the field and creating a better learning environment, making the bachelor more accessible for qualified students without prior coding experience (Borsotti, 2018). Faculty members in the department introduced the following learning activities in the summer and fall of 2016, specifically targeting first year students:

BootIT: an optional, free and informal workshop that targets first year computer science students with no prior coding experience. The goal of the workshop is to expose students to the basics of programming in a stress-free environment, increasing self-confidence.

The ITU Study Lab: a peer-to-peer optional support activity run by experienced students working as tutors, developed and supervised in collaboration with academic staff.

Live coding sessions where experienced teaching assistants demonstrate how coding is done and encourage students to get more hands-on experience.

These support activities were reviewed by both female and male first year students interviewed in the fall of 2016. Those with no prior coding experience highlighted that extra support activities positively affected both the learning experience and non-cognitive skills such as self-confidence.

4.4 THE WORKPLACE

Project Lily, which surveyed new students at Norwegian public universities and university colleges, found that young women and men have many similar priorities around future jobs. However, young women value idealism, meaning and a good working environment more than young men, whereas the men, more than the women, want to develop technology and use tools and instruments (Shreiner et al., 2010). The McKinsey (2018) report «Bridging the Talent Gap in Denmark» suggests that «attracting» women to STEM jobs is only the first step - retaining women within STEM careers is also vital, particularly after having children, as well as advancing them to leadership positions. This report notes

«ATTRACTING» WOMEN TO STEM JOBS IS ONLY THE FIRST STEP - RETAINING WOMEN WITHIN STEM CAREERS IS ALSO VITAL.

that after graduating from STEM higher education in Denmark men dominate graduate positions in core STEM roles, such as engineering and software development. Danish women suffer setbacks in their pay after having children, and fewer women than men make it into management roles.

In terms of what can be done to improve the gender balance in tech workplaces there is no 'silver bullet' or single all encompassing solutions. More research is needed in this area, as there are a dearth of studies undertaken in Scandinavian workplaces specifically. However, 58.14% of respondents engaging in the survey conducted for this report selected «Inclusive employment practices from tech companies (for example unbiased hiring, flexible working, equal pay)» as helpful in enabling more young women to work in tech/STEM. Below are some suggestions from the survey respondents:

«We should be allowed to compete equally. Unbiased hiring and promotion of women especially from delivery IT based backgrounds would really help this»

«There is [a scheme] in Denmark where they are trying to encourage foreign women in tech to move to work in Denmark in tech. All the jobs advertised are developer jobs. Frankly as a programmer you can earn big money anywhere. Why would I move to Denmark for an average danish wage? When I can go to America and earn a lot more? There are little prospects for progression in the jobs on offer and the environment is often hostile to foreigners as much as women. Advertising on a women specific website with average pay rates won't get the numbers of women up. Positive discrimination with competitive pay offers and within 2 years a proper promotion might»

«Offer training on salary negotiations and statistics. Women under-value themselves. Companies should also be aware of this and try to help women be paid fairly, and not pay less because they can get away with it. Companies need to be open to different types of tech experience, not assume that you can only be a good coder if you have done it in mom's basement since you were nine. Create a working environment where women feel welcome, included and equal, and differences in point of view and experience are seen as resources not problems. Organisations could reach out to younger age groups and make female tech role models more visible… Forgot to mention mentor.se that has job mentors talking about their career in schools, which I think is great. I have joined as a mentor once, and tried to put emphasis on the programmer job not being antisocial or boring but actually very collaborative and dynamic. I think the social aspect of a career is generally more important to women, and maybe also an «ideological» factor, wanting to do something good or meaningful in some way. At least to me it is. So organisations could highlight this type of aspect in tech, like sending drones with medicine in Africa, researching for more environmentally friendly energy sources etc. Women in Tech conference does a great job with this, but the reach is limited»

«What works» - Attraction: Career Networks, The Girl Project Ada, NTNU, Norway

The career networks are collaborative projects between the Girl Project Ada and a number of companies in the business community. Their aim is to promote networking between female students in the programmes: Mathematical Sciences, Informatics, Computer Science, Communication Technology, Electronic System Design and Innovation as well as in Cybernetics and Robotics and the project's business associates in the private sector. The Girl Project Ada runs two different career networks; one for electronics and cybernetics and another for the IT students. Each network has four annual gatherings where students and representatives of the companies meet for professional and social purposes, with a focus on networking.

The company representatives are usually (but not always) women, and many of them were students at NTNU themselves. The companies taking part include Accenture, Cisco and Telenor. At the career network gatherings, students can get to know people in the industry, and they gain valuable information about career opportunities and the type of working day that awaits them when they complete their studies. For the companies, the Career Networks are an effective way to get in touch with potential employees. Many of the women who have participated have gained their first job as a direct result of contacts they established through the Career Network.

Just over 30% of the respondents engaging in the survey carried out for this reported similarly selected «Engaging in networks on tech and STEM» as helpful for young women wishing to pursue a career in this sector.

«What works» - Retainment: Flexible working in a large IT company, USA

In a field experiment at a large US IT company, more than 800 employees were randomly assigned to the «treatment» or «business as usual» group. The intervention program gave employees greater control over their schedules and involved active supervisor support for providing flexibility to prioritize family and personal life. Participants were surveyed over 12 months, and the measures were found to both increase job-related well-being among IT workers, as well as general well-being among women (Moen, et al., 2016).

«What works» - Advancement: Mandatory gender quotas on company boards, Norway

In 2003, Norway became the first country to adopt mandatory gender quotas on the company boards of public limited companies (PLCs) (Act on Companies no. 120/2004), inter-municipal companies (Act on Inter-Municipal Companies no. 120/2004), and state enterprises (Act on State Enterprise no. 120/2004). In 2012, at least 40% of board members of PLCs and state-owned and municipally owned companies were women (Teigen, 2015).

«What works» - Industry cooperation for equality: Womentor

In 2006, Womentor, the leader- and mentorship programme for companies in the IT and telecommunications industry, was initiated. Apart from leadership and change programmes, Womentor allows companies to match junior managers with more senior mentors. In 2016, the Swedish Nyckeltalsinstitutets equality index showed that companies that have participated Womentor have a more positive development than the industry at large. These companies represented a 135 median score, versus the 116 median score for the whole industry (Womentor 2018).

5.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

This report has focused on the gender imbalance in digital technology related studies and careers in Scandinavia, drawing on both academic and non-academic literature and on primary survey and interview findings with young women and experts from the region. Firstly, the gender gap in technology in Scandinavia was discussed in detail, and the rationale for closing it presented. Then the specific barriers that young women face to pursuing education and jobs within the digital technological sector were examined. This then led on to a chapter explicitly focusing on the evidence as to «what works» in addressing each of these barriers at different stages of a young woman's life. Large gaps remain in the evidence base for «what works» in closing the gender gap in technology in Scandinavia. Just as there is a lack of coherent strategies that address the truly multifaceted and multi-levelled nature of this phenomenon, there are also very limited long-term, rigorous investigations that have tracked the impact of particular strategies and approaches over time in controlled circumstances. From the evidence currently available, however, it is clear that there is much more that could be being done right now to support young women and girls in Scandinavia to become future «creators» within the tech sector, and to build long-lasting and fulfilling careers doing so.

Whilst no one group can be held responsible for this task alone, and it will require the combined efforts of many different societal groups to overcome the divide, this report highlights the role that technology companies, in partnership with other actors, can play in closing the gender divide in Scandinavian tech sector. Plan International could see the significant contribution that tech companies stood to make in resolving this issue. Yet very little research carried out up until this point has concentrated on the capacity that they have to make a difference. This was the rationale behind commissioning this report. If Scandinavian tech companies are motivated to make a change and contribute to supporting young women to embark on a career in digital technology creation, thus also supporting the growth and longevity of their work and the sector as a whole, then what steps can they take?

The interviewees and survey respondents taking part in this study specifically noted the key role that technology companies have to play. In the words of one of the survey respondents:

«Corporates are major employers and investors after all they could do a lot more to help»

Therefore, the below recommendations are for technology companies looking to drive progress in this area.

RECOMMENDATIONS

INTERNAL

FIRST STEPS

1. **ASSESS THE SITUATION** - is there a gender imbalance within the technology design, creation and decision-making teams in your organisation?

2. **INSTATE A DIVERSITY AND INCLUSION LEAD** role within your organisation (if this doesn't exist currently) that has direct communication with the CEO to drive momentum and ensure the following steps are achieved in a timely manner.

3. **MAKE A BUSINESS CASE** for change in terms of the gender balance internally in tech roles. Highlight why more women are needed in design, creation and decision-making roles, rather than in the organisation more generally.

4. **CREATE A CLEAR** company strategy to address any imbalances.

5. **MONITOR SET TARGETS** to ensure accountability. Publish the results of this monitoring publicly, both for transparency and to establish your organisation as a leader on this issue.

PUTTING WORDS INTO ACTION

6. **REDUCE RECRUITMENT BIAS**
   - Train recruiters to recognise unconscious biases.
   - Use anonymous application procedures.
   - Ensure job applications are written in gender neutral language.

7. **PROMOTE AN INCLUSIVE WORK CULTURE**
   - Provide flexible working hours.
   - Promote shared parental leave.

8. **CONDUCT GENDER AUDITS OF EXISTING**, and future, products to ensure that they are not contributing to existing harmful stereotypes regarding gender and technology.

RECOMMENDATIONS

EXTERNAL

PROVIDING MENTORSHIP

1. RUN MENTORING SCHEMES (for young women outside the organisation and for those within it)

- One-on-one mentoring relationships are most effective.
- High frequency of mentor-mentee communication is required.
- Programmes should last at least several months.
- High degree of compatibility between mentor and mentee needed from the outset.
- Online mentoring using video calls may be an effective way of ensuring wider participation beyond urban centres.

2. PARTNER WITH UNIVERSITIES to create careers networks where young women in STEM can meet women from different tech companies, build networks and find job opportunities.

SUPPORTING EXTRACURRICULAR TECH ACTIVITIES

3. CREATE, OR CONTRIBUTE TO, EXTRACURRICULAR DIGITAL TECH/STEM ACTIVITIES FOR GIRLS

CONTRIBUTING TRAINING opportunities, materials and sponsorship to already existing groups and schemes may be more feasible, and as many already exist this may be more productive rather than starting anew.

UP UNTIL THE AGE of 12, mixed gender STEM activities that specifically aim to bring boys and girls together to jointly work on technological projects help to break down gender stereotypes and build confidence and enthusiasm.

FOR OLDER GIRLS, for whom stereotypes that tech is 'not for girls' have already become entrenched, it may be more suitable to host, or support, single sex activities. This will enable young women to build a strong female peer group within STEM and reduce stereotype threat - however, care should be taken not to reinforce tired 'feminine' stereotypes within these.

ACTIVITIES THAT TAKE place over a longer period of time, rather than just a single day, are likely to be more effective.

THE TEACHING and learning style within these activities, whether single sex or co-ed, should encourage group and project-based work, creativity, hands-on/practical experience, and connect tech/STEM to real-world issues.

REACHING PARENTS AND TEACHERS

4. CONSIDERING THE INFLUENCE of parents and teachers on girls' decision to follow a digital technology pathway consider creating and/or supporting initiatives that target these role models rather than girls themselves – i.e. a day for computing and STEM teachers where they can build confidence and gain knowledge on how to motivate young women to pursue tech and STEM. There is little currently happening in this area in Scandinavia, despite the evidence suggesting the vital role that parents and teachers play, so there is much to contribute here.

UTILISING MEDIA

5. GENERATE AND/OR FUND gender transformative content across different media channels.

FORGO CAMPAIGN websites (as these receive low engagement).

CONTRIBUTE TO AND/OR CREATE «popular media» around computing, digital tech and STEM.

6. ALSO ENSURE THAT in general company advertising any images used are diverse and non-stereotypical

PARTNER WITH OTHERS

7. PARTNER WITH OTHER TECH organisations, gender equality organisations, schools, and universities - sign agreements, collaborate, and share best practices on addressing the gender digital divide. Closing the gender gap in digital tech and STEM will require the work of many hands rather than a few.

CONTRIBUTE TO POLICY

8. CONTRIBUTE TO POLICY discussions around national tech and digital strategies. Attend meetings, write to ministers, provide expert opinions and evidence to government panels etc. This will help to ensure that teacher training and pedagogical strategies meet the skills needs of the tech industry.

FUND RESEARCH

9. FUND RESEARCH to address knowledge gaps, and provide concrete, longitudinal evidence as to 'what works' in supporting women in digital tech and STEM.

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