Girls and young women underperform in mathematics relative to their male peers – a loss of talent that may hinder productivity growth. **Almudena Sevilla** and **Pilar Cuevas-Ruiz** explain how new developments in gender economics are changing our understanding of the maths gender gap and reshaping policy as a result.

Reducing gender gaps in mathematics education

Boys tend to outperform girls in mathematics, particularly among students who achieve the highest grades. This is significant as gender differences in maths performance can explain an important part of the gender gap in educational choices and future labour market outcomes.

Despite progress in women's college preparation and graduation rates over the last 70 years, women remain under-represented in the higher-paying and maths-intensive STEM fields (science, technology, engineering and maths). They also tend to choose degrees that lead to fields with about 6% lower average earnings than men and 10% lower 90th percentile earnings – the level that 90% of earners are below – indicating even the highly-paid in these fields are paid less than elsewhere (Bertrand, 2018).

How differently do girls and boys perform in mathematics?

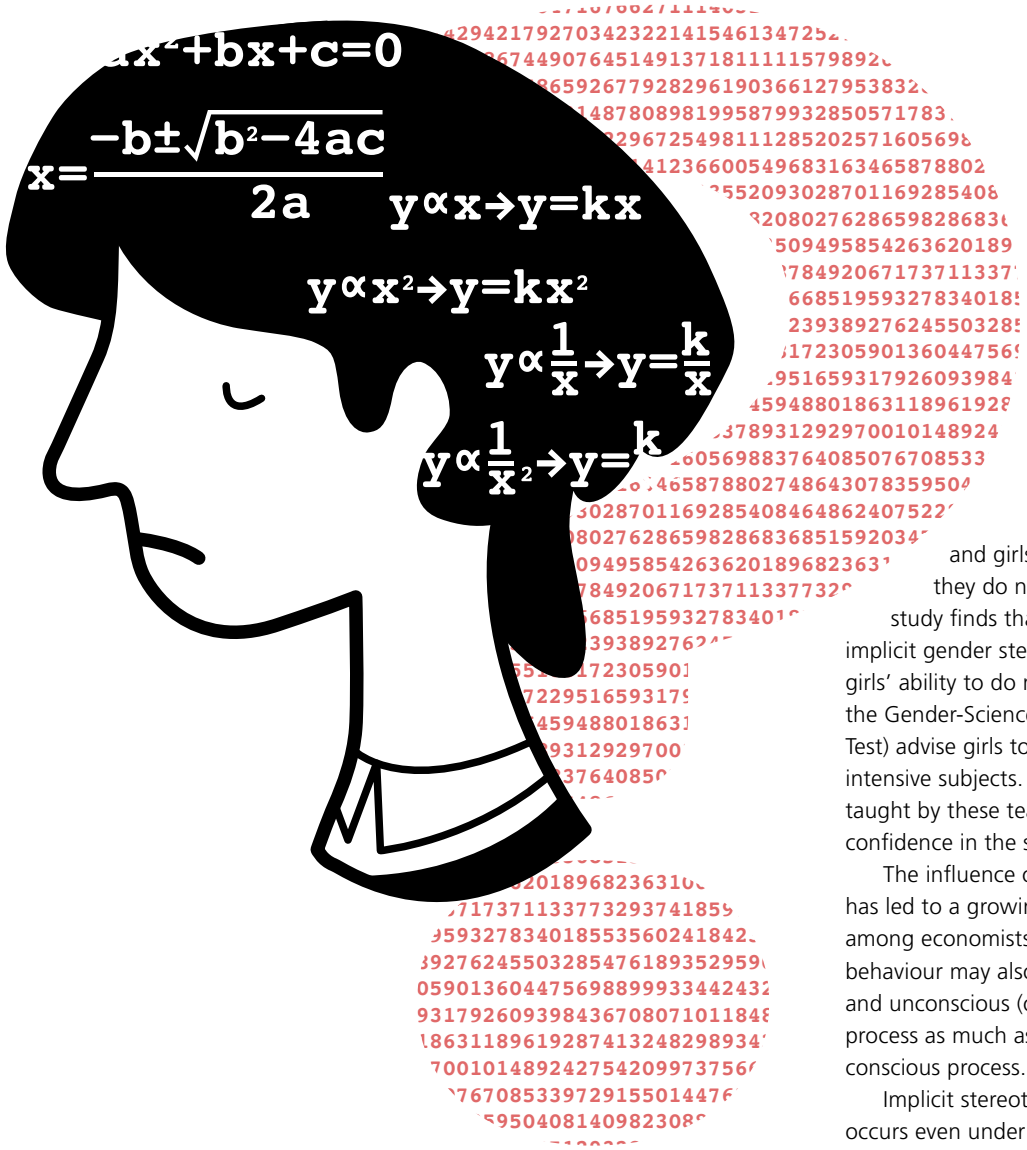
At the age of 11 in the UK, research has shown boys are four percentage points more likely to achieve the expected standard in maths than girls. They are also eight percentage points more likely to achieve the higher standard in standardised tests (Borra et al 2021, Cavaglia et al, 2020).

A similar pattern is found in other countries. On average, girls' maths results are lower than boys' at the age of 15 (see, for example, Borgonovi et al, 2018, which analyses data from 13 OECD countries). These differences are seen particularly among the most able students.

Recent evidence from several countries shows that while the gender gap in maths is almost negligible in primary school, it more than triples between the ages of 9-10 and 15-16 – equivalent to girls missing around four months of schooling. Girls' underperformance in maths represents a potential loss of talent, which may lead to lower productivity and economic growth.

There is no biological reason why boys should be better at maths than girls. But since boys and girls are shaped by the society in which they grow up, what role do gender stereotypes play in creating this maths gap?

Gender stereotypes are fixed ideas about what someone of a particular gender is like (descriptive) or should be like (prescriptive). Common gender stereotypes are that girls are biologically worse than boys at maths, that girls are more risk-averse than boys and that mothers should stop work to look after young children.



In economics textbooks three-quarters of the people mentioned, whether real or imagined, are men

Stereotypes influence women's and girls' preferences and expectations. Prescriptive stereotypes such as conservative beliefs about the role of women in society, rather than biology, have long been named as a factor that can explain much of the gender gap in mathematical attainment between boys and girls across countries.

Social expectations lower women's incentives to do well. The lower performance of girls versus boys in maths may also be the result of girls internalising a socially constructed behaviour in line with widely held descriptive gender stereotypes (for example, that girls shy away from competition and take lower risks) in contexts in which the task at hand has a strong gender stereotype associated with it, such as in mathematical assessments.

Stereotypes also constrain women's and girls' choices, even when they do not internalise them. One study finds that teachers with more implicit gender stereotypical beliefs about girls' ability to do maths (as measured by the Gender-Science Implicit Association Test) advise girls to pursue less maths-intensive subjects. It also finds that girls taught by these teachers display lower confidence in the subject.

The influence of social psychology has led to a growing acceptance among economists that stereotyping behaviour may also arise from a fast and unconscious (or "implicit") thought process as much as from a slow and conscious process.

Implicit stereotyping behaviour occurs even under scenarios of "perfect information". Whereas economists have traditionally assumed that stereotypes kick in when we know little about a person, new evidence is beginning to emerge about stereotyping occurring even in family and classroom settings where parents and teachers know a lot about their children and students.

Either because girls receive less resources from parents and teachers when they pursue male-dominated subjects such as maths, or because girls internalise these gender-stereotypical preferences, the end result is that girls end up choosing subjects of study that are "believed appropriate" for their gender, and/or do worse in male-dominated subjects such as maths.

How is policy being reshaped?

When unconscious gender stereotyping is at play, "coercive policies" that explicitly

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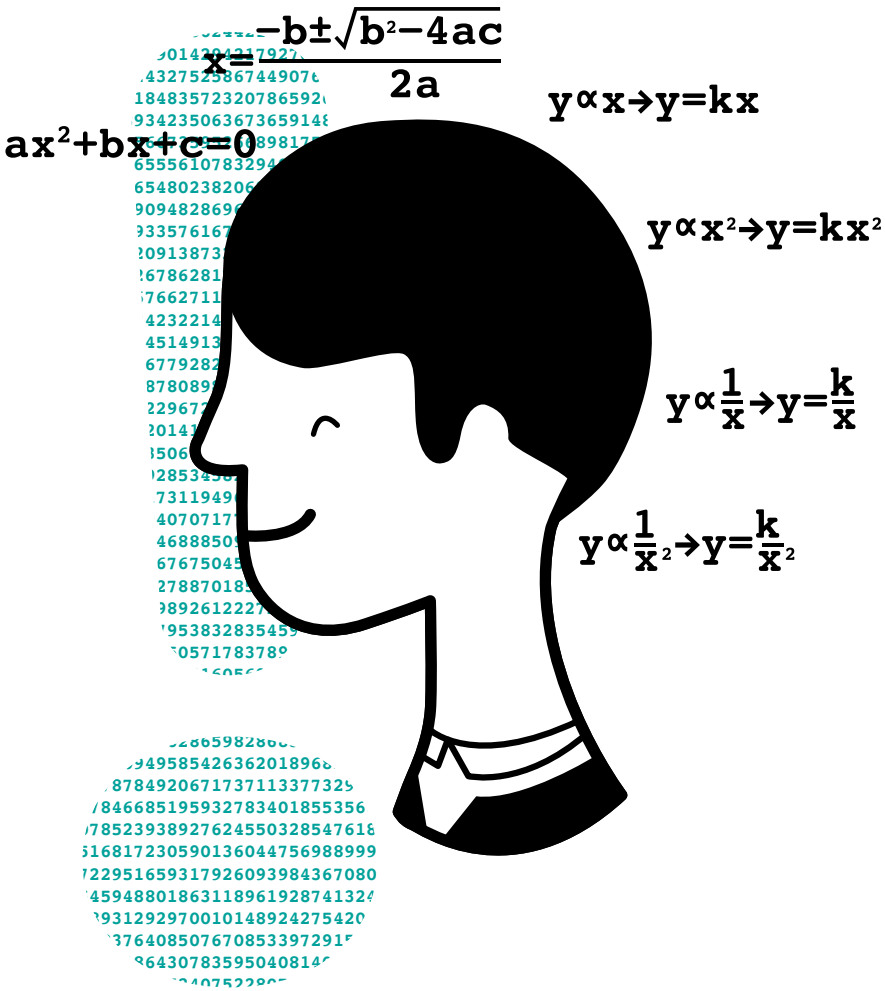


tell people what to do may not be as effective as interventions involving small nudges. A major objective of behavioural policy interventions is to avoid unconscious stereotypes entering the decision-making process in the first place.

One type of intervention consists of tackling implicit stereotyping on the part of teachers (and parents) by using awareness techniques so that more conscious (unbiased) processes kick in.

A popular tool for addressing unconscious stereotyping is revealing biases. This can be done, for example, through an implicit association test (IAT), a computer-based tool developed by social psychologists to measure the attitudes and beliefs that people may be unwilling to report, or even not know they held (Greenwald et al, 2009).

An increasing number of firms and institutions, including Harvard University, administer the IAT to their employees. In an educational context, one study shows that revealing to teachers the stereotypes they implicitly hold via the IAT could be a powerful intervention to decrease gender discrimination in grading. Other awareness interventions targeting decision-makers are "unconscious bias training" and "perspective-taking training".

An alternative to awareness interventions is introducing measures that change the context in which decisions are made, so that a more conscious process comes into effect. Researchers suggest that a large part of the gender gap in maths at high levels can be explained by the different ways in which men and women respond to competitive test-taking environments.

The rise in girls' underperformance in maths has been attributed to a higher aversion to competitive pressure. Others show that girls outperform boys in all tests but to a greater extent when the stakes are low. These results can help policy-makers to design tests that reduce gender differences in performance resulting from factors unrelated to true ability.

Policy interventions aimed at girls start early in childhood. Certain policies are aimed at preventing girls (and boys) from implicitly internalising gender stereotypes by not exposing them to stereotypical roles. These include having female role models, such as women maths teachers, adopting gender-neutral language and using teaching materials that challenge the prevalence of gender stereotypes.

This is important as it has been found that three-quarters of the people mentioned in economics textbooks, whether real or imagined, are men. The under-representation of women in economics books can reinforce the notion that economics is not a discipline for women.

Recent work tested whether a one-hour exposure to external female role models with a background in science affects students' perceptions and choice of field of study. It finds that the intervention increased the share of girls in the final year of school enrolling in selective (male-dominated) STEM programmes in higher education from 11% to 14.5%.

Researchers have also found that young women assigned to all-female classes in their first year of university are roughly 57% less likely to drop out and 61% more likely to get a top ranked degree under the UK system.

Other interventions include making girls more prepared to succeed, for example, by promoting resilience and grit, skills that are highly predictive

of achievement. For example, when children are exposed to a world view that emphasises the role of effort in achievement and encourages perseverance, the gender gap in the willingness to compete disappears. This shows that elimination of this gap implies significant efficiency gains.

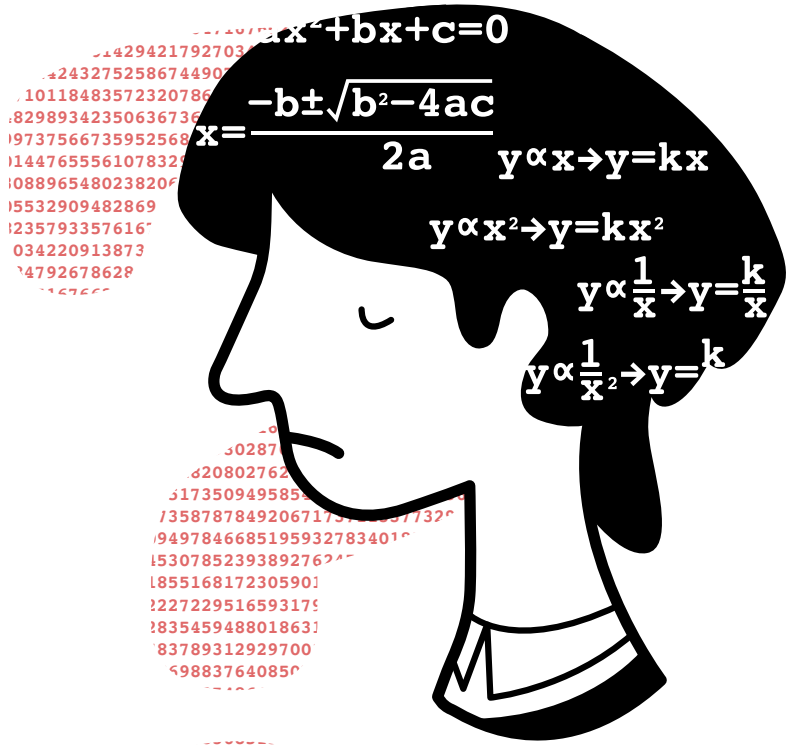
Prescriptive gender stereotypes are more often than not based on descriptive biased beliefs about girls' skills and abilities, and these contribute to the maths gender gap. This matters economically because talent is lost, and productivity suffers. As a result, policy-makers need to tackle unconscious and conscious biases.

Whereas awareness interventions have become popular because they can be cost-effective and easy to implement, sometimes challenging the stereotyping habits of decision-makers such as teachers and parents can backfire. For example, when provided with feedback about their own implicit associations, people may react defensively and question the validity of the bias test.

Similarly, unconscious bias training programmes can be very context-specific and their external validity is often questioned. Further, the underlying assumption of interventions that push girls to be more like boys is that the returns to these skills are the same across genders. Yet there is evidence that girls may not benefit in the same way and could even be penalised when acting like boys (Exley et al, 2020).

When gender-entrenched stereotypes are not unconscious – but rather conscious and explicit within the education system – avoiding gender stereotypes in decision-making requires changing biased beliefs. Recent psychological research shows that stereotypical beliefs about girls' (and women's) skills and abilities have indeed changed over time.

Economists are starting to recognise the malleable nature of stereotypes. Understanding what promotes change is a fruitful avenue for future economics research and can help us to design interventions to close the maths performance gap between girls and boys.



Exposure to female role models with a background in science can increase the share of women enrolling in selective, male-dominated, STEM programmes in higher education

This article first appeared on the Economics Observatory blog as 'How can we reduce gender gaps in mathematics education?' (https://www.economicsobservatory.com/how-can-we-reduce-gender-gaps-in-mathematics-education).

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Further reading

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