Advancing women's representation and opportunities in STEM fields through exposure to role models

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In high-income countries, exposure to women role models often positively impacts women students' participation and educational performance in science, technology, engineering, and mathematics (STEM) fields, by improving students' perceptions and aspirations of having STEM careers.

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Summary

Across countries, women's representation in science, technology, engineering, and mathematics (STEM) remains low. Globally, as of 2022, the percentage of women graduating with a degree in engineering and manufacturing was 7 percent, compared to 25 percent for men.[1], In the United States, for example, women represented 35 percent of the STEM workforce in 2021, compared to 51 percent of the total workforce.[2], Since salaries in STEM fields tend to be quite high, underrepresentation can contribute to sustained gender gaps in the labor market, affecting women's opportunities and economic growth. Addressing such gender gaps is particularly relevant in high-income countries as the rising demand for STEM jobs is paired with shortages of STEM-skilled workers. For example, in the United States, employment in STEM fields is projected to increase 11 percent by 2032, compared to 2 percent in non-STEM occupations.[3]

While multiple factors may explain women's underrepresentation in STEM, gender norms seem to be a relevant factor in high-income countries, shaping women's preferences and aspirations, often very early on. [1], For example, women may perceive

STEM careers to be less attractive due to internalized gender stereotypes such as women being less likely to succeed in them, lack of women role models, or overrepresentation of men in these fields. One theory is that increased exposure to women role models—including through academic programs like the Undergraduate Women in Economics (UWE)—may help to address underrepresentation driven by restrictive gender norms and improve girls' and women's economic opportunities, particularly in high-income countries.

A review of seven randomized evaluations of role model interventions from four high-income countries found that exposure to women role models can positively impact women students' participation and educational performance in STEM fields. In this context, role models are women working in science-related fields, such as teachers, practitioners, and advisors. The evidence also suggests that exposure to women role models reduced gender gaps by improving girls' and women's perceptions and aspirations of having STEM careers. The interventions included in this policy insight vary in the modality and duration of exposure and age of the target population. While role models' behavior and level of professional success are important for ensuring that role models are effective, additional research can help to shed light on which role model attributes are most influential in improving gender gaps in STEM fields and in which contexts.

Supporting evidence

Exposure to women role models generally increases the likelihood of women students entering STEM fields, especially for fields with a more severe gender imbalance.

Across five studies, exposure to women role models increased the probability of girls and women enrolling in STEM programs.[1], [2], [4], [6], [7], In France, a one-hour in-class talk by women scientists— who provided information about science-related careers, addressed gender stereotypes, and shared the role models' own experiences—increased the likelihood of girls in grade 12 enrolling in male-dominated STEM programs by 3.4 percentage points, from 17 percent in the comparison group (a 20 percent increase).[1], In Norway, researchers found in an outside-the-classroom intervention that girls whose medical doctor (MD) during childhood was a woman were 4 percentage points (20 percent) more likely to choose a science, technology, engineering, mathematics, and medicine (STEMM) program in high school. They also found that these effects persisted into college.[7]

One way that role model interventions shifted girls' and women's preferences toward STEM careers was by improving their perceptions of such careers and increasing their aspirations of holding jobs in these fields. In France, the one-hour talk by women scientists increased science-related career aspirations for grade 12 students of both genders, with a slightly higher impact for girls. Moreover, it improved perceptions of science-related careers, with stronger impacts for girls, and provided reassurance to those who may have been concerned about the compatibility between STEM jobs and a fulfilling family life. Among the perceptions that researchers studied were salary expectations, required length of education, and a stereotype that science-related occupations are solitary and monotonous.[1]

Impacts of role models may be concentrated in academic fields with a more severe gender imbalance given that there may be more misperceptions about women in these fields. In France, the one-off exposure to a woman scientist only had positive effects in fields where girls were severely underrepresented, such as computer science and engineering.[1], In the United States, one short speech given by a woman economist at her alma mater increased the likelihood of women in that college majoring in economics by 8 percentage points, from 9 percent in the comparison group to 17 percent in the intervention group. Such impacts were paired with decreases in women's plans to major in lower-earning majors, thereby increasing their likely future earnings opportunities.[6]

While role model interventions may shift perceptions for both genders, exposure to women role models did not impact boys' and men's educational choices. Boys and men may be less responsive to information about STEM careers and gender stereotypes shared by role models given the higher presence of boys and male role models in STEM. In Norway, the gender of assigned MDs

during childhood had no discernible effect on boys' educational choices in high school.[7], In the United States, professors' gender during introductory courses at the undergraduate level did not affect male students' likelihood of graduating from a STEM degree, while it increased women students' performance.[2], Also in the United States, classroom visits by women economists did not impact male students' majoring decisions.[6]

The impact of role model exposure is concentrated among girls and women who are already high achievers in math and are more likely to thrive in STEM fields.

While exposure to role models generally increased STEM enrollment, four studies show that exposure to women role models primarily benefits girls and women who already had high achievement in math.[1], [2], [4], [7], These students may have been more responsive to shared information and have better identified with women role models. Given this predisposition, interventions may have been more successful in challenging gender stereotypes of STEM careers. Conversely, students with low achievement may not have considered gender stereotypes the primary barrier to a STEM career. Two studies conducted in academic settings in the United States found that exposure to role models increased the likelihood of high-performing women students choosing programs in which women were underrepresented by 8 and 26 percentage points.[2], [4] In these studies, researchers evaluated the impact of the mentor's gender on students' occupational choice at a military academy and the impact of the professor's gender during introductory courses at the undergraduate level, respectively.

Additionally, evidence from one study suggests that same-gender role models may help close the socioeconomic STEMM gap within gender.[7], In Norway, the positive impact of repeated interactions with women medical professionals on girls' educational outcomes was driven by high-ability girls from less-advantaged socioeconomic backgrounds, as measured by their mothers' education level. Researchers suggest that this group may have had less exposure to same-gender role models, and exposure to role models enabled them to realize their abilities and potential. The impact was not explained by girls receiving more information since there was no effect from having a highly educated father. Information provided solely by same-gender role models challenged gender stereotypes.[7] Programs that encourage high-ability girls, who otherwise shy away from STEM, to enter STEM fields lead to economic efficiency through more efficient talent allocation. However, additional interventions would be necessary to improve outcomes for lower-achieving girls.

Role model interventions with repeated interactions often improve girls' and women's educational performance in STEM courses.

Three studies that evaluated educational performance following regular interaction showed that the interventions helped close the gender gap in math and science achievement by increasing girls' and women's academic performance.[2], [5], [7], Repeated interactions may be more effective in shifting perceptions about science-related fields and consistently incentivize students, particularly those with high academic achievement. In the United States, having a woman professor during introductory courses at the undergraduate level increased women students' performance in math and science courses by 10 percent of a standard deviation, translating to helping to close 75 percent of the gender gap in grades. Women students' performance increased, although male students' grades dropped. Researchers suggest that students changed their preferences toward math and science as the professor's gender did not impact retention rates across achievement levels.[2], Another study in South Korea found an increase in middle-school girls' performance when assigned to school classrooms with women teachers. This assignment increased girls' performance relative to boys since girls had a similar performance to boys before the intervention.[5], However, the study mentioned above in France found no impact on performance from one-off exposure to women role models among high school students. While a single interaction may improve perceptions about science-related careers, it did not lead to increased taste and effort toward STEM courses.[1]

Some role model attributes, such as their professional success or behavior, may also impact their effectiveness.

Women role models with more professional success may be more effective in shifting women students into STEM careers. In France, in the one-hour talk mentioned above, older women professionals with more experience were more effective than young researchers at improving perceptions about the STEM field and increasing the likelihood of enrolling in a selective STEM program for girls in grade 12. Researchers suggest that their professional achievements may have been easier to identify, thereby conveying a more attractive work environment. Similarly, qualitative evidence reports that neither communication skills nor role models' motivation drove the effects.[1], In the United States, exposure to a woman teaching assistant in introductory undergraduate courses did not have discernable effects on women's choice of major, suggesting that graduate-level women students may not be an important factor in college decisions for undergraduate women students.[3]

Moreover, one study suggests that role models' behavior may also impact their effectiveness. In the South Korean study referenced above, women students shared that their women professors were more likely to provide encouragement and equal opportunities to participate in class.[5] Girls who had women professors and equal opportunities to participate in class were more likely to do well in STEM-related courses. While behavior and level of professional success are both important for ensuring that role models are effective, additional research can help to shed light on which role model attributes are particularly critical. There is also a need to understand the optimal timing of interventions, especially if the aim is to mitigate the effects of restrictive social norms. Because social norms, including gender norms, are notoriously slow to change, focusing on youth may be particularly effective as children's beliefs and attitudes are relatively more malleable.

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