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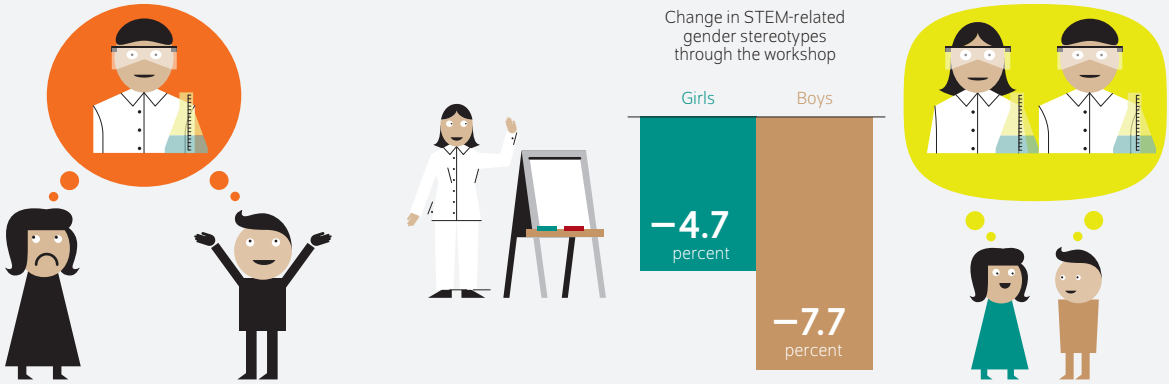
AT A GLANCE

STEM Careers: Workshops Using Role Models Can Reduce Gender Stereotypes

By Katharina Drescher, Simone Häckl, and Julia Schmieder

- Women remain underrepresented in STEM careers (science, technology, engineering, and mathematics)
- Based on a survey of Viennese students, we analyze interest in STEM careers and factors that influence students' interest
- 38 percent of the 12 to 14-year-old male students can imagine working in a technical career while only five percent of female students can
- Gender stereotypes are a potential explanation for the difference in career aspirations; parents also play a role
- A half-day career guidance workshop can reduce gender stereotypes towards technology among both boys and girls

Gender stereotypes contribute to the lack of women in STEM careers; workshops with female role models can change students' gender stereotypes



Girls' interest in technology is influenced by gender stereotypes.

A career guidance workshop can effectively reduce gender stereotypes.

Source: Authors' own surveys and calculations.

FROM THE AUTHORS

"Stereotypes can be tackled by providing young people with role models. We are able to show that a short workshop with female role models from STEM fields can reduce gender stereotypes amongst girls and boys."

— Julia Schmieder —

MEDIA

Audio Interview with Julia Schmieder (in German)
www.diw.de/mediathek

STEM Careers: Workshops Using Role Models Can Reduce Gender Stereotypes

By Katharina Drescher, Simone Häckl, and Julia Schmieder

ABSTRACT

Women continue to be underrepresented in STEM occupations (science, technology, engineering, and math). Based on a survey among secondary school students in Vienna, we show, for instance, that girls' career aspirations, interests, and self-assessed skills in STEM fields are related to gender stereotypes. Parents also play a crucial role in this context. Further results indicate that a half-day career guidance workshop, which confronts students with role models, can change gender-biased attitudes towards technology. This demonstrates that short, inexpensive interventions can be an effective way of fostering girls' interest in STEM.

Equal Pay Day is dedicated to raising awareness about the wage differences between women and men. This day marks how far into the subsequent year women have to work to earn what the average man will have earned in the previous year.[1] Since the gender pay gap has remained at relatively constant 20 percent over the past years, the event took place on March 17 this year.[2] One important reason for the difference in pay between men and women is the pronounced gender segregation in the labor market and the tendency for the female-dominated professions to be lower paid than those that are typically practiced by men.[3]

In order to counteract gender-specific career choices, numerous initiatives are implemented to show young people that their gender does not have to impact their career and corresponding education choices.[4] One such initiative is *Girls' Day*, which has been taking place annually since 2000.[5] The campaign gives girls the opportunity to learn about careers based on vocational or university education in IT, sciences, technology, and skilled craft and trades, all of which are fields where women are traditionally underrepresented. On the same day, *Boys' Day*, a related campaign which has been in place since 2011, provides boys with an insight into the professions that tend to be dominated by women.[6]

1 For further information, see the Equal Pay Day homepage (available online; last accessed March 3, 2020; this applies to all other online sources in this report unless stated otherwise) and on the homepage of the State Agency for Civic Education of Baden-Württemberg (Landeszentrale für politische Bildung Baden-Württemberg) (available online).

2 Federal Statistical Office "Gender pay gap 2019: women earned 20 percent less than men," press release, March 16, 2020, (available online).

3 Katharina Wrohlich and Aline Zucco, "Gender pay gap varies greatly by occupation," *DIW Economic Bulletin*, no. 43 (2017): 429–435 (available online) and Claudia Finke, Florian Dumpert, and Martin Beck, "Verdienstunterschiede zwischen Männern und Frauen – Eine Ursachenanalyse auf Grundlage der Verdienststrukturerhebung 2014," *WISTA Wirtschaft und Statistik*, no. 2 (2017): 43–62.

4 These initiatives include, for instance, the National Pact for Women in STEM Careers *"Komm, mach MINT" (Nationaler Pakt für Frauen in MINT-Berufen)*, which aims to encourage girls and women to enroll in STEM subjects at university and pursue STEM careers. For more information on this, see the homepage of the *Kompetenzzentrum Technik-Diversity-Chancengleichheit* (available online). The "Klischeefrei" initiative campaigns for career and study choices to be made free from gender stereotypes; for more information on this, see the homepage of the Federal Institute for Vocational Education and Training (*Bundesinstitut für Berufsbildung*) (available online).

5 For more information on this, see the Girls' Day homepage (available online).

6 For more information on this, see the Boys' Day homepage (available online).

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Men and women in Germany choose very different education paths

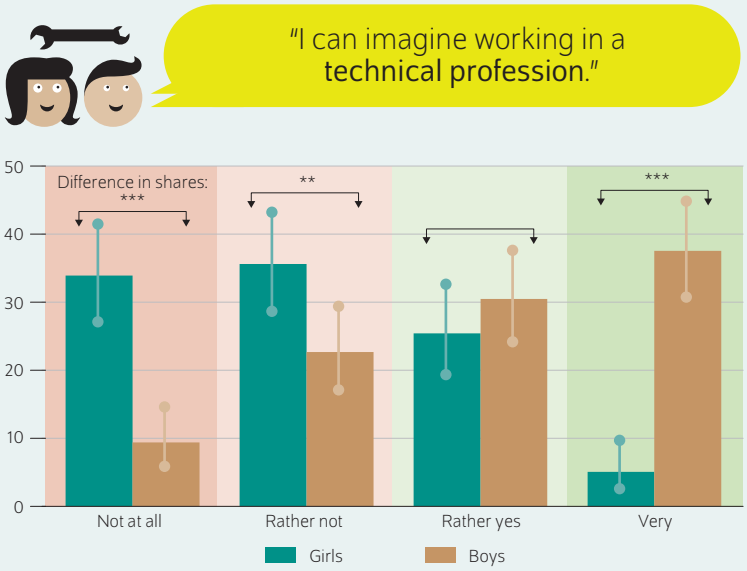
There are still significant gender differences in the education paths pursued by young people in Germany. When considering vocational education options, young women most frequently choose to train as a management assistant (office management, industry, or retail) or dental/medical assistant. Young men, in contrast, are more likely to pursue a vocational education as a mechanic (with a focus on motor vehicles, industry, or plants), electrician, or IT specialist.[7] In science, technology, engineering, and math fields, commonly abbreviated as STEM, the share of female apprentices is a meager 10.7 percent.[8] The choice of subjects at German universities also heavily depend on gender. None of the five most popular subjects chosen by female students in the 2018/2019 winter semester are in STEM fields. In contrast, four of male students' top five subjects are STEM-related.[9] Among students in STEM subjects, women make up a 30.9 percent share, which means that fewer than one in three students are female.

This situation is unlikely to change in the near future. According to PISA data from 2018, the career aspirations of secondary school students in Germany remain highly gender specific. When asked about what kind of job they expect to have when they are about 30 years old, the most frequent responses from girls are teacher, doctor, childcare worker, psychologist, or nurse. In contrast, boys expect to be working as specialists in information and communication technology, agricultural machinery and industrial mechanics, motor mechanics, policemen, or teachers.[10] Overall, 48.3 percent of boys and 16.2 percent of girls mention a STEM occupation in response to this question.[11] In contrast, 6.8 percent of boys and 36 percent of girls say they see themselves pursuing a career in the fields of education, health, and welfare.[12]

Based on a survey of more than 200 secondary school students in Vienna aged between 12 and 14, we investigate the extent to which the desire to enter a technical career differs between boys and girls.[13] We further examine the relationship between these career aspirations and differences in interests, skills, behavior of parents, and gender stereotypes. Our findings also highlight gender differences in confidence. In the second part of this report we discuss to what extent a career guidance workshop can influence individuals' interest, self-assessment, as well as gender stereotypes in technology. The workshop provides participating school classes with the opportunity to learn about STEM careers and confronts them with mainly female role models from these fields. These role models aim to tackle the students' stereotypes towards technical occupations and to encourage them to trust in their abilities.[14]

Figure 1

Students' (12 to 14 year olds) interest in a technical career
Shares in percent



Notes: Distribution of answers to the question if respondents can imagine working in a technical profession. The dots indicate the upper and lower limits of a 95 percent confidence interval, respectively. The shares of boys and girls are compared using a logit model. ***, **, and * represent the significance of the difference at the one, five, and ten percent level. Number of observations (respondents): 246.

Source: Authors' own surveys and calculations.

Substantially more boys than girls report interest in a technical profession.

7 Findings based on the Federal Statistical Office of Germany, *Berufliche Bildung*, special series 11, no. 3 (2018) (available online). An apprentice is defined as an individual who participates in a dual vocational training program, which comprises on-the-job training at a company and classes at a vocational school.

8 Federal Institute for Vocational Education and Training, *Datensystem Auszubildende, Auszubildende am 31.12. nach Geschlecht und Ausbildungsjahr, Deutschland, MINT-Berufe insgesamt* (trainees in Germany on December 31st by gender and training year, total STEM professions) (2018) (in German; available online).

9 The five most popular subjects among women are business administration, law, psychology, general medicine, and German studies. The subjects most frequently chosen by male students are business administration, computer sciences, mechanical engineering, electrical engineering/electronic engineering, and business engineering (with a major in engineering). The analysis is based on data from the Federal Statistical Office of Germany, "University Students," special series 11, no. 4.1, 2018/2019 winter semester (2019) (available online).

10 OECD, *Dream Jobs? Teenagers' Career Aspirations and the Future of Work* (2020) (available online).

11 Own analysis based on PISA data from 2018 (available online). STEM professions are defined according to the classification of the German Federal Employment Agency, transferred to ISCO-2008 categories (available online).

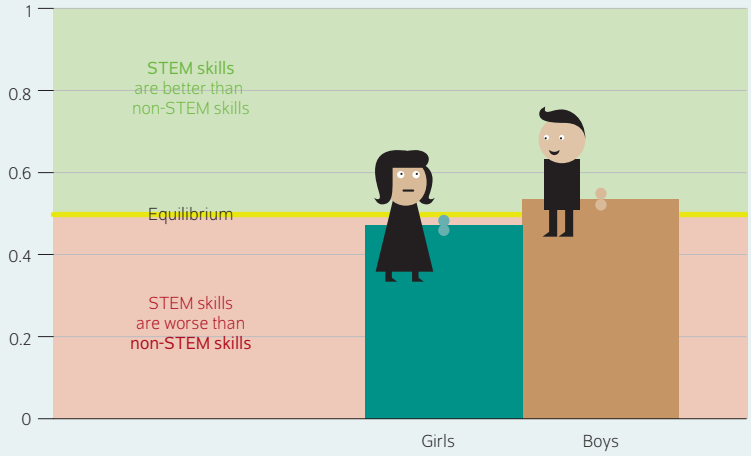
12 Occupations in the field of education, health, and care include the ISCO-08 categories health professionals, teaching professionals, health associate professionals, and personal care workers.

13 Participation in the study was voluntary but was rewarded with a project day for the class as well as small amounts of money as part of the incentive-compatible experiment.

14 This study was conducted in cooperation with the Vienna Business Agency (*Wirtschaftsagentur Wien*). The Vienna Business Agency was established by the City of Vienna to support businesses and the economy. The study was financed through research grants from Vienna University of Economics and Business. The cooperation partner had no influence over the financing and content of the study.

Figure 2

Self-assessments of STEM skills compared to other areas
Measure for relative STEM skills



Notes: Relative STEM skills were measured as the sum of the answers to three questions (Likert scale from 1 to 4) of "I am good at x," with x referring to the STEM-related skills of calculating, repairing things, and problem solving divided by the sum of the answers to all six questions (STEM skills as well as telling stories, painting, and speaking foreign languages). A value of 0.5 means that a person estimates his or her STEM skills to be just as good as his or her non-STEM skills. The dots indicate the upper and lower limit of a 95 percent confidence interval, respectively. Number of observations (respondents): 246.

Source: Authors' own surveys and calculations.

Girls do not see their strengths in STEM subjects.

Table

Correlation between interest in a technical career and possible explanatory factors

	Technical career	Relative STEM skills	Interest in technology	STEM-related gender stereotypes
		Boys		
Relative STEM skills	0.199 **			
Interest in technology	0.627 ***	0.265 ***		
STEM-related gender stereotypes	−0.053	0.017	−0.076	
Parents discuss technology with me	0.379 ***	−0.028	0.338 ***	−0.054
		Girls		
Relative STEM skills	0.086			
Interest in technology	0.536 ***	0.047		
STEM-related gender stereotypes	−0.163	0.165 **	−0.219 **	
Parents discuss technology with me	0.264 ***	−0.155	0.302 ***	−0.213 **

Notes: The correlation matrix shows the linear correlation between an interest in a technical career, relative STEM skills, an interest in technology, technology-related gender stereotypes, and the amount of exposure to technology in the family. A positive Pearson correlation coefficient shows a positive correlation, a negative Pearson correlation coefficient shoes a negative correlation. The Pearson correlation coefficient ranges from −1 to 1, a strong correlation exists at a coefficient of +/−0.5. ***, **, and * indicate significance at the one, five, and ten percent level.

Legend: For both boys and girls, interest in a technical career is strongly related to an interest in technology and parental behavior.

Source: Authors' own surveys and calculations.

Gender differences in education paths and career aspirations: Similar situation in Germany and Austria

In Germany and Austria, the prevailing gender differences are fairly similar, both in general and in the field of education in particular.[15] Given the similarities between the two countries' education systems, we can also draw conclusions from our results based on Austrian data about Germany.

After four years of primary school, Austrian children attend either an *Allgemeinbildende Höhere Schule* (academic-track secondary school) or a *Neue Mittelschule* (vocational secondary school). The former is the equivalent of the German *Gymnasium* and the latter is comparable to the *Verbundene Haupt- und Realschule*. Substantial differences between the career choices of women and men are also evident in Austria's dual vocational education system.[16] The share of women enrolled in STEM subjects at Austrian universities in the 2018/2019 winter semester is, with 36.7 percent, a few percentage points larger than in Germany. Still, this number is approximately one-third in both countries and, hence, of similar magnitude. [17] According to data from PISA 2018, 61.8 percent of boys and 15.9 percent of girls expect to work in a STEM field at the age of 30. The difference is around 15 percentage points higher than in Germany. In contrast, a total of 5.1 percent of boys and 28.6 percent of girls aged 12 to 14 state that they would like to pursue a career in the fields of education, health, and welfare.[18]

Career aspirations of boys and girls differ substantially

In line with the representative PISA data, we find statistically significant gender differences when it comes to career aspirations in our survey. While 38 percent of male students can definitely see themselves in a technical profession, the corresponding share for girls is as low as five percent (Figure 1).[19]

In the following analysis we examine a range of different factors (interests, skills, parents' behavior, and gender stereotypes) which could influence an individual's interest

15 European Institute for Gender Equality (EIGE), *Gender Equality Index 2019 by Country* (available online).

16 The five most popular apprenticeship programs among girls are management assistant in retail businesses and for office management, hairdresser, administrative assistant, and cook. The top five programs among boys are construction mechanic, electrician, automotive mechatronics technician, management assistant in retail businesses, and installations and buildings technician. See Austrian Federal Economic Chamber, *Die zehn häufigsten Lehrberufe: 2002–2019, Mädchen/Burschen* (available online).

17 Own calculations based on data from Statistics Austria (*Statistik Austria, Belegte ordentliche Studien an öffentlichen Universitäten 2018/19 nach Studienart und Hauptstudienrichtung, Ordentliche Studierende an Fachhochschul-Studiengängen im Wintersemester 2018/19)* (available online). STEM subjects include science, technology, and mining engineering. In Austria, unlike in Germany, nutrition and sports science, and psychology are categorized as sciences. These subjects are excluded from our calculations. If they had been included, the share of women studying STEM subjects would have been 39.2 percent.

18 Own analysis based on the PISA data for 2018 (available online).

19 Here and below, we test for differences in the proportions of boys and girls by comparing the proportions based on a logit model. We claim statistical significance if the difference is statistically significant at the five-percent level.

in pursuing a STEM career. We explore whether there is a linear relationship between the aforementioned factors and career aspirations. We also discuss how these factors are related to each other (Table). We are, however, not able to draw any conclusions regarding the causality of these relations. Nonetheless, we can make statements like boys with higher skills in STEM also have a higher level of interest in technology. What we cannot say is whether female or male students perform better at STEM subjects because they are interested in technology or, whether they are more interested in technology because they are better at STEM subjects.

STEM skills: Girls' self-assessment is lower than boys'

When it comes to choosing a career, beliefs about one's ability to work in the respective profession are crucial. A recent study shows that the decision whether or not to enroll in a math-related field of study or pursue a math-oriented career depends on how good one thinks one is in math relative to other subjects.[20] To analyze the relation between career aspirations and relative ability, participants were asked to rate their skills in different areas. Half of these areas were STEM-related.[21] The survey shows that girls rate both their absolute and their relative skills in STEM fields significantly lower than boys (Figure 2).[22] The higher self-assessment of boys in terms of their STEM skills is paralleled by a greater interest in pursuing a STEM career (see Table).[23]

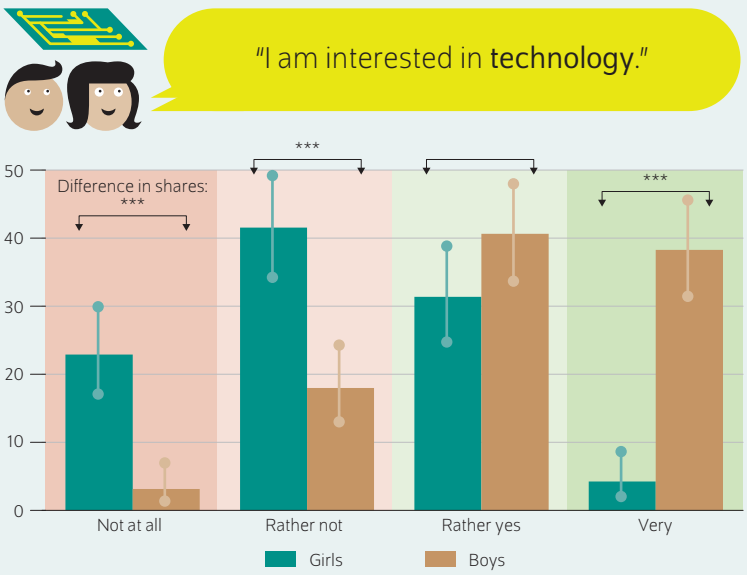
Interest in technology relates to career aspirations and STEM skills

Another factor that plays an important role in deciding what type of career to choose is, of course, the level of interest in a given subject. Gender differences in career choice might therefore be related to the fact that boys are more interested in technology than girls. We find that the number of boys (38 percent) stating they are very interested in technology is statistically significantly higher than the number of girls (four percent) (Figure 3). At the same time, both male and female students who are highly interested in technology tend to aim for a career in technology (Table).

We also find that for boys there is a strong positive, statistically significant correlation between interest in technology and self-assessed skills in this area. It is, however, likely that these factors are mutually reinforcing. A child that has a strong interest in technology will engage more in technology-related activities, ultimately learning more about technology and developing more skills in this area. Conversely, a child will get more joy out of doing things which she or he is good at. To conclude, a child might be more likely to develop an interest in technology if she or he is good at it.[24]

Figure 3

Students' (12 to 14 year olds) interest in technology
Shares in percent



Notes: Distribution of the answers to the question if the respondents are interested in technology. The dots indicate the upper and lower limit of a 95 percent confidence interval, respectively. The shares of boys and girls were compared using a logit model. ***, **, and * represent the significance at the one, five, and ten percent level. Number of observations (respondents): 246.

Source: Authors' own surveys and calculations.

Significantly more boys than girls indicate they are interested in technology.

Link between interest in technology, gender stereotypes, and family environment

The aforementioned correlations are interdependent with other factors shaping one's interest. How early and in which way children are confronted with STEM can be important for the development of an interest in technology. Gender-biased attitudes of parents can result in girls being confronted with technology less frequently and thus developing less interest in the subject.[25] Gendered attitudes can also lead to poorer performance in stereotypical tasks.[26]

20 Thomas Breda and Clotilde Napp, "Girls' comparative advantage in reading can largely explain the gender gap in math-related fields," *Proceedings of the National Academy of Sciences* 116, no. 3 (2019): 15435–15440.

21 Participants were asked to indicate on a Likert scale from 1 (not at all) to 4 (very) how good they were at the following things: repairing, calculating, problem-solving (STEM fields); telling stories, painting, speaking foreign languages (non-STEM fields).

22 To determine the statistical significance, a comparison of means test was conducted.

23 By the same token, there is also a significant positive correlation between absolute skills in STEM fields and interest in pursuing a technical career.

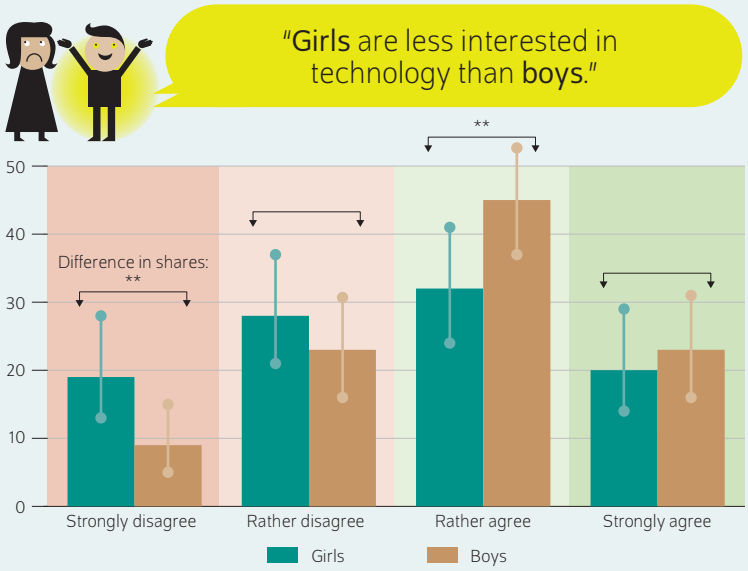
24 Robert W. Lent, Steven D. Brown, and Gail Hackett, "Social cognitive career theory," *Career Choice and Development*, no. 4 (2002): 255–311.

25 A gender stereotype is when certain characteristics and behaviors are ascribed to individuals according to their gender. More information on this can be obtained from the Humboldt-Universität zu Berlin (available online). An example of a gender stereotype is that girls are less interested in technology than boys. Gender stereotypes are one of the reasons why fewer women are interested in professions in the STEM fields; See Ming-Te Wang and Jessica L. Degol, "Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions," *Educational Psychology Review*, no. 29, vol. 1 (2017): 119–140.

26 R. Shapiro Jenessa, Amy M Williams, and Mariam Hambarchyan, "Are all interventions created equal? A multi-threat approach to tailoring stereotype threat interventions," *Journal of Personality and Social Psychology*, no. 104, vol. 2 (2013): 277–288.

Figure 4

STEM-related gender stereotypes held by students (12 to 14 years old)
Shares in percent



Notes: Distribution of the answers to the question what the respondents think about the statement "Girls are less interested in technology than boys." The dots indicate the upper and lower limit of a 95 percent confidence interval, respectively. The shares of boys and girls were compared using a logit model. ***, **, and * represent the significance at the one, five, and ten percent level. Number of observations (respondents): 246.

Source: Authors' own surveys and calculations.

More than half of the girls and boys believe that girls are less interested in technology.

Box 1

Incentive-Compatible Experiment

Incentive compatibility plays an important role in economic experiments. It is achieved by giving the participants small amounts of money (based on their average hourly wage) depending on the decisions they make in the experiment. It hereby aims to ensure that participants answer truthfully. In this study we implement incentive compatibility in the following way: After the quizzes, two participants per quiz are selected at random. The student that answered more questions correctly receives five euros. If the student also assessed his or her performance correctly, he or she gets another euro. The Austrian government's recommendation for pocket money for young people aged between 12 and 14 years corresponds to 12 to 20 euros per month.[1] The money the students can potentially receive in the experiment is more than 25 percent of their monthly income, which, thus, provides a strong incentive.

1 Recommendations of the Austrian government for 2019 (available online).

We investigate gender stereotypes about STEM by examining the extent to which the respondents agree with three statements.[27] Taking one of these statements as an example—"Boys are more interested in technology than girls."—we show that the majority of participants agrees or strongly agrees with this statement (52 percent of the girls and 68 percent of the boys) (Figure 4). Girls with strong gender stereotypes are, in turn, less interested in careers in technology (Table).

One way of confronting children with technology is to talk about it in the family. The share of young people with an interest in a technical career is significantly higher when parents discuss technology with them. This correlation is as strong for girls as it is for boys. If we look at what parents discuss with their children, we can see that in family environments, girls are exposed to technical subjects less frequently. When asked whether their parents discuss technology with them, 41 percent of the male students answer with "Rather agree" or "Strongly agree". The respective number for girls is as little as 21 percent (Figure 5). Girls who discuss technology with their parents are less likely to endorse gender stereotypes. There is no significant correlation for boys (Table).

Experiment verifies that girls underestimate their skills

The findings described so far are based on responses to survey questions. We also draw on an incentive-compatible experiment conducted with the participants, as described below (Box 1). This experiment seeks to investigate whether the confidence of boys and girls differs in gender-stereotyped environments such as STEM. This is relevant because such structural differences in the evaluation of one's own skills can, in part, account for gender differences on the labor market. In fact, differences in women's self-assessments may be the reason why they, underestimating their chances of success, tend not to enter competitive environments.[28]

To measure confidence, the respondents were asked to take part in two quizzes. The first asked ten questions on science and technology, while the second asked questions on movies and music. The quiz results are in line with the findings of the survey (see Figure 2). In the STEM quiz, boys answer an average of 0.7 questions more than the girls. This difference is statistically significant. In the entertainment quiz, boys and girls perform similarly.

After having completed the quizzes, the students were asked how many questions they believed they had answered correctly. For boys and girls with the same actual score, boys' self-assessment is higher than girls' (Figure 6). This is the case for both the STEM quiz and the entertainment quiz.

27 The three statements were: "Girls are less interested in technology than boys", "Boys are better at solving computer problems," and "Girls and boys can do the same job". For the last statement, stronger agreement means that the respondent has less pronounced gender biased views.

28 Muriel Niederle and Lise Vesterlund, "Gender and competition," *Annual Review of Economics*, no. 3, vol. 1 (2011): 601–630.

This gender gap is statistically significant based on a test of means. Both boys and girls who answered very few questions correctly in the STEM quiz, tend to overestimate their performance, although this is not quite as pronounced for girls as it is for boys. Only considering students with five or more correct answers, boys tend to assess their performance accurately. In contrast, girls with seven or more correct answers underestimate their performance. Overall, girls are more likely to underestimate their performance.

Our finding—i.e., that girls who achieve the same results as their male counterparts have a tendency to rate themselves worse than boys—is in line with that of a nationally representative study among young Germans which finds that boys believe to be better in math than girls, despite their actual scores not being different.[29]

Role models can strongly impact career aspirations

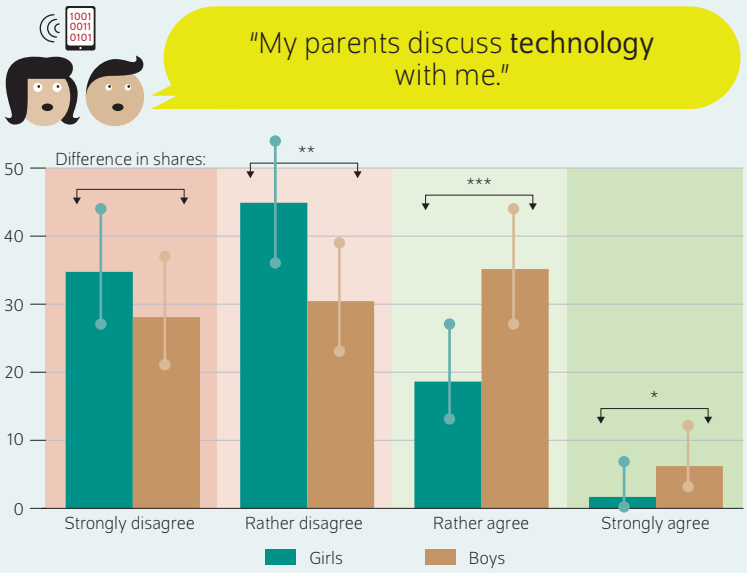
Role models such as teachers, older family members, as well as famous people can have a strong impact on career aspirations.[30] German Chancellor Angela Merkel, for example, signifies the fact that women, too, can lead a country or become a physicist. In many countries, including Germany and Austria, programs have been introduced that confront young people, especially girls, with role models, both famous and not.[31]

Career guidance workshop provides young people with an insight into STEM professions

One such program is a half-day career guidance workshop, which has been held at regular intervals at the Vienna Business Agency since 2016. At the workshop, students from grades 7 and 8 learn about careers in the STEM fields of software development, robotics, and renewable energies. During the workshop students are confronted with different role models. University students studying STEM subjects support the students throughout the workshop. Furthermore, people with professional experience in one of the three aforementioned areas talk about their career path as well as their day-to-day working lives. The students then develop and present their own projects. To combat gender stereotypes towards technical careers, many of the role models presented are female. By showing the students that they can be inventors themselves, the workshop aims at increasing the students' confidence in their own technical skills.

Figure 5

Childrens' exposure to technology in the family
Shares in percent



Notes: Distribution of the answers to the question how applicable the statement "My parents discuss technology with me" is to the respondents. The dots indicate the upper and lower limit of a 95 percent confidence interval, respectively. The shares of boys and girls were compared using a logit model. ***, **, and * represent the significance at the one, five, and ten percent level. Number of observations (respondents): 246.

Source: Authors' own surverys and calculations.

Significantly more boys than girls report that their parents discuss technology with them.

Short programs using role models can help to reduce gender stereotypes

We analyze the effect of the workshop with a before-after comparison, separately for male and female students (Box 2). We examine the mean difference between the answers given a few weeks before and a few weeks after the workshop.[32] No statistically significant change in the students' interest in technology or in a STEM career is found (Figure 7). Similarly, the workshop does not change the students' self-assessment of their performance in the STEM quiz.

What the workshop does achieve, however, is a change in gender stereotypes towards technology. Stereotypical thinking of boys is reduced by an average of 0.194 points, which is equivalent to a 7.7 percent reduction. Similarly, the girls' agreement with gender-biased statements regarding the field of technology drops by 0.116 points or 4.7 percent relative to the baseline value.[33]

29 Felix Weinhardt, "Ursache für Frauenmangel in MINT-Berufen? Mädchen unterschätzen schon in der fünften Klasse ihre Fähigkeiten in Mathematik," *DIW Wochebericht*, no. 45 (2017): 1009–1014 (in German; available online)

30 Shulamit Kahn and Donna Ginther, "Women and science, technology, engineering, and mathematics (stem): Are differences in education and careers due to stereotypes, interests, or family," *The Oxford Handbook of Women and the Economy*, (2017): 1–39.

31 A study conducted in France shows that even short interventions with role models are effective. See Thomas Breda et al., "Can female role models reduce the gender gap in science? Evidence from classroom interventions in French high schools," *PSE Working Papers* (2018).

32 The analysis is based on students who participated in the survey both before and after having attended the career guidance workshop. Students from two school classes did not attend the workshop until after the second survey and are thus not included in the analysis.

33 This change is statistically significant at the one percent significance level for boys and the ten percent level for girls. To calculate the statistical significance, a paired sample t-test is implemented, where the mean difference between the values before and those after the workshop is compared.

Box 2

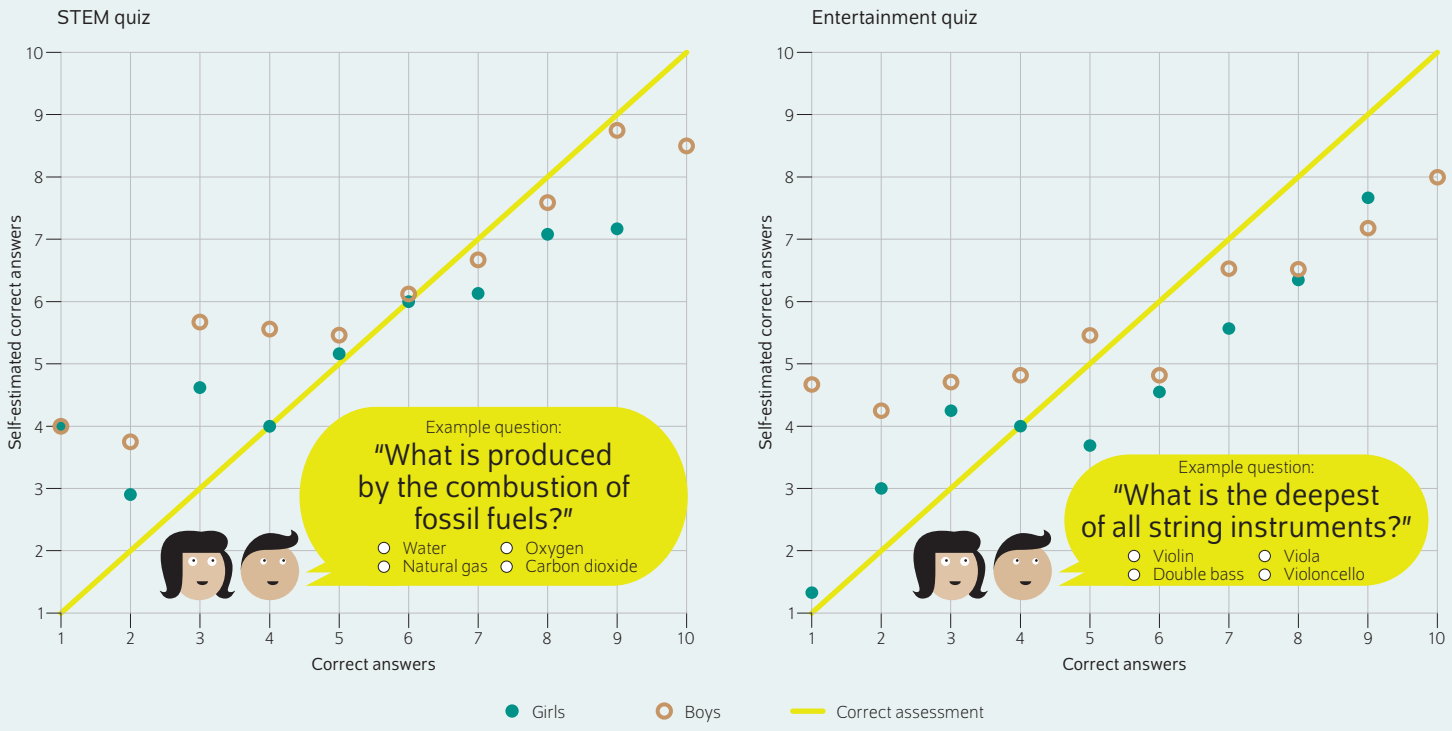
Limitations of Before-After Comparisons

To estimate the causal effect of the career guidance workshop, we would ideally compare two groups: one group (chosen at random) takes part in the workshop and one does not. Otherwise, the groups are identical. Data are collected for both groups at the same point in time. The differences between the two groups can be interpreted as causal effects of the workshop, because the only difference between the groups is their participation in the workshop. Random assignment was not possible in this study, which is why a before-after comparison is carried out.

In before-after comparisons such as this, the data are collected on the same group before and after the participation in the workshop. For this study, we surveyed the students in their school before and after the workshop. These surveys took place on average about five weeks before and after the workshop. A potential problem is that other factors besides the fact that the students had taken part in the workshop might have changed between the two surveys. Participants have grown older and, in the second data collection, they are familiar with the survey technique. Both of these factors can affect their responses. In a before-after analysis, these time- or experience-driven behavioral changes may be incorrectly attributed to the workshop participation. The extent to which this can distort the results of the analysis depends, for example, on how much time has elapsed between the two surveys. In this study, both surveys took place within a few months, which is why the time difference is not likely to have too much of an impact.

Figure 6

Self-assessments of boys and girls in relation to actual performance



Notes: The yellow line displays an accurate self-assessment. Number of observations (respondents): 246.

Legend: Boys and girls with four correct answers on the STEM quiz estimate, on average, that they answered 5.5 or four questions correctly, respectively.

Source: Authors' own surveys and calculations.

Boys tend to overestimate their skills more than girls do.

Conclusion: Huge potential for more women in STEM careers

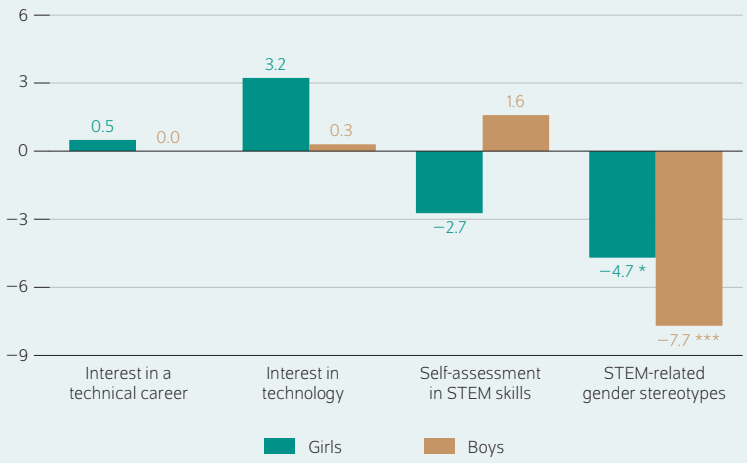
One reason for the gender pay gap, i.e., the difference in wages between women and men, is their different career choices. More men work in areas that tend to be better paid, like for example in STEM fields. We show that even at the age of 12 to 14, boys and girls have very different career aspirations when it comes to STEM fields. The reason for this could lie in gender stereotypes.

Measures that seek to foster girls' interest in STEM careers have a large potential. We show that workshops can help to reduce gender stereotypes towards STEM fields of both male and female students. This finding is even more remarkable given the short duration of the program that we examine. The effect of the workshop could even be reinforced by confronting the students with role models repeatedly.[34]

Successful interventions, however, require greater parental involvement. If parents talk to their children about technical subjects, regardless of whether they are boys or girls, they are more likely to be interested in pursuing a career in STEM fields. Therefore, it might be advisable to address parents' gender stereotypes, too. For far-reaching recommendations, more detailed analyses are needed, but this study is a first step towards analyzing the causes of gender-biased career choices.

Figure 7

Changes due to participation in a career guidance workshop
In percent



Notes: Average change in the values after the workshop compared to the values before the workshop relative to the value in the base survey. Statistical significance based on a paired t-test. ***, **, and * represent the significance at the one, five, and ten percent level. The analysis considers all students who participated in the survey before and after participating in a career workshop. Students from two classes first participated in the workshop after the second survey and are therefore not included. Number of observations (respondents): 201, 97 girls and 104 boys.

Source: Authors' own surveys and calculations.

Boys' and girls' technology-related gender stereotypes can be reduced by the workshop.

34 See, for example, Maria Olsson and Sarah E. Martiny, "Does exposure to counter stereotypical role models influence girls' and women's gender stereotypes and career choices? A review of social psychological research," *Frontiers in Psychology*, no. 9 (2018): 2264.

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