Equations and Inequalities: Making Mathematics Accessible to All

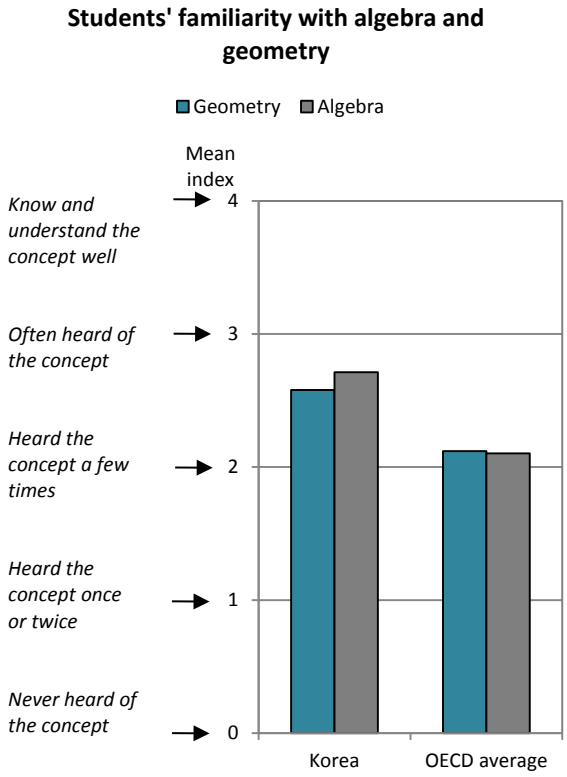
Country note
Korea

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. But proficiency in mathematics 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 Korea?

- In 2012, the average 15-year-old student in Korea spent 3 hours and 33 minutes per week in regular mathematics lessons at school (OECD average: 3 hours and 32 minutes), 33 minutes less per week than the average student spent in 2003 (OECD average: 13 minutes more). Only in Korea, which had the fifth longest mathematics class time in 2003, did class time shrink over the period.
- Students in Korea 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) more than a few times, more than the OECD average. Overall familiarity with mathematics is the highest among participating countries and economies.
- Students in Korea reported the highest exposure to pure mathematics (linear and quadratic equations) among PISA 2012 participating countries and economies, and one of the highest exposure to applied mathematics tasks (such as working out from a train timetable how long it would take to get from one place to another).



Source: Figure 1.7

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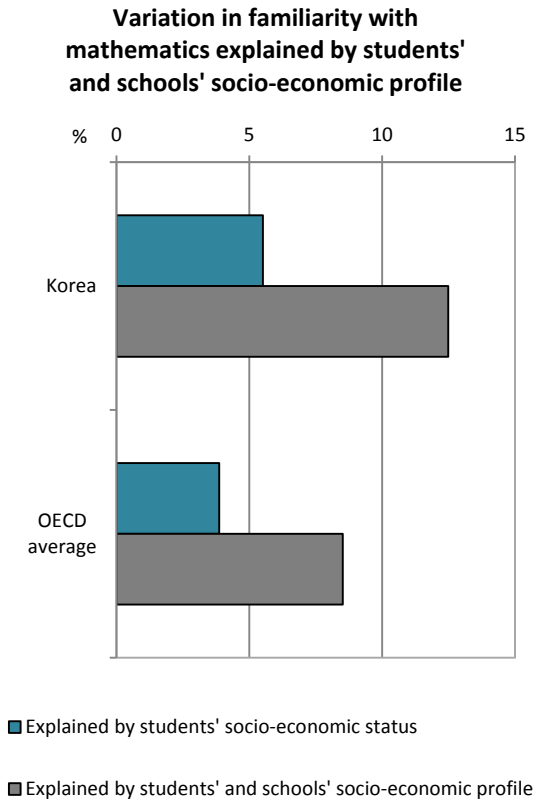
How does access to mathematics vary across students, schools and school systems?

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 Korea?

In Korea, as on average across OECD countries, students' and schools' socio-economic profile is strongly related to students' access to opportunities to learn mathematics. Stratification between schools is also strongly associated with more unequal opportunities to learn.



- Girls in Korea are as familiar with mathematics concepts as boys, (while on average across OECD countries girls are more familiar with mathematics than boys). Students who have attended at least one year of pre-primary education are more familiar with mathematics than students who have not, as is the case on average across OECD countries.
- In Korea, 12% of the variation in familiarity with mathematics is explained by students' socio-economic status and by the concentration of socio-economically advantaged students in certain schools (OECD average: 9%).
- Korea first tracks students at the age of 14. PISA 2012 data show that early tracking into academic or vocational programmes is related to inequalities in opportunities to learn mathematics. On average across OECD countries, the earlier the students' age at first tracking in a country, the less equity in opportunity to learn mathematics in that country.
- Some 20% of 15-year-old students in Korea attend a vocational school. Students in Korea who attend vocational schools are more than three times as likely to be socio-economically disadvantaged and more than twice as likely to be less familiar with mathematics as students who attend academically oriented schools.

Source: Figure 2.2

- In Korea, the relationship between students' socio-economic status and their familiarity with mathematics is significantly stronger for students attending upper secondary school compared to their peers in lower secondary school. This suggests that the transition to upper secondary education is a critical passage when students get selected into higher or lower mathematics tracks, and that the socio-economic status of the students shapes this transition.
- Some 90% of students in Korea attend schools practicing ability grouping for some or all classes. Ability grouping is as prevalent in socio-economically disadvantaged schools as it is in advantaged ones (across OECD countries, ability grouping is more prevalent in socio-economically disadvantaged schools than in advantaged ones). [*link to Figure 2.18a*] Across OECD countries, ability grouping is not strongly associated with the familiarity with mathematics of the average student , but might reduce disadvantaged students' access to advanced mathematics.
- About 67% of students in Korea 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.

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

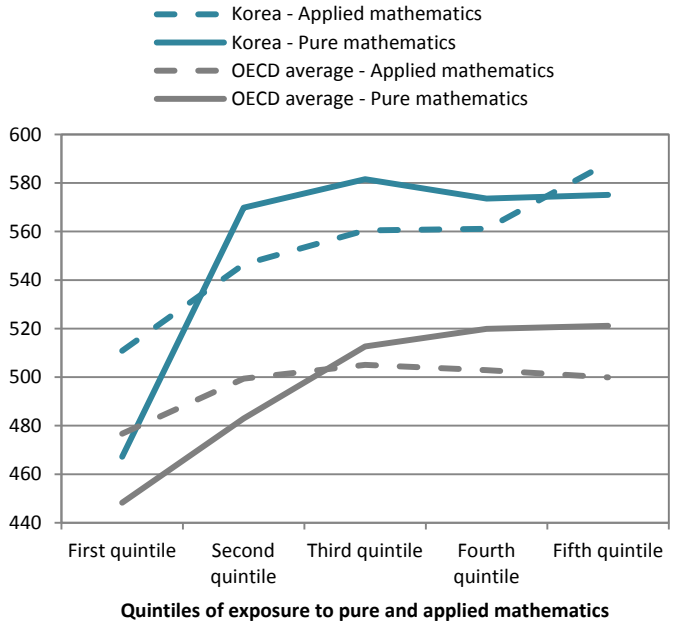
How is opportunity to learn mathematics related to students' performance in PISA? PISA challenges students to solve problems that might be encountered in real life and that do not necessarily look like the problems presented in mathematics classes at school. Even though PISA data cannot establish cause 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 Korea, longer instruction time in mathematics (even beyond six hours per week) is associated with an improvement in mathematics performance. Moreover, an increase in instruction time has a statistically significant positive impact on performance even after accounting for the fact that better-performing students may be sorted into schools and grades providing longer instruction time in mathematics. In Korea, students who are exposed to mathematics for a longer time study in classes with a better disciplinary climate than other students. This suggests that good class discipline allows long instruction hours to be productive. Differently from the majority of OECD countries, students who attend after-school mathematics classes in Korea perform better than students who do not attend such classes.

- Korea is the country where the association between exposure to pure mathematics and performance is highest. Greater exposure matters much more for performance among students who are not much exposed than among students who are very much exposed. Korean students in the first quintile of exposure to pure mathematics (the 20% least exposed students) score more than one hundred points less than students in the second quintile. 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.

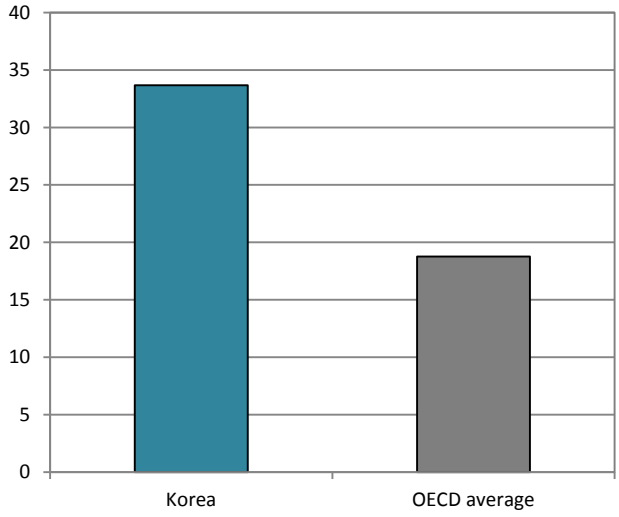
- In Korea, about 34% of the performance difference between socio-economically advantaged and disadvantaged students can be attributed to disadvantaged students' relative lack of familiarity with mathematics concepts (OECD average: 19%).

Performance in mathematics, by exposure to applied and pure mathematics



Source: Figure 3.9

Percentage of the performance difference between advantaged and disadvantaged students explained by different familiarity with mathematics



Source: Figure 3.15

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

If not everyone is born to become a mathematician, 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 Korea, greater exposure both to pure and applied mathematics is associated with more self-confidence (higher self-concept) in mathematics, after accounting for students' mathematics performance.

- Students in Korea who reported less familiarity with mathematics than the average student in the school have lower mathematics self-concept (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. In Korea, the reduction in self-confidence associated with having less familiarity with mathematics than other students in the school is the largest among PISA 2012 participating countries and economies.

- In Korea, students' use of a computer in class is related to a higher interest in mathematics, even after taking into account students' and schools' characteristics.

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 on equity in exposure to mathematics** by postponing the age at which students are first tracked, allowing students to change tracks, 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