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PISA

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Are disadvantaged students given equal opportunities to learn mathematics?

- Some 65% of socio-economically advantaged students reported that they know well or have often heard of the concept of quadratic function, on average across OECD countries; but only 43% of disadvantaged students so reported.
- On average across OECD countries, the 20% of students who are most exposed to pure mathematics tasks (equations) score, on the PISA mathematics test, the equivalent of almost two school years ahead of the 20% of students who are least exposed. Exposure to simple applied mathematics tasks is much less strongly associated with better performance.
- About 19% of the performance difference between socio-economically advantaged and disadvantaged students can be attributed to differences in familiarity with mathematics. In Austria and Korea, more than 30% of the performance gap between these two groups of students is related to differences in familiarity with mathematics. In other words, there are clear indications that disadvantaged students systematically receive mathematics instruction of lower quality than advantaged students.

Thomas Fuller, brought from Africa to Virginia as a slave in 1724, could multiply two nine-digit numbers and state the number of seconds in a given period of time even though he never learned to read or write. Fuller's name did not make it into history-of-mathematics books as did the names of other prodigies of calculation, such as Wallis, Gauss or Ampère, simply because, as a slave, Fuller was not given the opportunity to practice his skills and express his genius.

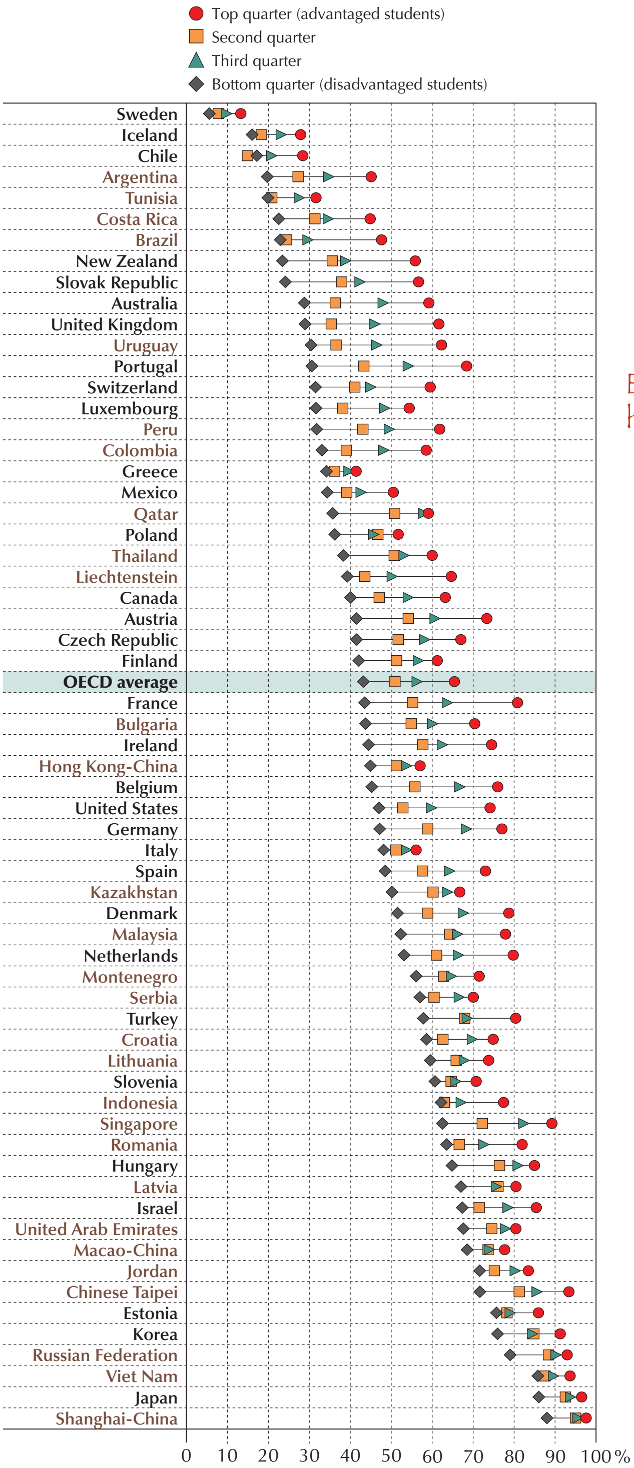
The new PISA report, *Equations and Inequalities: Making Mathematics Accessible to All,* shows that inequalities in access to mathematics are unacceptably wide even today. These inequalities, largely related to socio-economic status, result in a waste of the talents of hidden geniuses like Fuller, and limit the life opportunities of all other students, including those who struggle with numbers and formulas.

Disadvantaged students are less familiar with mathematics concepts.

On average across OECD countries, disadvantaged students spend about the same time in mathematics classes in school as their advantaged peers; but at school, they are less exposed to pure mathematics tasks and concepts (involving equations or functions, for example) that tend to be associated with better learning outcomes. As a result, many disadvantaged students have only little knowledge of core concepts in algebra and geometry. The difference between the shares of advantaged and disadvantaged students who reported that they know well or have often heard the concept of quadratic function is larger than 30 percentage points in Australia, Austria, Belgium, France, New Zealand, Portugal, the Slovak Republic, the United Kingdom and Uruguay.

Familiarity with the concept of quadratic function, by students' socio-economic status

Percentage of students who reported that they know well or have often heard the concept



Countries and economies are ranked in ascending order of the percentage of disadvantaged students who reported that they are familiar with the concept.
Source: OECD, PISA 2012 Database.

The relationship between the content covered during mathematics instruction at school and the socio-economic profile of students and schools is stronger in countries that track students early into different study programmes, that have larger percentages of students in selective schools, and that transfer less-able students to other schools.

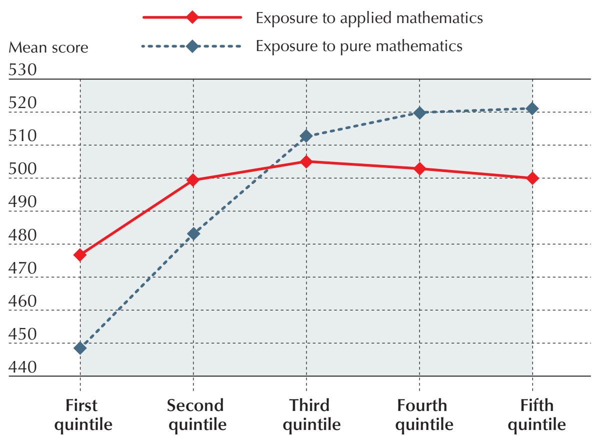
Exposure to mathematics concepts and procedures has an impact on performance…

Greater exposure to complex mathematics content is a strong predictor of higher performance in PISA, especially at low levels of exposure, among both advantaged and disadvantaged students. Even after accounting for the fact that better-performing students may attend schools that offer more mathematics instruction, exposure to pure mathematics is associated with higher performance. This suggests that exposing all students to challenging problems and conceptual knowledge in mathematics classes can have a large impact on performance.

In contrast, exposure to simple applied mathematics problems has a weaker relationship with student performance. Including some references to the real world in routine, drill-and-kill tasks has only a modest relationship with students' capacity to solve PISA problems. Nevertheless, the use of real-life contexts in mathematics problems is related to students having greater self-confidence in their mathematics ability. Disadvantaged students perform better on those PISA problems that connect mathematics concepts to concrete situations they encounter in their life than on problems formulated in less familiar contexts.

Performance in mathematics, by exposure to applied and pure mathematics

OECD average



Notes: The *index of exposure to applied mathematics* measures student-reported experience with applied mathematics tasks at school, such as working out from a train timetable how long it would take to get from one place to another or calculating how much more expensive a computer would be after adding tax.

The *index of exposure to pure mathematics* measures student-reported experience with mathematics tasks at school requiring knowledge of algebra (linear and quadratic equations).

Source: OECD, PISA 2012 Database.

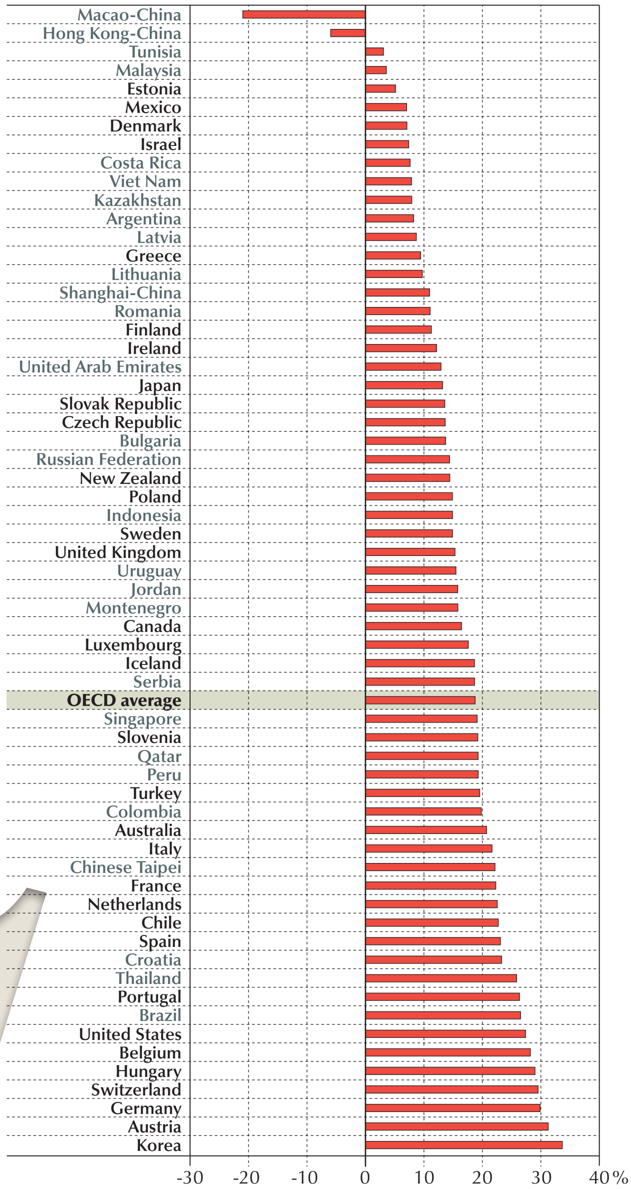
StatLink http://dx.doi.org/10.1787/888933377377

...and familiarity with mathematics is related to the performance gap between advantaged and disadvantaged students.

In the vast majority of countries, a substantial share of the disparities in PISA mathematics performance between advantaged and disadvantaged students can be attributed to differences in students' familiarity with mathematics concepts. On average across OECD countries, differences in familiarity with mathematics account for about 19% of the performance difference between these two groups of students. In Austria, Belgium, Brazil, Germany, Hungary, Korea, Portugal, Switzerland, Thailand and the United States, more than 25% of the performance difference between advantaged and disadvantaged students is related to familiarity with mathematics.

Differences in performance related to familiarity with mathematics, by socio-economic status

Percentage of the score-point difference between advantaged and disadvantaged students explained by differences in familiarity with mathematics



How to read the chart: The OECD average shows that across OECD countries, 19% of the difference in mathematics scores between advantaged and disadvantaged students is explained by disadvantaged students being less familiar with mathematics. The values for Macao-China and Hong Kong-China are negative because disadvantaged students have higher familiarity than advantaged students.

Note: Socio-economically advantaged students are defined as those students in the top quarter of the *PISA index of economic, social and cultural status* (ESCS). Disadvantaged students are students in the bottom quarter of ESCS.

Countries and economies are ranked in ascending order of the percentage of the performance gap between advantaged and disadvantaged students explained by familiarity with mathematics.

Source: OECD, PISA 2012 Database.

StatLink http://dx.doi.org/10.1787/888933377436

Disadvantaged students perform worse than their peers across all PISA mathematics tasks, but more so on the most difficult problems, and on those requiring students to think and reason mathematically. Better mathematics instruction that improves disadvantaged students' familiarity with mathematics would go a long way towards reducing the performance gap, particularly on problems that require students to apply formulas and procedures. But greater familiarity alone may not be sufficient for solving more complex problems that require the use of a broader set of mathematics skills. If the performance gap related to socio-economic status is to be closed, disadvantaged students would benefit not only from policies that increase opportunities for them to develop technical and procedural mathematics skills, but also from more experience with mathematical modelling and problem solving.

The bottom line: Socio-economically advantaged and disadvantaged students are not equally exposed to mathematics problems and concepts at school. Exposure to mathematics at school has an impact on performance, and disadvantaged students' relative lack of familiarity with mathematics partly explains their lower performance. Widening access to mathematics content can simultaneously improve performance and reduce inequalities. But to take full advantage of the mathematics knowledge they gain at school, disadvantaged students also need assistance in acquiring problem-solving skills.

For more information

Contact Mario Piacentini (Mario.Piacentini@oecd.org) and Chiara Monticone (Chiara.Monticone@oecd.org)

See OECD (2016), *Equations and Inequalities: Making Mathematics Accessible to All*, PISA, OECD Publishing, Paris.

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Are there differences in how advantaged and disadvantaged students use the Internet?

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