OECD

PISA IN FOCUS 56

education **data** education **evidence** education **policy** education **analysis** education **statistics** education **data** education **evidence** education **policy**

How confident are students in their ability to solve mathematics problems?

- On average across OECD countries, students' belief that they can solve mathematics problems (mathematics self-efficacy) is associated with a difference of 49 score points in mathematics – the equivalent of one year of school.
- There is a strong connection between how confident students feel about being able to solve pure and applied mathematics problems, and whether or not they were exposed to similar problems in class.
- When comparing students with similar academic performance and socio-economic status, those whose parents expected that they would enter university generally reported greater mathematics self-efficacy than those whose parents did not hold such high expectations for them.

The term "self-efficacy" describes students' belief that, through their actions, they can produce desired effects. This belief fuels a student's motivation to act or to persevere in the face of difficulties. In 2012, PISA examined students' self-described mathematics self-efficacy, which refers to students' convictions that they can successfully solve mathematics problems when they encounter them.

PISA 2012 asked students to report on whether they would feel confident doing a range of pure and applied mathematics tasks. These tasks included: using a train timetable to work out how long it would take to get from one place to another; calculating how much cheaper a TV would be after a 30% discount; calculating how many square metres of tiles would be needed to cover a floor; calculating the petrol-consumption rate of a car; understanding graphs presented in newspapers; finding the actual distance between two places on a map with a 1:10 000 scale; and solving equations like $3x+5=17$ and $2(x+3)=(x+3)(x-3)$.

Mathematics self-efficacy and mathematics performance are strongly associated.

At the country/economy level, mathematics self-efficacy is strongly associated with mathematics performance. Countries with higher mean performance in mathematics are those where students are more likely to report feeling confident about being able to solve a range of pure and applied mathematics problems. A positive relationship is also seen within countries. Students who have less mathematics self-efficacy perform worse in mathematics than students who are confident about their ability to handle mathematics tasks. On average across OECD countries, mathematics self-efficacy is associated with a difference of 49 score points in mathematics – the equivalent of one year of school. In 23 countries and economies, the difference in mathematics performance that is associated with students' self-efficacy is 50 points or more; in Liechtenstein, Chinese Taipei and Viet Nam, the difference is at least 60 points.

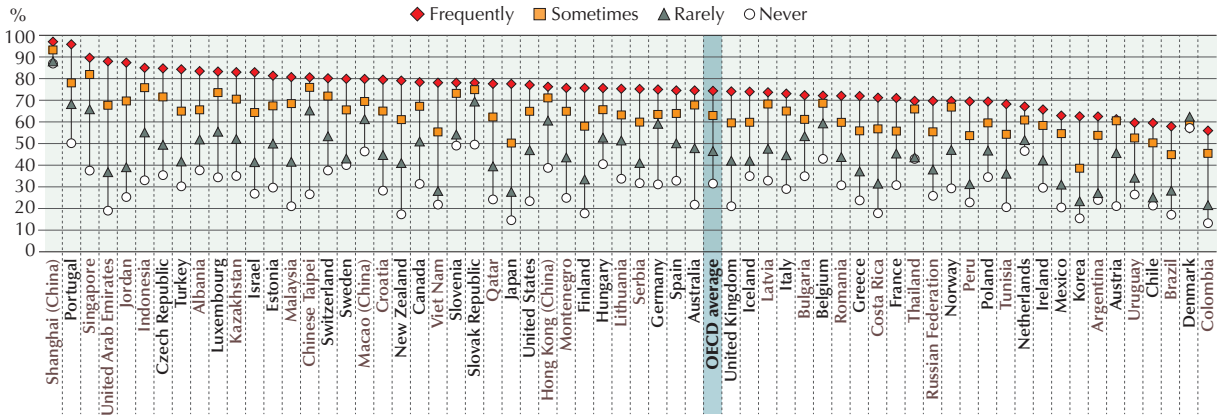
 © OECD 2015

PISA IN FOCUS

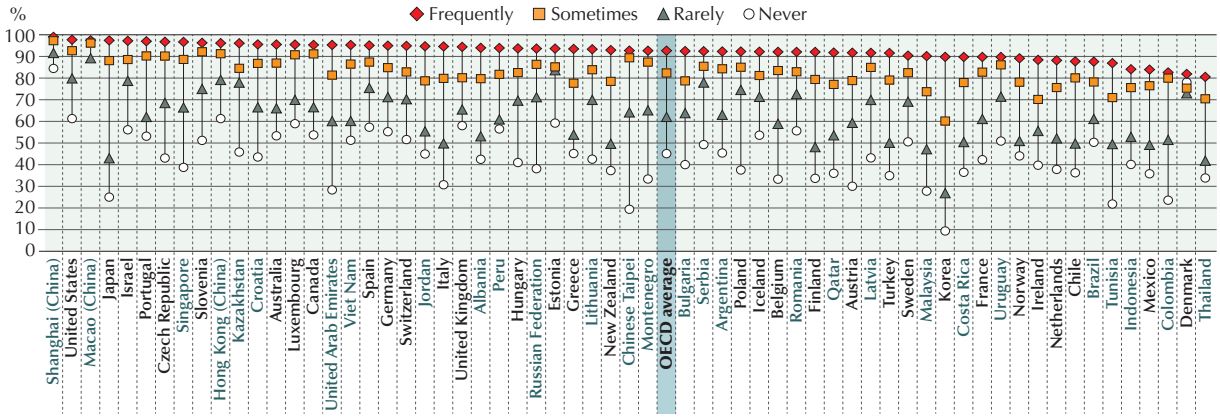
The relationship between mathematics self-efficacy and mathematics performance is mutually reinforcing. While better performance in mathematics leads to greater self-efficacy, students who have less mathematics self-efficacy are at greater risk of underperforming in mathematics, regardless of their actual abilities. If students do not believe in their ability to accomplish particular tasks, they will not exert the effort needed to complete the tasks successfully; then a lack of self-efficacy becomes a self-fulfilling prophecy.

Students' confidence in solving a mathematics task is related to how often they encountered similar tasks at school

Percentage of students who reported feeling "confident" or "very confident" about having to find the actual distance between two places on a map with a 1:10 000 scale if the students reported having encountered similar tasks…



Percentage of students who reported feeling "confident" or "very confident" about solving an equation like 3x + 5 = 17 if the students reported having encountered similar tasks...



Countries and economies are ranked in descending order of the percentage of students who reported being confident or very confident about having to solve the problem when they frequently encountered similar problems at school.

Source: OECD, PISA 2012 Database, Table III.5.12.

StatLink http://dx.doi.org/10.1787/888932963996

Schools can promote mathematics self-efficacy by exposing students to a variety of tasks…

The strong and mutually reinforcing relationship between mathematics self-efficacy and mathematics performance suggests that education systems that help students to become confident and motivated also help them to develop specific skills. PISA reveals that there is a strong connection between how confident students feel about being able to solve specific pure and applied mathematics problems, and whether or not they were exposed to similar problems in class. For example, although 56% of students feel confident or very confident about finding the actual distance between two places on a map, on average across OECD countries, this percentage varies greatly depending on whether students reported that they had encountered the problem frequently, sometimes, rarely

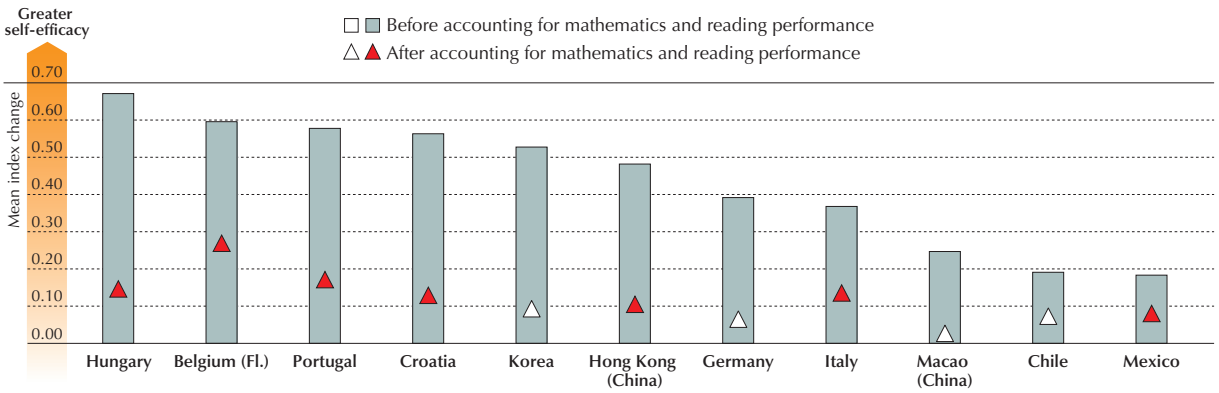
or never in class. Across OECD countries, 74% of students who reported that they had frequently encountered this applied problem reported feeling confident about their ability to solve it; 63% of those who reported that they had sometimes encountered the problem reported feeling confident or very confident; 47% of those who reported that they had only rarely encountered the problem reported feeling confident or very confident; and 32% of those who reported that they had never encountered the problem felt confident or very confident.

Although many more students feel confident or very confident about solving a linear equation like $3x+5=17$, fewer than one in two of those who reported that they had never seen such an equation reported feeling confident or very confident about solving it. The difference in the percentage of students who feel confident or very confident about solving a linear equation between those who reported that they had frequently encountered similar problems in class and those who reported that they had never encountered such a problem is larger than 50 percentage points in 28 countries and economies. In Japan, Korea and Chinese Taipei, this difference is larger than 70 percentage points, while in Denmark and Shanghai-China it is smaller than 30 percentage points.

In general, almost all students who reported that they had frequently encountered pure mathematics problems feel confident about solving such problems. But students are less confident about their ability to solve applied mathematics problems, even when they reported that they had frequently encountered such problems in class. One reason for this lack of self-efficacy could be that applied mathematics problems are, by nature, more ambiguous and diverse. A second could be that solving applied mathematics problems generally requires both a good understanding of an underlying problem as well as a good understanding of the context in which the problem is set.

Students whose parents hold ambitious expectations for them are generally more confident in their own maths abilities

Change in the Index of mathematics self-efficacy *that is associated with parents who expect their child to complete a university degree*[1]



Note: Mean index changes that are statistically significant at the 5% level ($p<0.05$) are marked in a darker tone.
1. A university degree refers to ISCED levels 5A and 6.
Countries and economies are ranked in descending order of the mean index change before accounting for mathematics and reading performance.
Source: OECD, PISA 2012 Database, Table III.6.13d.
StatLink http://dx.doi.org/10.1787/888932964034

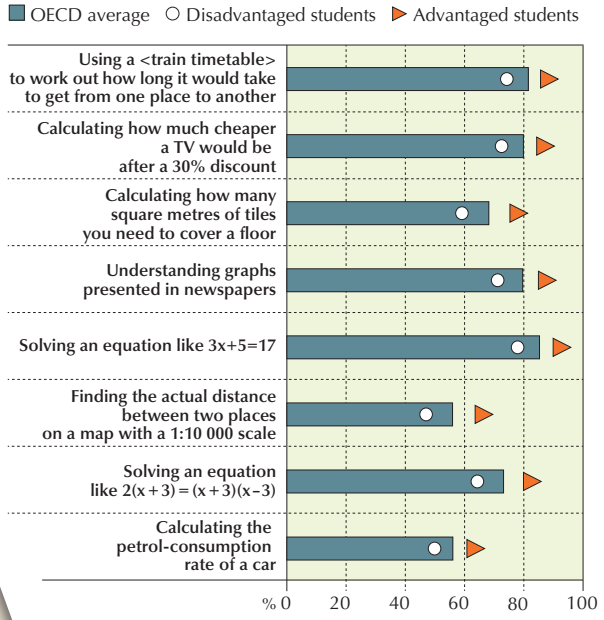
… and families can play a supportive role too.

PISA results also suggest that families can help students to become confident learners by giving them support and encouragement. In 2012, 11 education systems distributed a questionnaire to the parents of students who took the PISA test. The responses to this questionnaire reveal that, when comparing students with similar academic performance and socio-economic status, those whose parents expected that they would enter university generally reported greater mathematics self-efficacy than those whose parents did not hold such high expectations for them.

PISA IN FOCUS

Socio-economically advantaged students are more confident in their ability to solve mathematics problems

Percentage of students across OECD countries who reported feeling confident or very confident about doing the following tasks



Notes: Results for each participating country and economy can be found in Table III.4.1a.

The difference between advantaged and disadvantaged students is always statistically significant at the 5% level.

Source: OECD, PISA 2012 Database, Tables III.4.1a and III.4.1c.

StatLink http://dx.doi.org/10.1787/888932963958

Socio-economic disparities in mathematics self-efficacy are pervasive.

Disadvantaged students are generally less likely to feel confident about their ability to tackle specific mathematics tasks than advantaged students. While these differences partly reflect differences in mathematics performance related to socio-economic status, they remain large even when comparing students who perform similarly in mathematics. PISA reveals that two crucial factors that influence students' self-efficacy – exposure to tasks and parents' expectations – are influenced by students' socio-economic background. Among students who perform similarly in mathematics, disadvantaged students are less likely than advantaged students to be exposed to a variety of applied and pure mathematics problems, and their parents are less likely to expect that they will graduate from university.

The bottom line: A sense of self-efficacy is essential if students are to fulfil their potential. Yet too many students, particularly disadvantaged students, do not have confidence in their ability to tackle mathematics tasks. Schools and families can help students to develop a mastery of mathematics by exposing them to a variety of mathematics problems while providing encouragement and support as they work to solve them.

For more information

Contact Francesca Borgonovi (Francesca.Borgonovi@oecd.org)

See OECD (2013), *PISA 2012 Results: Ready to Learn (Volume III): Students' Engagement, Drive and Self-Beliefs*, PISA, OECD Publishing, Paris.

Visit

www.pisa.oecd.org
www.oecd.org/pisa/infocus
Adults in Focus
Education Indicators in Focus
Teaching in Focus

Coming next month

Can schools help to integrate immigrants?

Photo credits: ©khoa vu/Flickr/Getty Images ©Shutterstock/Kzenon ©Simon Jarratt/Corbis

This paper is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and the arguments employed herein do not necessarily reflect the official views of OECD member countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.