Equations and Inequalities: Making Mathematics Accessible to All

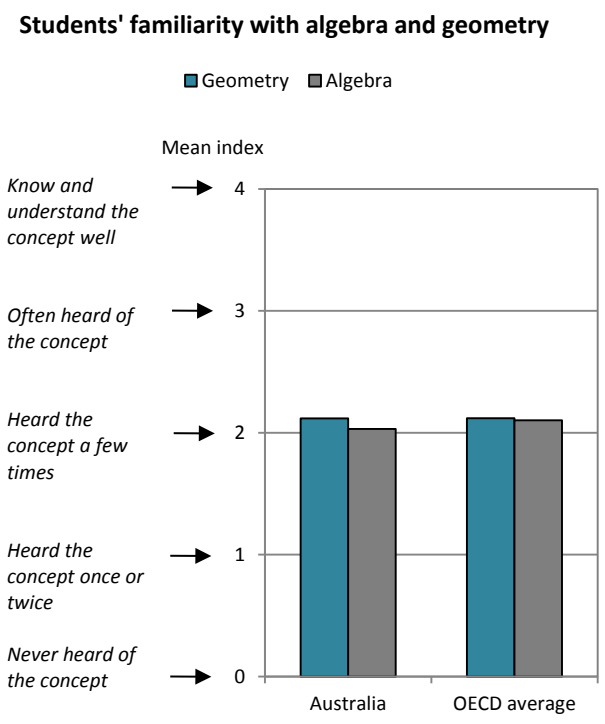
Country note Australia

Numeracy skills are used daily in many jobs, and proficiency in numeracy is important for a wide range of outcomes in adult life, from employment to health and civic participation. In Australia, almost 30% of employees use algebra at work, and people with high numeracy skills are 60% more likely to earn high wages than the average worker. Proficiency in numeracy involves more than the ability to make simple calculations; people also need to be able to reason mathematically. Given the importance of mathematics reasoning in everything from preparing a meal to exploring space, mathematics curricula and teaching practices need to give all students the opportunity to develop higher-order thinking and reasoning skills.

Opportunity to learn (OTL) refers to the content taught in the classroom and the time a student spends learning this content. Not all students, not even those in the same school, have equal opportunities to learn. Opportunity to learn can be affected not only by the content of the curriculum and how that content is taught, but also by how students from different socio-economic backgrounds progress through the system, how well learning materials match students' skills, and how well teachers understand and manage the diverse learning needs of their students.

What opportunities to learn mathematics are offered to students in Australia?

- In 2012, the average 15-year-old student in Australia spent 3 hours and 56 minutes per week in regular mathematics lessons at school (OECD average: 3 hours and 32 minutes), 6 minutes more per week than the average student spent in 2003 (OECD average: 13 minutes more).
- Students in Australia have heard of algebra concepts (such as exponential function, quadratic function and linear equation) and of geometry concepts (such as vector, polygon, congruent figure and cosine) a few times, similar to the OECD average.
- Students in Australia reported less frequent exposure at school to pure mathematics (linear and quadratic equations) and to applied mathematics tasks (such as working out from a train timetable how long it would take to get from one place to another) than the average across OECD countries.



Source: Figure 1.7

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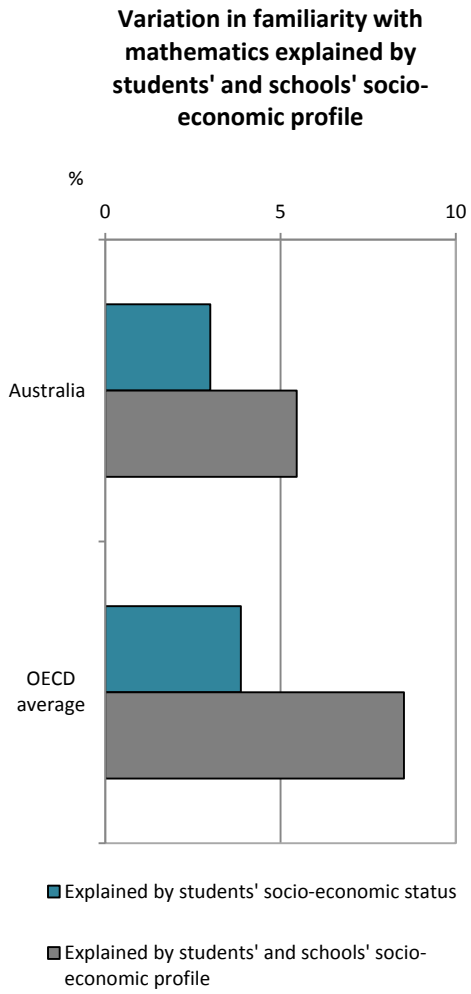
How does access to mathematics vary across students, schools and school systems?

Lack of access to mathematics content at school can leave young people socially and economically disadvantaged for life. Education systems that fail to provide the same learning opportunities to all students can end up reinforcing, rather than beginning to dismantle, the inequalities already present in society. How are opportunities to learn mathematics distributed in Australia?



Source: Figure 2.2

- Girls in Australia are more familiar with mathematics concepts than boys, as on average across OECD countries.
- In Australia, around 5% of the variation in familiarity with mathematics is explained by students' socio-economic status and by the concentration of socio-economically disadvantaged students in certain schools (OECD average: 9%).
- In Australia, the relationship between students' socio-economic status and their familiarity with mathematics is stronger among students attending upper secondary school than among students attending lower secondary school, as is the case on average across OECD countries.
- In Australia, around 11% of students attend vocational schools. These students are more likely to be socio-economically disadvantaged and to be less familiar with mathematics than students in academic tracks. However, the difference in familiarity between students in academic and vocational tracks is smaller than the OECD average.
- In Australia, over 98% of students attend schools that practice ability grouping. Across OECD countries, ability grouping is not strongly associated with the average student's familiarity with mathematics , but might reduce disadvantaged students' access to advanced mathematics.
- Some 44% of students in Australia attend schools where a student's academic performance and/or recommendations from feeder schools are always considered for admission. On average across OECD countries, the higher the percentage of students enrolled in selective schools in a country, the less equity in opportunity to learn mathematics in that country.
- In Australia, 70% of mathematics teachers in advantaged schools and 60% of teachers in disadvantaged schools have a major in mathematics according to what reported by the schools' principals (OECD average: 63% in advantaged and 55% in disadvantaged schools).

What is the relationship between exposure to mathematics in school and performance in PISA?

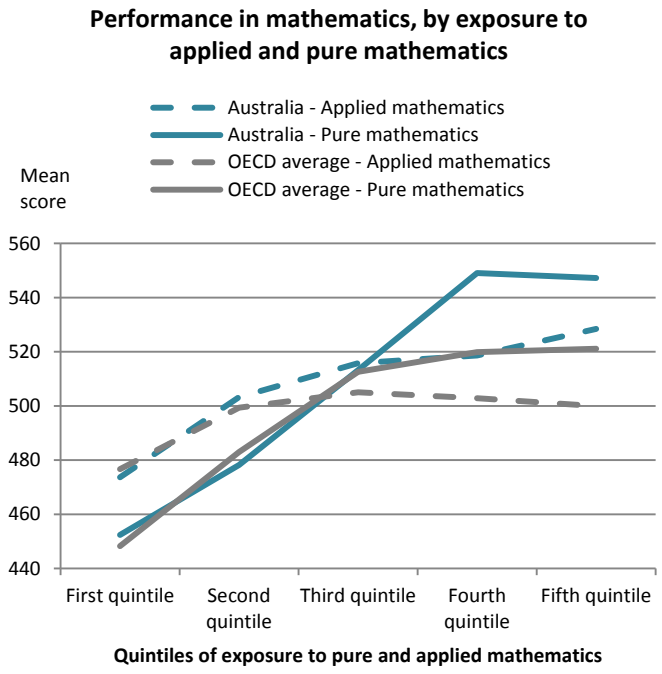
How is opportunity to learn mathematics related to students' performance in PISA? PISA challenges students to solve problems that might be encountered in real life and that do not necessarily look like the problems presented in mathematics classes at school. Even though PISA data cannot establish cause and effect, by analysing students' exposure to mathematics and how those students perform on different PISA tasks, PISA can provide evidence of whether students can apply the mathematics they learn at school to novel problems.

- In Australia, longer instruction time in mathematics (even longer than six hours per week) is associated with an improvement in mathematics performance. Students who are exposed to mathematics for a longer time also enjoy a positive learning climate. This suggests that good class discipline allows long instruction hours to be more productive. But after accounting for the fact that better-performing students may be sorted into better schools and grades that provide longer instruction time in mathematics, an increase in instruction time has no statistically significant impact on performance.

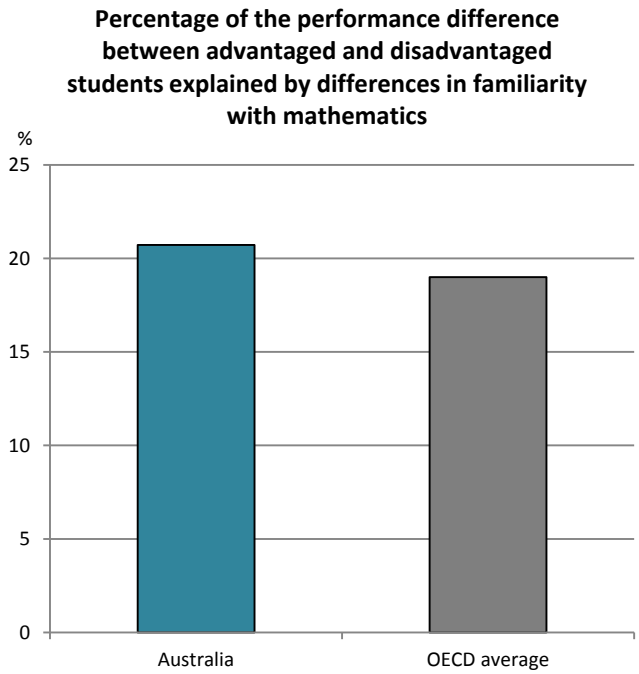
- Exposure to pure mathematics is more strongly related to higher performance than exposure to applied mathematics, in Australia as on average across OECD countries. Even after accounting for the fact that better-performing students may attend schools that offer them more mathematics instruction, exposure to pure mathematics is related to higher performance, both in Australia and on average across OECD countries.

- Exposure to simple applied mathematics is also positively related to performance, particularly so at low levels of exposure.

- In Australia, around 21% of the performance difference between socio-economically advantaged and disadvantaged students can be attributed to disadvantaged students' relative lack of familiarity with mathematics concepts (OECD average: 19%).



Source: Figure 3.9



Source: Figure 3.15

How are opportunity to learn, students' attitudes towards mathematics and mathematics performance related?

Not everyone is born to become a mathematician, however, everyone needs to be able to reason mathematically. Positive feelings towards mathematics and the ability to solve mathematics problems are closely interconnected. That is why it is important to nurture positive attitudes towards mathematics among students of all ages.

- In Australia, greater exposure to complex mathematics concepts, as measured by the *index of familiarity with mathematics*, is associated with less self-confidence (lower self-concept) in mathematics and with more mathematics anxiety, after accounting for students' mathematics performance.

- About 18% of students in Australia report that they are exposed to algebraic word problems in tests more frequently than they are exposed to the same type of problems during lessons. Students who are more frequently exposed to mathematics problems – including algebraic word problems, contextualised mathematic problems, procedural tasks, pure mathematics problems – during tests than during lessons feel more anxious than students of similar ability who are less or equally exposed to these problems in tests and in lessons.

- Students who reported less familiarity with mathematics than the average student in their school have lower mathematics self-concept (in Australia as on average across OECD countries), meaning that their self-concept may be undermined by social comparisons with peers who have a greater familiarity with mathematics.

Giving all students similar opportunities to learn mathematics

How can all students be helped to understand mathematical ideas, compute fluently, engage in logical reasoning and communicate using mathematics? One way is to ensure that all students learn core mathematics concepts and learn how to solve challenging mathematics tasks at school.

A policy strategy centred on giving all students similar opportunities to learn mathematics can reduce the number of students who lack the knowledge and understanding of mathematics expected of 15-year-olds and could ultimately result in greater social mobility. A general strategy for the countries participating in PISA would include:

- **Developing coherent standards, frameworks and instruction material for all students**, to increase focus and connections between topics in the curriculum and to set the same expectations for all students.

- **Helping students acquire mathematical skills beyond content knowledge**, by supporting teachers in including problem solving in mathematics classes.

- **Reducing the impact of tracking and ability grouping on equity in exposure to mathematics**, by postponing the age at which students are first tracked, allowing students to change tracks and courses, and increasing the quantity and improving the quality of the mathematics taught in vocational tracks.

- **Addressing heterogeneity in the classroom**, by offering individualised support to struggling students and by providing pedagogical training to teachers on how to handle students with different abilities in the same class.

- **Promoting positive attitudes towards mathematics through innovations in the curriculum and teaching**, by creating and using engaging tasks and giving feedback to struggling students.

- **Monitoring and analysing opportunity to learn**, by collecting and analysing data on the mathematics content and the teaching methods to which students are exposed.

To learn more, see…

OECD (2016), *Equations and Inequalities: Making Mathematics Accessible to All*, PISA, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264258495-en