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Why confidence matters: The hidden barrier for women in STEM

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Despite strong educational achievements, women in Germany remain underrepresented in Science, Technology, Engineering, and Mathematics (STEM) careers – an imbalance that fuels the gender pay gap, as these fields tend to offer higher wages. Beyond structural barriers, psychological factors such as confidence play a crucial role in shaping educational and labour market choices. Research suggests that gender differences in confidence help explain persistent inequalities, though these confidence gaps vary across contexts and domains.

In recent decades, substantial progress has been made in women's education, with German women's academic achievements often surpassing that of men. Today, women are more likely to obtain a bachelor's degree and graduate with higher grades than their male counterparts.

In 2023, nearly half (49 percent) of women aged 30 to 34 in Germany held a university degree, compared to 39 percent of men. However, women still choose different professions and fields than men and they remain significantly underrepresented in Science, Technology, Engineering, and Mathematics fields (STEM). For example, in 2024 around 39 percent of university entrants enrolled in STEM subjects in Germany according to the Federal Statistical Office 2026. However, the female share amongst these students was only 36 percent. This gap is even more pronounced in vocational training. While around 35 percent of all new entrants to vocational training start a STEM subject, women only made up around 12 percent of all STEM trainees in 2024.

This gender gap becomes even more pronounced in the context of the transition from education to the labour market. An article in the IAB Forum by Judith Hild and Anika Kramer from 2022 reveals that amongst STEM graduates, women are more likely than men to end up working outside their field of study.

This underrepresentation carries economic consequences. STEM occupations are not only in high demand in today's labour market, but they also offer on average higher salaries than less technical fields. As a result, the gender gaps in STEM educational attainment and careers directly contribute to the broader gender wage gap, reinforcing occupational segregation and limiting women's access to high-paying jobs, making this a key concern for policymakers.

The role of personality traits in explaining the gender gap in STEM educational choice

Earlier explanations of the gender gap in STEM educational outcomes often focused on gender differences in cognitive abilities or academic performance. However, recent research suggests that while these factors do play a role in shaping STEM choices, they explain only a limited share of the STEM gender gap. Increasingly, attention has shifted to psychological and behavioural factors or preferences that may influence career choices and outcomes, as shown by Marianne Bertrand in her work from 2011. Bertrand documents gender differences in psychological attributes and sets out that women are found to be more risk-averse, less competitive, more empathetic, and less confident than men. These traits may influence career choices, salary negotiations, and professional advancement. For example, in a study by Guido Heineck and Silke Anger from 2010 a link between personality traits and earnings in Germany is highlighted.

Confidence is a particularly important trait which has been shown to have a strong gender gap, especially in male dominated environments. Confidence can be defined as an individual's belief in their own abilities and performance, and it is closely linked to academic achievement, career

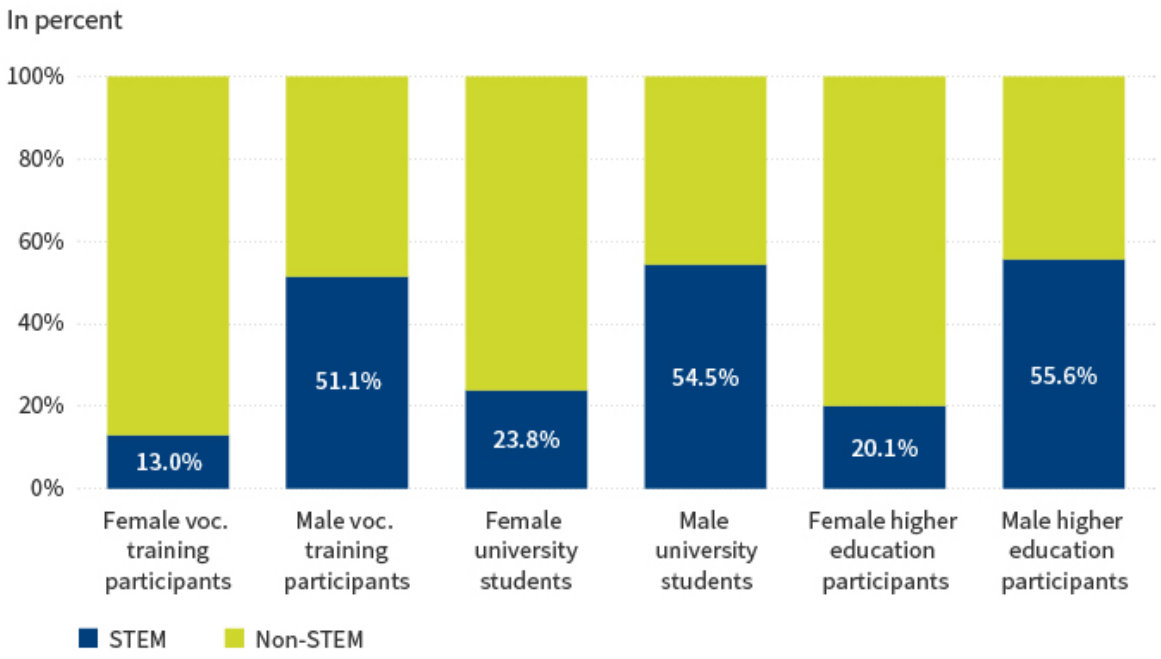
decisions, job progression, and earnings. For example, a recent study by Anna Adamecz and Nikki Shure quantifies its impact, showing that men's overconfidence explains approximately 5.5 percent of the gender wage gap amongst individuals mid-career. They further find that underconfident individuals tend to earn less because they are more likely to choose lower-paying occupations, have worse pre-university education, and are less likely to pursue high-earning degrees, for example STEM subjects.

The gender gap in STEM

The Starting Cohort 4 of the German National Educational Panel Study (NEPS), which was first conducted during the 2011/2012 school year, provides data on ninth-grade students who are observed throughout their upper secondary and tertiary education and into their participation in the labour market.

The data reveal a gender gap in respondents' first STEM vocational training and university programmes. According to Figure 1, more than half (51.1 percent) of all male vocational training participants enrol in STEM vocational training programmes, compared to just 13 percent of female vocational training participants. Similarly, while 54.5 percent of men enrolling at university study STEM subjects, only 23.8 percent of all new female students choose such a subject. Overall, 55.6 percent of men in this sample choose STEM-related studies and training, compared to only 20.1 percent of women.

Fig. 1: Educational choice of Science, Technology, Engineering, Mathematics (STEM) by gender



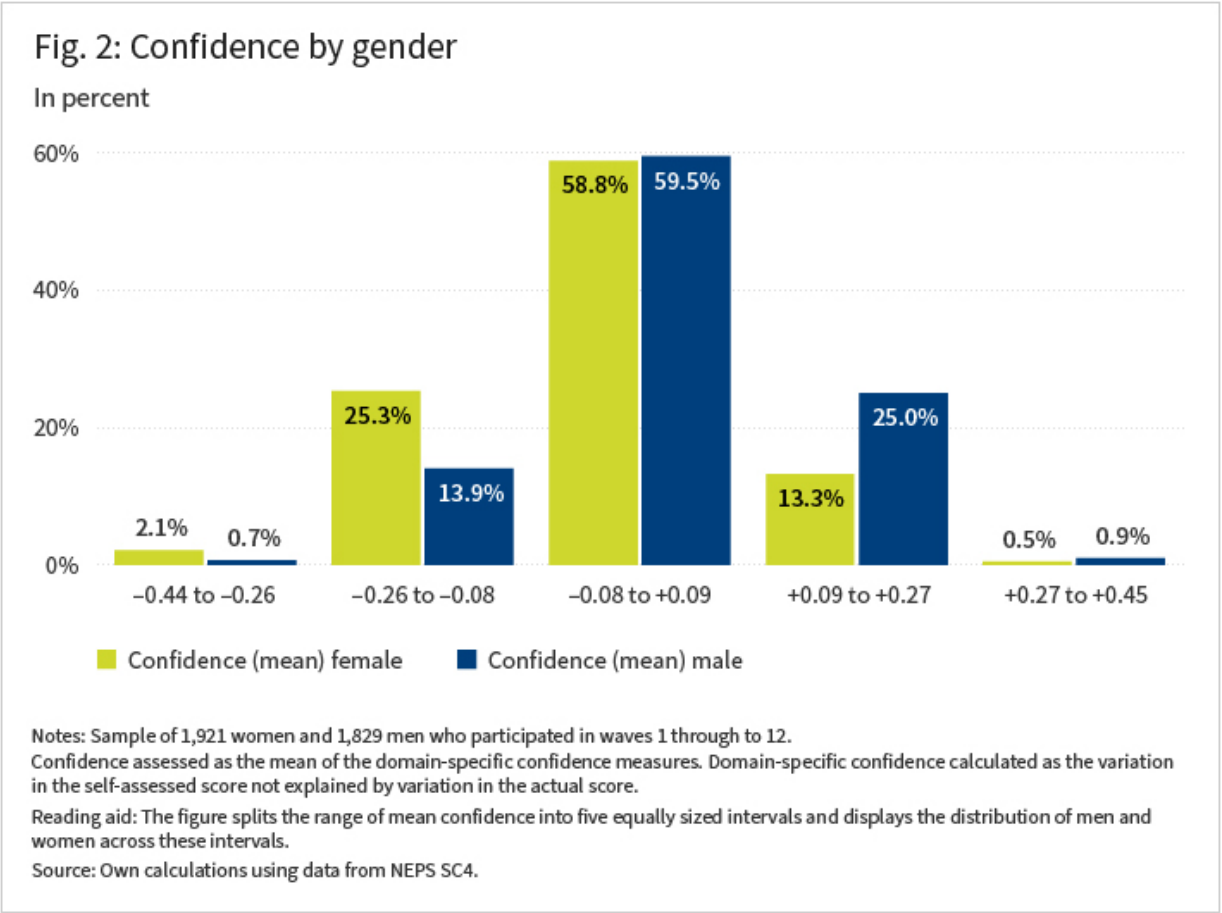
Notes: Sample of 1,921 women and 1,829 men who participated in wave 1 through to 12. Vocational training includes any type of vocational training (e.g. dual or school-based). University also entails other types of tertiary education institutions such as university of applied sciences or business academies.

Reading aid: The bars show the share choosing STEM versus non-STEM subjects for different subgroups. For example, 13% of all female vocational training participants choose a STEM vocational training occupation.

Source: Own calculations using data from NEPS SC4.

The gender gap in confidence

The Starting Cohort 4 of the German National Educational Panel Study (NEPS) dataset provides further evidence of the gender confidence gap. Confidence is measured by comparing self-assessed and actual performance. More specifically, students performed competence tests and were subsequently asked to assess how they performed. As previous research – for example by Christine L. Exley and Judd B. Kessler from 2022 – indicates that gender gaps in confidence may vary by domain and are particularly pronounced in stereotypically male domains, confidence is assessed in the domains Reading, Information and Communication Technologies (ICT), Science, and Mathematics. The domain-specific confidence was then calculated as residual scores, meaning the variation in the self-assessed score not explained by variation in the actual score. Positive values thereby indicate self-assessments which are higher than to be expected based on the actual performance. For a more detailed explanation of this measure, see the discussion paper by Britta Hecker, Nikki Shure and Ipek Yükselen Saif from 2026.

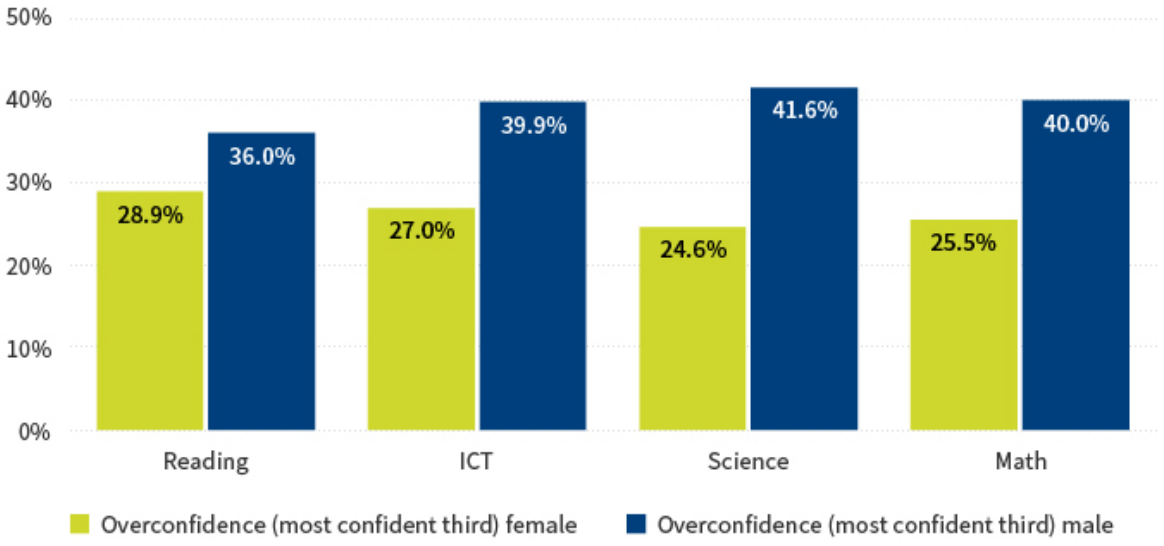


When examining the distribution of confidence levels by averaging across all domains, the data shows that students are generally somewhat accurate in assessing their own abilities. Figure 2 shows that most students fall within the range closely around 0, indicating that they tend to be at most slightly over- or underconfident. However, a closer look at the distribution reveals that males are more likely to have high confidence compared to female respondents.

By focusing on confidence by academic domain, Figure 3 reveals a notable gender gap in overconfidence across various domains, with male students being more likely to be overconfident than female students in all four domains. In this context, overconfident individuals are defined as the most confident third for each domain. Although this classification is based on the distribution of individuals rather than the range of the variable, all individuals in this top third exhibit positive residual scores in the respective domain, indicating that they overestimate their performance. The largest gender gap in the share of overconfident respondents can be seen for Science, while the smallest gender gap is seen for Reading.

Fig. 3: Overconfidence by domain and gender

In percent



Notes: Sample of 1,921 women and 1,829 men who participated in waves 1 through to 12. Share of overconfident respondents in the 4 domains Reading, ICT (Information and Communication Technologies), Science and Mathematics identifying the most confident third of individuals as overconfident. Domain-specific confidence calculated as the variation in the self-assessed score not explained by variation in the actual score.

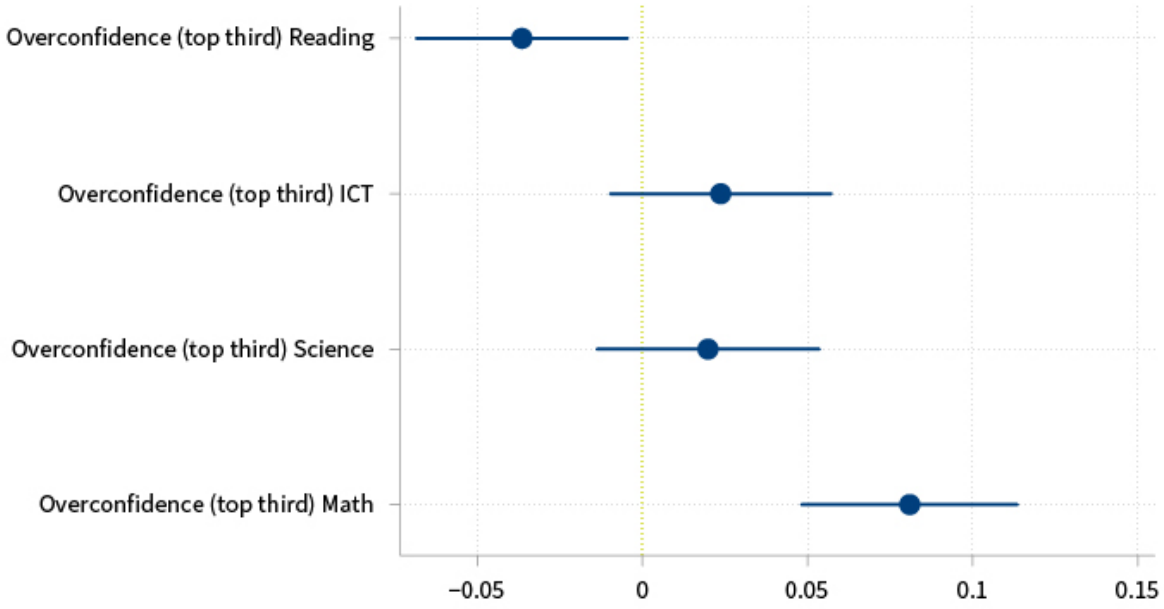
Source: Own calculations using data from NEPS SC4.

Confidence and STEM choice

Building on the finding that men tend to exhibit a higher likelihood of overconfidence than women across various domains, and that personality traits may influence labour market outcomes, the question as to whether overconfidence plays a role in choosing STEM university programmes and STEM vocational training is examined. Competence, gender, migration background, parental education and school leaving degrees are controlled for.

Fig. 4: The effect of confidence on educational choice of Science, Technology, Engineering, Mathematics (STEM)

Point estimates (probabilities) and confidence intervals



Notes: Sample of 3,750 individuals (1,921 women and 1,829 men) who participated in waves 1 through to 12, of whom 1,403 individuals participated in STEM.

Reading aid: The figure depicts coefficients (dots) and the corresponding 95% confidence intervals for the OLS regression of STEM education (1= participation in STEM major or STEM vocational training) on overconfidence dummies in all domains simultaneously controlling for competence (in all four domains), gender, migration background, parental education and school leaving degree. Robust standard errors are used.

Source: Own calculations using NEPS Starting Cohort 4.

The coefficients in Figure 4 present evidence that individuals displaying overconfidence in Mathematics are significantly more likely to sort into STEM-related educational tracks and vocational programmes. In contrast, overconfidence in ICT and Science do not exhibit a statistically significant association with STEM choices, while overconfidence in Reading even shows a negative link with sorting into STEM education. Further analyses using metric confidence measures as well as a more detailed discussion are provided in the recent discussion paper by Britta Hecker, Nikki Shure and Ipek Yükselen Saif from 2026. For example, gender-based heterogeneity analyses reveal positive significant associations of higher confidence in Science with sorting into STEM education for women, and of higher confidence in ICT with sorting into STEM education for men.

These results highlight the importance of confidence in choosing STEM related educational tracks. However, the results also show that the impact is domain-specific, as not all types of overconfidence appear to exert the same influence on STEM educational choices. Consequently, any policy interventions aimed at fostering STEM participation through confidence-building measures should be designed to focus on the domains that actually drive decision-making. In the case of STEM educational choice, the domain increasing sorting into STEM is Mathematics. Policies aiming at

closing the gender gap in STEM higher education might therefore aim at reducing the gender gap in confidence in the domain Mathematics by increasing female confidence. A focus on confidence in Reading, however, might drive women away from STEM, highlighting the importance of distinguishing between domains.

Furthermore, these results provide valuable insights into STEM educational choices and suggest that identifying individuals with high abilities but possibly lower confidence and encouraging enrolment into STEM subjects and courses might lower existing gaps in STEM educational tracks.

Conclusion

Although female educational attainment has made significant progress, women remain underrepresented in STEM fields and high-paying jobs, contributing to persistent gender gaps in the labour market. Traditional explanations based on ability fall short, while recent research suggests that personality traits — especially confidence — play a key role in shaping these outcomes. Data from the NEPS study shows that overconfidence in Mathematics and ICT is more common amongst males and strongly linked to choosing STEM paths.

To address this gap in STEM education, policy interventions may focus on building confidence in key subjects. Schools can integrate courses designed to build confidence — especially in areas like Mathematics. For example, female mentors can play an essential role in fostering student development and guiding them through challenges. Research, for example from Thomas Breda and colleagues, shows that role models — especially women in STEM — are crucial in inspiring young people to pursue these fields. Addressing both the academic and psychological barriers to STEM participation could be key to achieving more equitable educational and labour market outcomes.

Summary

- Despite outperforming men in educational attainment, women remain significantly underrepresented in STEM fields. Only 20.1 percent of women in post-secondary education choose STEM training or study programmes versus 55.6 percent of men.
- This underrepresentation may contribute to the gender wage gap due to the high earnings potential of STEM jobs.
- Personality traits, such as confidence, are important factors in STEM subject choice and career decisions.
- Men are more likely to be overconfident than women in all domains.
- Overconfidence in Mathematics is linked to higher likelihood of pursuing STEM paths.
- To narrow the gender gap in STEM, schools can implement targeted programmes to build confidence in key domains, while mentoring and visible female role models in STEM can offer essential support and inspiration.

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