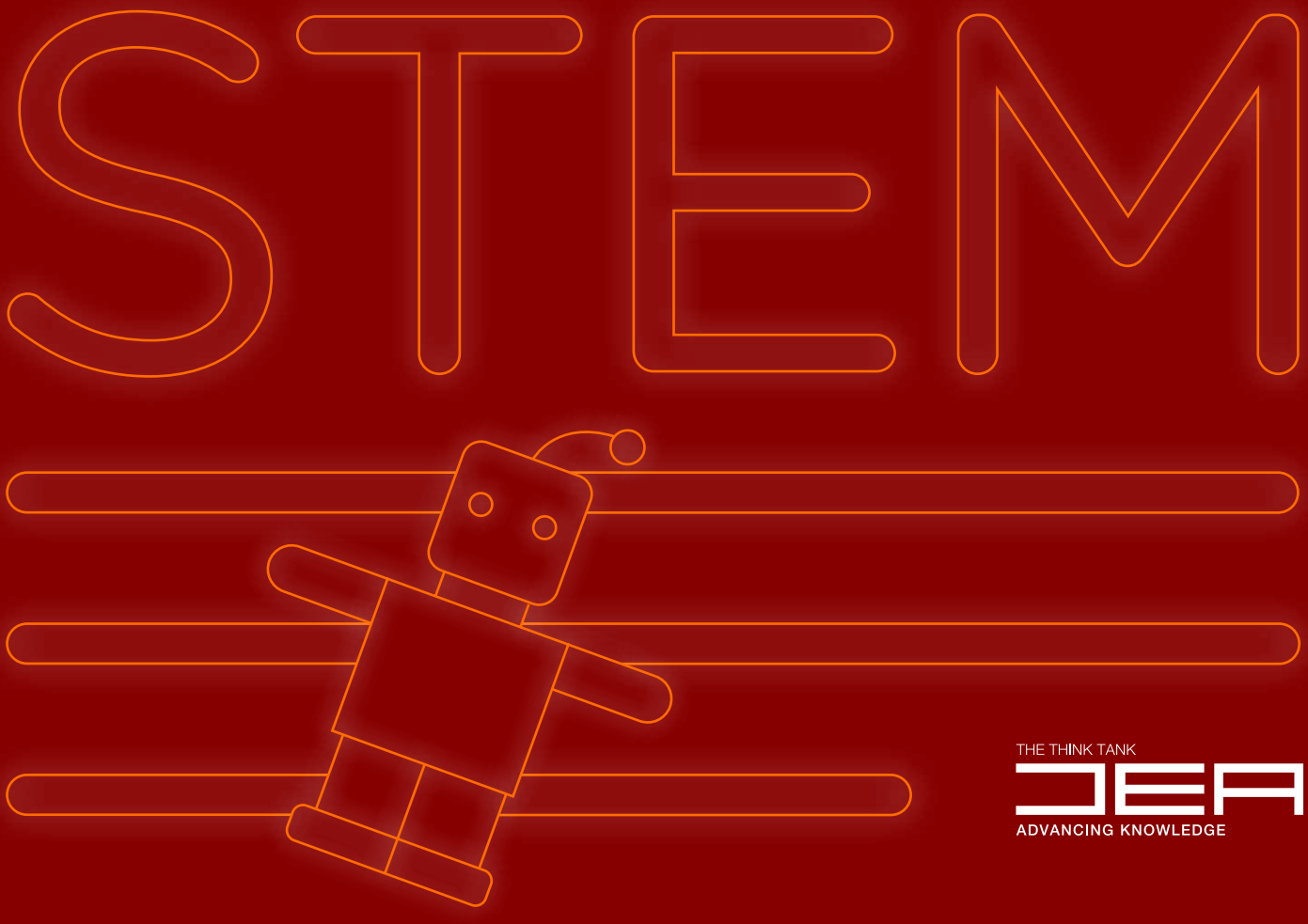
Putting the spotlight on STEM possibilities for youths in Denmark

– Does gender play a role in developing youths' interest in STEM?



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The analyses presented in this report were partly financed with support from Microsoft. Nonetheless, the Think Tank DEA is solely responsible for the findings and conclusions in this report.

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Publisher: The Think Tank DEA
Date of publication: February 2019
Design: Spine Studio

Foreword

Denmark, like several other Western countries, faces serious societal challenges due to a shortage of STEM skills – i.e. skills within Science, Technology, Engineering, and Mathematics. Skills that are critical if we are to successfully adapt to a new technological age. As it is, many Danish companies are finding it hard, if not impossible, to find skilled engineers, IT professionals, and natural scientists, and there are no signs that recruitment will become easier in the immediate future (The Danish Society of Engineers, (IDA) 2018).

Analyses predict a shortfall of 6.500 engineering professionals and 3.500 natural science graduates by 2025 in Denmark. Furthermore, an uncovered potential need for 19.000 IT professionals is expected by 2030 (Engineer the Future 2018). This places new and considerable demands on skills, particularly for young people heading for the labour market. In spite of a great demand by industry for natural science, IT, and engineering professionals, Denmark is poorly placed in rankings of the number of young people opting for these educational programmes. The latest statement from the Organisation for Economic Cooperation and Development ranks Denmark 20th out of 27 (OECD 2019).

Not that there has been a shortage of political initiatives to boost children's and young people's interest in technology and natural science in recent years. In March last year, things gathered momentum with a national natural science strategy backed by DKK 180 million (the Ministry of Education (UVM) 2018). A month later, the Teknologipagten (Technology Pact) was launched with the Government earmarking DKK 75 million and setting a target for an additional 20 per cent of students to complete a vocational or higher education programme over the next ten years in the STEM field (Ministry of Industry, Business and Financial Affairs (EM) 2018).

Moreover, STEM is one of the fields with the greatest gender imbalance. Only every third applicant admitted to higher education programmes in the STEM field is female and this share has remained unchanged since 2011 (Ministry of Higher Education and Science (UFM) 2018). This is not to say that there is a gender imbalance in all STEM fields. It is evident, for example, that the education programmes in health science and bio- and laboratory technology actually admit more women than men. This contrasts with the figures for IT-related fields, technology (including engineering programmes), and the maritime field, where less than a third of the admitted candidates are women. In the field of natural science, generally speaking, there is a relatively even gender distribution, except for in certain subjects such as the physical subjects (physics, astrophysics, geophysics, meteorology, quantum physics, bio- and medical physics). A gender imbalance is also evident among young people enrolled in vocational education programmes in 2018. Vocational programmes in technology, construction, and transport are most popular with the boys and least popular with the girls (UVM 2018).

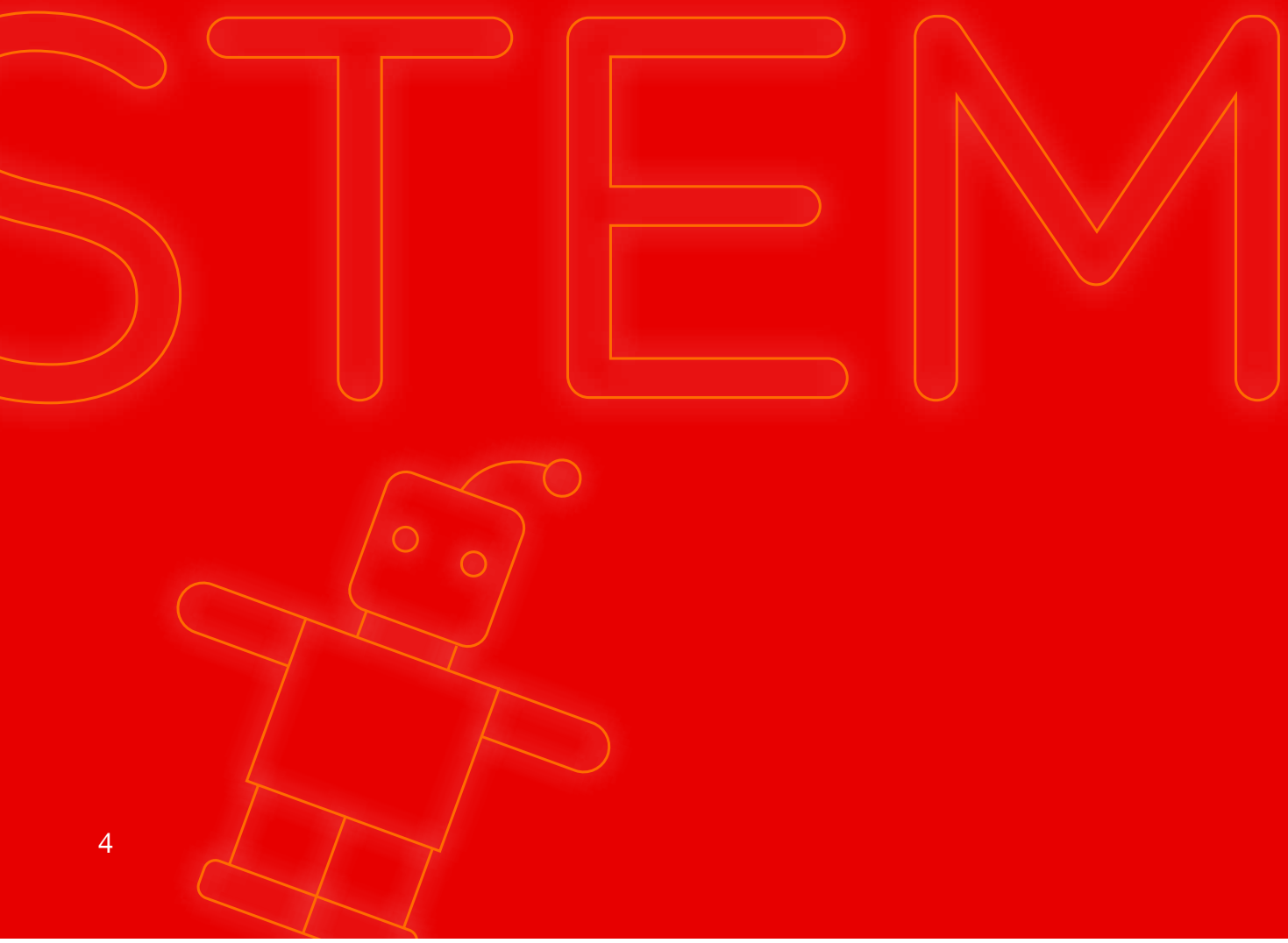
A more even gender distribution in all STEM subjects would not only increase the recruitment pool, but also contribute to a more diverse workforce in these fields. Research suggests that gender diversity provides better team dynamics and ensures higher levels of

creativity and enhanced problem-solving. Work quality is quite simply enhanced by improving gender balance (McKinsey & Company 2018). Further, a more balanced gender distribution in fields developing and producing technology is also relevant, so as to reflect the diverse groups of end users.

If we are to raise the number of young people opting for STEM, these subjects need to be perceived as identity-building, interesting, and relevant. With this analysis, the Think Tank DEA hopes to offer new knowledge on how to achieve this goal.

We are very grateful to Microsoft for partially financing this analysis and providing valuable response and innovative ideas during the process. Thanks are also due to central actors within STEM who have critiqued elements and results of this analysis via a series of workshops.

Introduction



MORE KNOWLEDGE NEEDED ABOUT HOW TO GET MORE YOUNG PEOPLE – ESPECIALLY GIRLS – TO OPT FOR STEM SUBJECTS

In recent years, there has been intense focus on the low demand for STEM programmes, the skills shortage in STEM occupations, and how recruitment to STEM programmes could be increased.

The purpose of DEA's analysis is to contribute new knowledge on how to stimulate, support, and retain young people's interest in STEM. The goal being that an increased interest will eventually result in more young people choosing an education and a career within a field so very important for society.

THE CONCEPT OF STEM

For the purposes of this analysis, STEM is a collective term denoting Science, Technology, Engineering, and Mathematics. IT is part of the four STEM elements and covers fields such as programming, software development, coding, computer science, robot technology, and technological understanding. As the target group of the analysis is children of various age groups at primary school and lower secondary level, the concept of STEM should be interpreted widely and as a two-tier term. Firstly, the concept defines STEM-related subjects at elementary level, including maths, natural science/technology, physics/chemistry, etc. Secondly, the concept defines the general inclination of children to learn and develop an interest in IT, technology, and natural science, which may also occur outside school.

Prior to this analysis, a survey of existing literature describing the paths taken by young people to STEM was conducted in order to effectively add to existing knowledge.

The main findings of this literature survey showed that:

- STEM is undergoing a crisis in several Western countries, and young people in these countries often choose education programmes that will sustain identity formation – quite a number of young people experience a mismatch between the identity they want to foster and the identity offered by STEM subjects. Moreover, gender-stereotypical ideas tend to influence how girls in particular perceive their abilities within STEM. This is evident, for example, when girls increasingly deselect or lose interest in subjects traditionally perceived as a 'boys' subject'.

- An interest in STEM is strongly evident in children starting primary school, but declines gradually during this period. It is worth noting that once interest in STEM has declined at primary level, it is difficult to rekindle it later.

- Parents have great influence on children's and young people's interest in STEM – reflected in their economic resources and socio-economic background, but also how they rear their children and their function as role models. Similarly, children's and young people's in-school and out-of-school activities are very significant.

Based on these results, particularly two issues need clarification in a Danish context.

The first issue addressed by the analysis is the interest development in primary school children during a relatively limited period. The target group for the analysis is children at the intermediate level (aged 10-11) and young people at lower secondary level (aged 15-16). According to the literature, these periods are crucial

for interest development in children and young people and many

The second issue investigated is the extent to which children's lives have any impact on interest development. In other words, we look at interest development in both children and young people during their school lives (subjects, teachers, etc.), but also outside school and at home. Other analyses show that parents, the home, and out-of-school activities are significant for the choice of upper secondary education. It is necessary, therefore, to take a broad view of the aspirations of children and young people and recognise that they are, to a large extent, also fostered and developed outside of the school.

ISSUES INVESTIGATED

With reference to the challenges for STEM subjects and the societal challenges derived from these, the analysis addresses the overall question: How do we encourage more young people, especially girls, to choose STEM subjects and consider a STEM career?

The analysis investigates the following four issues:

1. What is the level of interest for STEM among pupils at primary level? Is it possible to identify a difference in numbers showing an interest in STEM at primary and lower secondary level, respectively?

2. What distinguishes the pupils who show (most) interest in STEM at primary and lower secondary level, respectively? What is the significance of gender?

3. How many and which pupils at lower secondary level expect to select STEM subjects in upper secondary education? How do young people experience STEM in relation to their future prospects? Is there a gender-specific difference in expectations and future prospects?

4. Which part do parents play in supporting their children's interests and directing and guiding them in their further education, including broadly sustaining any STEM interest with a view to making a choice of education?

HOW WAS IT DONE?

Apart from studying the literature derived from Danish and English language surveys concerning young people's paths to STEM, the analysis consists of two main elements:

- A questionnaire survey for pupils aged 10-11 (1,983 replies), pupils aged 15-16 (1,348 replies), and parents of the latter group (1,565 replies) with focus on STEM interest in the family, at school, and outside school. The questionnaires for the children and young people were piloted in the respective target groups. Representative samples from each respondent group were selected. Statistics Denmark were in charge of collecting the data via an online questionnaire based on postal distribution and a subsequent telephone follow-up. The three final respondent groups were then compared to the respective populations. A non-response analysis was conducted and any variables have been weighted, so that all three surveys are representative of the population. Subsequently, all three respondent groups were enriched with register data from Statistics Denmark. Further, register analyses were conducted for all three respondent groups to see whether any distinct features could be linked to the respondent patterns from the three surveys.

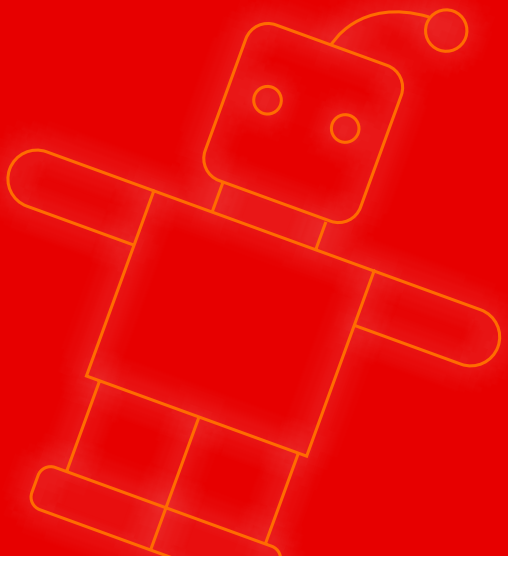
Thirteen qualitative follow-up interviews with girls aged 15-16 showing interest in STEM. The interviewees were selected on the basis of their questionnaire responses where they showed an interest in STEM and had undertaken STEM activities within the past two weeks. Apart from this, selection was done with inspiration from

critical case study methods. Interviewee statements were used to provide examples of how the general patterns that emerged from the survey might be interpreted, and to delve into special challenges for girls in relation to STEM. The interviews were conducted across geographical areas and across special interest areas within STEM. They were conducted as semi-structured personal in-depth interviews with two qualitative consultants interviewing the girls face-to-face. The interviews were recorded by Dictaphone and later transcribed. All the interviewees in this report are anonymous and consent was given by both parents and interviewees.

Moreover, a number of experts and central actors in STEM areas have, via two workshops, critiqued the methodology and results of the analysis.

In addition to the main results detailed on the following pages, an analysis report has been prepared where the results are clarified and described in more detail. Download the full report (in Danish) and read more here: www.dea.nu/publikationer/hvordan-faar-stem-paa-lystavlen-boern-unge

Main Conclusions



STEM interest outside school and at home

The analysis looked at the development of out-of-school interests of children and young people, i.e. outside school and at home, and it shows that:

- Children and young people generally have several interests which they actively practice outside school. Young people aged 15-16 generally have fewer interests than children aged 10-11. This is seen as a natural part of the maturing process from child to teenager.

- There is a steep decline in STEM interest, however, between these two age groups. On average, STEM interest drops by a fourth between these two age groups. In comparison, young people's interest in subjects outside STEM drops by a tenth. The girls, in particular, tend to lose interest in STEM by the time they reach lower secondary level. A decline in interest is notably felt in maths, natural science, and technology, while the interest in IT follows the development of interests outside STEM areas.

- The decline in interest among girls for certain STEM-related subjects is markedly bigger than among boys. There is a major difference within the subjects of biology, chemistry, and maths. More specifically, the interest in reading or watching programs about animal life or the human body, and in conducting chemistry and maths experiments drops by 20 percentage points for girls between these two age groups.

- There appear to be no significant socio-economic differences between children and young people interested in STEM and those not interested in STEM. The two groups differ primarily in that more boys than girls have STEM interests and that young people showing interest in STEM tend, to a larger extent, to have parents with an interest in STEM. Further, it is characteristic for young people with STEM interests that they, to a greater extent, like natural science subjects at primary level and consider the subjects important for their future. Also, they consider applying for STEM programmes in their upper secondary education and working in a STEM occupation when adults.

- The declining interest in STEM is reflected in the difference between children's and young people's STEM activities. Here, a similar drop is evident between the two age groups. This drop should be seen in light of the fact that parents participate less in their children's STEM activities as the children get older. Moreover, the girls feel that it becomes increasingly difficult for them to couple an interest in STEM with 'fun' leisure activities.

- STEM subjects are experiencing several problems in relation to parental support. Parents and children generally discuss the children's interests less as the children grow older. Beyond this, parents and children talk less about STEM-related interests compared to other interests at both intermediate and lower secondary levels. There is evidence to suggest that STEM interests may be difficult conversational topics. Fewer parent-child discussions about STEM can be a problem in relation to children's and young people's interest in STEM. Literature shows that the general attitude of parents and their knowledge about STEM are cornerstones when it comes to children and young people developing an interest in STEM.

STEM interest in primary school

The analysis also focused on the interest shown in STEM by children and young people at primary and lower secondary level, showing that:

- Children and young people interested in STEM outside school also tend to like STEM-related subjects. Teachers also play a key role in whether a subject is experienced as 'fun'.

- There is a decline in the interest girls show in maths between intermediate and lower secondary level, while there is a decline in interest levels for natural science subjects in both boys and girls. In comparison, both girls and boys retain their interest in linguistic subjects. For the girls who retain their 9 interest in STEM at lower secondary level, their interest is stimulated by the methodology of the subjects. Conversely, they typically show no interest in the topics and domains of the STEM subjects.

- While interest in the subjects, including maths, develop differently in boys and girls, there are changes as to which parent tends to help with maths homework. Children in the 10-11 age group receive equal amounts of help from both parents for maths homework while young people in the 15-16 age group receive distinctly more help from their fathers than from their mothers. This result should be seen in the context of the fact that fathers to a greater extent feel better equipped to help with maths homework than mothers.

STEM interest in the future

Finally, the analysis focused on children's and young people's thoughts about future educational and career choices with special focus on STEM, indicating that:

- Almost all parents (93 per cent) talk either often or sometimes with their child about education opportunities after primary school. There is a striking coincidence between how much parents talk to their child about educational opportunities and how resolved their child is. In addition, there is a striking coincidence between the type of upper secondary education parents believe their child should choose and what the child actually plans to choose. So, parents exert, in varying degrees, influence on young people's choice of upper secondary education. This influence is expressed in the guidance and counselling given to their children.

- A majority of young people want to progress to upper secondary education, a fact corroborated by the enrolment figures for upper secondary education. A close look at young people's preferred study programmes in upper secondary education reveals gender-specific differences. Substantially more boys than girls want to start a STEM programme.

- Parents' attitude to the specific type of upper secondary education their children should opt for differs depending on their child's gender. 54 per cent of the parents of boys think their son should opt for a technology- and IT-related programme. This is true for 26 per cent of the parents of girls. On the other hand, 46 per cent of the parents of girls think their daughter should opt for a linguistic programme while this is true of 35 per cent of the parents of boys.

- Parents perceive boys to be more interested than girls in maths, technology, IT, and physics/chemistry in an educational context. 70 per cent of the parents believed boys to be more interested in technology and IT than girls, while less than one per cent replied that girls were more interested in technology and IT than boys. Youngsters join in this perception, unanimously explaining that boys' interest in IT is likely to be due to their interest in computer games.

- Looking further into the future for young people, there are gender differences in job aspirations. The boys specifically prefer working with robots and technology (32 per cent), developing computer programmes and apps (31 per cent), and constructing or designing houses, bridges, and trains (26 per cent). The girls prefer helping and looking after people (42 per cent), designing and painting (30 per cent), and working with animals (29 per cent). From intermediate to lower secondary level, the jobs in which children mostly lose interest are: developing computer programmes and apps, working with nature and the environment, and working with animals.

- Thus, it is worth noting that the dream about working with IT declines significantly while, broadly speaking, there is only a minor decline in interest for IT. This suggests that young people find it difficult to see themselves in job functions within IT, although they retain an interest in IT.

- The 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. Moreover, there is a lack of female role models.

- Girls find it difficult to reconcile STEM jobs with their interests and preferences despite actually being interested in STEM subjects. This being a challenge for girls interested in STEM seems to indicate a general problem in the STEM area as a whole. The lack of role models and the perception of opportunities within STEM contribute significantly to teenage girls not gravitating towards STEM jobs, including jobs within technology and IT.

RECOMMENDATIONS

Based on the literature and the findings of this analysis, it becomes apparent that children's and young people's interest in STEM at school, outside school, and as a future occupation is influenced by many complex factors.

Consequently, there is a need for long-term action if we are to succeed in bringing about the necessary cultural changes to elevate the perceived prestige and relevance of STEM occupations. A number of initiatives have already been set in motion. For example, a national natural science strategy has been launched, TeknologipagtRådet (the Technology Pact Council) has been established, and several private foundations have pledged their support for initiatives in this area. As such, a number of actors and initiatives are committed to changing the view of STEM in the long term.

With these recommendations, we hope to inspire future initiatives and to further clarify the many that already exist.

#1

Start early

The analysis shows that youngsters' interest in STEM is greater at the intermediate level than at lower secondary level. Children's minds are more receptive at this stage than later on, and the scope for interest development in children and young people is influenced by this. Although children's and young people's interest in school subjects shows a general decrease, it is evident that the interest in STEM is falling more than in other subjects – especially among girls. Similar findings were concluded in earlier analyses on this subject, indicating that motivation for learning about natural science declines during the school years, and that influencing young people's choice of education at the upper secondary education level is difficult. If we want to stimulate and retain interest in STEM, there is every reason to consider initiatives and activities which can stimulate curiosity about STEM in children and parents already at the preschool stage and in the early years of primary education.

#2

Use education material that breaks with gender stereotypes in education and career choices

The learning environment is of great importance. Teachers motivating and encouraging youngsters to work with STEM is vital in order to raise interest levels. Also, the impact of didactics is conspicuous, where notably girls and women are attracted to creative, applied, and collaborative work methods.

DEA's analysis and existing literature suggest a need to look closely at both the presentation of topics and the design of teaching materials when stimulating and sustaining an interest in STEM, particularly for girls, in a school context. From existing literature, we know that girls and boys are typically interested in different STEM subjects, where girls tend to focus on health-related subjects. Moreover, DEA's analysis suggests that girls interested in STEM are attracted to the actual STEM methodology while the specific topics in STEM subjects are rarely seen to reflect their interests. This may be a contributive factor to girls finding it difficult to link STEM educational programmes and jobs to their aspirations to work with people. It is vital, therefore, that schools work meticulously with selecting and presenting STEM subjects to appeal to the interests and preferences of the girls, thereby avoiding the gender imbalance which hitherto has posed a risk of gender stereotypes in educational and career choices.

#3

Make STEM subjects and careers visible and concrete in lessons

Existing literature and the findings of this analysis suggest that young people – especially girls – find it difficult to link their STEM interests with a STEM-related career. It is paradoxical that girls, despite showing a concrete interest in STEM subjects, find it difficult to visualise a career path resulting from this interest. One of the reasons for this is that girls do not connect their aspirations for working with and assisting people with a STEM career.

It is crucial, therefore, to bring STEM subjects into play during lessons in connection with concrete problems or phenomena. This may contribute to visualising the wider scope of STEM. It would be a good idea to make more use of role models, especially female ones, in lessons or via Åben Skole (Open School), for example, by involving specific people, prominent members of society, or company visits where STEM-concepts and methods are introduced as fun, natural, and useful explanatory tools for understanding our world.

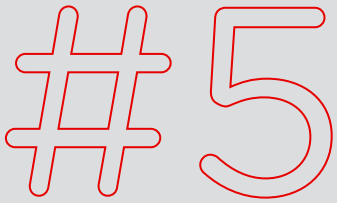
Another possibility would be to actively target work experience towards STEM jobs. Both young people and their parents express gender stereotypes in educational and career choices, thereby posing a risk of negatively informing young people's interest in STEM subjects and jobs. Also, girls find it particularly difficult to associate their STEM interest with a future career in this field. Working actively with work experience may help to shake off prejudice and provide new perspectives on the many STEM work opportunities.

#4

Get the STEM message across to pupils in after-school facilities (SFOs), clubs, and youth schools

There is a great potential for STEM in out-of-school contexts where STEM can be presented as much more than school subjects. In this way, we may be able to appeal to a broader target group of young people and to specifically and innovatively bolster girls' interest in STEM. The analysis shows that girls interested in STEM fail to link and relate their in-school interest in STEM with out-of-school activities – they simply do not perceive in-school STEM interests as consistent with 'fun' out-of-school activities.

Every week, children and young people spend many hours in SFOs, clubs, and youth schools, and when it comes to practicing STEM interests outside school, these institutions play a key role – with regard to sustaining existing and emerging curiosity, but equally to pique curiosity. These institutions are able to take a different approach from that used in the classroom – partly because theirs is a different pedagogical approach and partly because they have access to the children on an out-of-school basis. There is every reason, therefore, to keep focus on the role of SFOs, clubs, and youth schools in stimulating and sustaining young people's STEM-related interest.



Increasing natural science awareness among parents

This analysis suggests that young people are not the only ones disinterested in STEM or finding it difficult to relate its methodology and concepts to educational and career choices. Parents also show less interest in STEM subjects than in other topics and talk less with their children about STEM-related topics. We know from existing literature and survey findings that parents are key to young people's educational choices.

The many initiatives implemented over the years on a national scale to boost young people's interest in STEM have largely focused on either providing children and young people with practical experience of STEM via school activities, or on teachers as role models and their didactics. In contrast, few initiatives have focused on parents as the primary target group, which may seem surprising in light of the substantial influence on the children's interest, motivation, and educational choices usually ascribed to the parents.

It is crucial, therefore, to look beyond the school and to involve the parents in discussions of how to increasingly bring STEM into play. Parents largely define the frame-work for their children's out-of-school- activities and guide them in their choice of education. In continuation of this, there is every good reason to examine how to ensure that more families regularly take part in out-of-school activities capable of boosting children's and young people's interest in STEM.

The Think Tank DEA works to strengthen value creation and growth by improving the evidence base for the design and prioritization of early learning, education, research and innovation.

We strive to fulfill this mission by providing high-quality research, analyses and policy advice, and by engaging in constructive dialogue with the political system and key public and private stakeholders. We also collaborate with relevant public and private companies to ensure that policy development is informed by needs and insight from industry.

THE THINK TANK DEA ADVANCING KNOWLEDGE

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