



4

Student demographics and performance in collaborative problem solving

This chapter examines performance differences within countries and economies that can be related to the demographic and social characteristics of students and schools. The factors considered include students' gender, socio-economic status and immigrant background. The impact of student diversity on performance in collaborative problem solving is also discussed.



How does performance in collaborative problem solving relate to gender, socio-economic status and immigrant background? How do these differences compare to those observed in the three core PISA domains of science, reading and mathematics? This chapter aims to identify some of the factors that can explain the variation in performance in collaborative problem solving, both before and after accounting for performance in the three core PISA subjects.

What the data tell us

- Some 38% of the variation in students' collaborative problem-solving performance can be attributed to factors unique to collaboration; the remaining 62% is shared with factors common to performance in science, reading and mathematics.
- Girls perform significantly higher than boys in collaborative problem solving in every country and economy that participated in the assessment. On average across OECD countries, girls scored 29 points higher than boys; the largest gaps of over 40 points were observed in Australia, Finland, Latvia, New Zealand and Sweden, while the smallest gaps of fewer than 10 points were observed in Colombia, Costa Rica and Peru.
- Performance in collaborative problem solving improves as students' and schools' socio-economic profile improves, although this relationship is weaker than the relationship between socio-economic profile and performance in the three core PISA subjects.
- Non-immigrant students score 36 points higher in collaborative problem solving than immigrant students, on average across OECD countries.
- No significant performance difference remains between advantaged and disadvantaged students, or between immigrant and non-immigrant students, after accounting for performance in science, reading and mathematics. However, girls still perform 25 points higher than boys after accounting for performance in the three core PISA subjects.

VARIATION IN STUDENT PERFORMANCE IN COLLABORATIVE PROBLEM SOLVING

Variation in student performance within countries/economies

As discussed in Chapter 3 (Figure V.3.6 and Table V.3.1), there is considerable variation in collaborative problem-solving performance within each country/economy.¹

The standard deviation summarises the distribution of performance among 15-year-olds within each country/economy in a single number (Table V.3.2). By this measure, the smallest variation in problem-solving proficiency is found in Tunisia, with a standard deviation of 59 score points, and Costa Rica, Mexico, Montenegro and Turkey, with standard deviations of under 80 score points. Among top-performing countries, both Japan and Korea have narrow spreads of performance (standard deviations of 84 and 85 score points, respectively).

At the other end of the spectrum, Australia, Canada, Finland, France, Germany, Israel, New Zealand, the United Kingdom and the United States have the largest variations in collaborative problem-solving proficiency, with standard deviations of over 100 score points. The differences in performance in these countries are therefore wider than would be expected in a diverse population of students across all 32 OECD countries that participated in the collaborative problem-solving assessment.

Variations in student performance within and between schools

The variation in performance within countries can be divided into a measure of performance differences between students in the same school, and a measure of performance differences between groups of students from different schools. Figure V.4.1 shows the total variance in performance within each country/economy divided into its between-school and within-school components.²

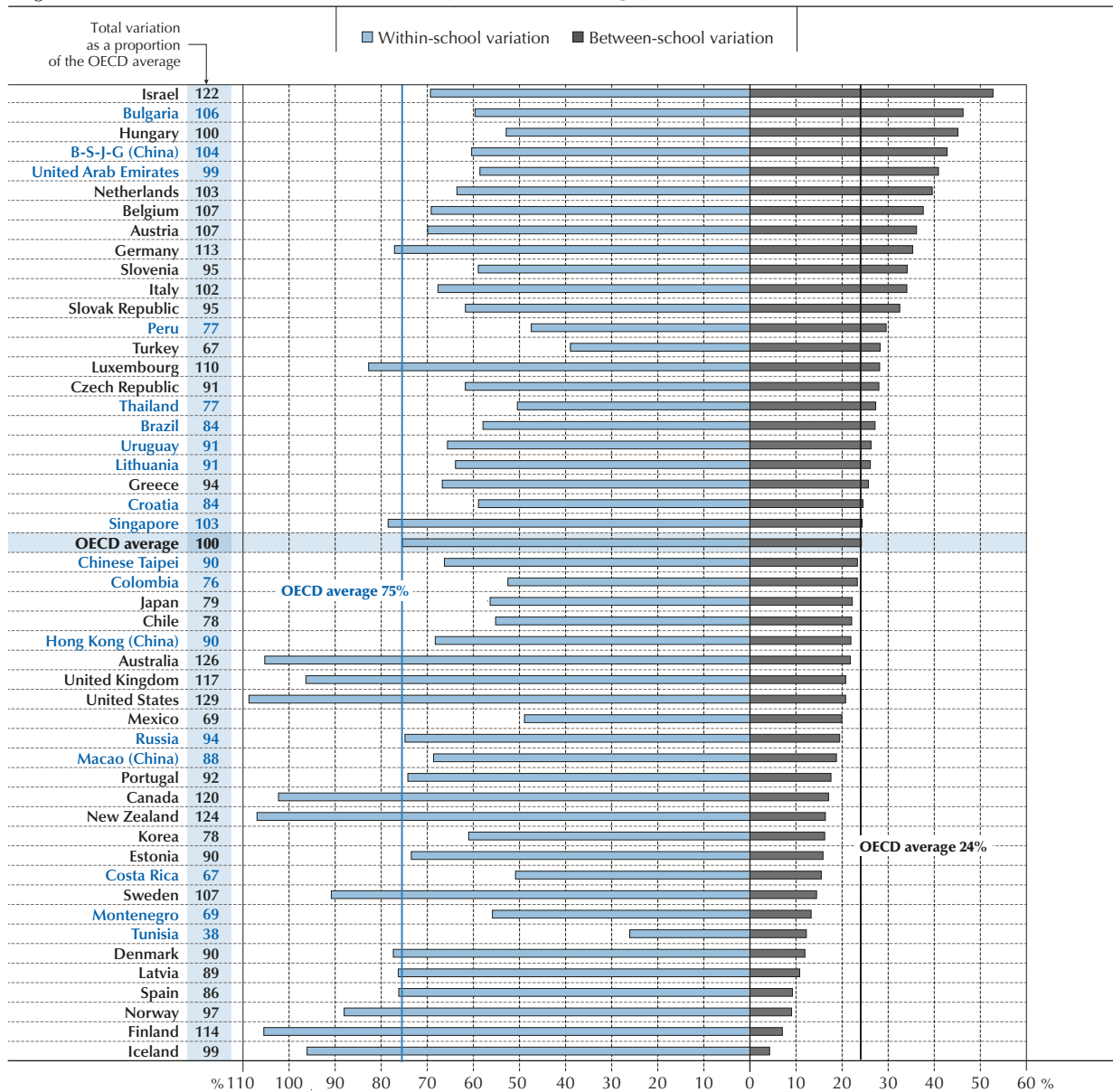
The data show that there is substantial variation in collaborative problem-solving results both within and between schools. On average across OECD countries, the variation in student performance that is observed within schools amounts to 75% of the OECD average variation in student performance. The remaining variation (24%) is due to differences in student performance between schools (Table V.4.1a).³



The variation in collaborative problem-solving performance between schools is a measure of how large “school effects” are. These school effects can be partly attributed to differences in the composition of schools and in the policies and practices that may develop or foster student performance in collaborative problem solving. The variation related to school demographics is discussed in this chapter; the variation related to policies and practices is discussed in Chapter 6.

As noted in the previous chapter, collaborative problem-solving performance is closely correlated to performance in the three core PISA subjects. Many school and neighbourhood factors foster the development of collaboration and problem-solving skills, just as they create the conditions for any type of learning. The importance of these common influences can be quantified and accounted for by separating the variation in problem-solving performance across students into a component that is shared with science, reading and mathematics performance, from a residual component, called the variation in relative performance, that measures the variation among students of similar performance in reading, mathematics and science.⁴

Figure V.4.1 ■ **Variation in collaborative problem-solving performance between and within schools**



Countries and economies are ranked in descending order of the between-school variation in collaborative problem-solving performance, as a percentage of the total variation in performance across OECD countries.

Source: OECD, PISA 2015 Database, Table V.4.1a.

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Differences in student performance in science, reading and mathematics accounted for 62% of the variation in student performance in collaborative problem solving, on average across OECD countries. In other words, on average, 38% of the differences in how students performed in the collaborative problem-solving assessment were not related to common cognitive factors that also dictated performance in the science, reading and mathematics assessments. This 38% of the variation is therefore unique to collaborative problem solving. In Bulgaria, less than 30% of the performance variation in collaborative problem solving is unique to collaborative problem solving (and not shared with the three core domains), while this figure was over 50% in Costa Rica and Tunisia (Table V.4.1b).

This reduction in the total variation in collaborative problem-solving performance was largely due to the between-school component of the variation, which decreased by 86%, on average across OECD countries, after accounting for performance in science, reading and mathematics. The decrease was particularly pronounced – more than 95% – in Bulgaria, Hungary, Luxembourg and Macao (China). In these countries, students in schools with high average scores in science, reading and mathematics also perform well in collaborative problem solving. This may be because schools in these countries develop their students' collaborative problem-solving skills simultaneously with the cognitive and disciplinary skills tested in the science, reading and mathematics assessments. It might also be due to demographic factors across schools that influence performance in collaborative problem solving and in the three core domains in the same way. Once performance in the three core subjects is accounted for, the between-school variation in relative student performance accounts for only 9% of the total variation in relative student performance (compared to the 25% of total variation before performance in the three core subjects is accounted for) (Tables V.4.1a and V.4.1b).

At the same time, a significant but smaller fraction of the within-school differences in collaborative problem-solving performance (46% on average across OECD countries) cannot be accounted for by differences in performance in the core PISA subjects. This fraction exceeds 60% in Slovenia, Tunisia and Turkey. Within-school variation accounts for 91% of the total between- and within-school variation in relative performance (Table V.4.1b). This suggests that differences in the experiences, personalities and opportunities among students attending the same school are the most likely explanations for the remaining differences in performance in collaborative problem solving, after performance in science, reading and mathematics has been accounted for.

Differences in the variation in performance in collaborative problem solving and in science

Figure V.4.2 compares the variation in student performance between schools in science and collaborative problem solving. To do so, it plots the intra-class correlation, defined as the proportion of between-school variation as a percentage of the overall within- and between-school variation. A higher intra-class correlation implies greater between-school variation, where schools have more of an impact on the performance of individual students.

On average across OECD countries, 25% of the overall within- and between-school variation in collaborative problem-solving performance is observed between schools.⁵ This is smaller than the 30% of overall variation in science performance observed between schools (Figure V.4.2 and Table I.6.9 from PISA Volume I). In other words, there is relatively less between-school variation in collaborative problem-solving performance than in science performance. This means that the school a student attends is less predictive of his or her performance in the collaborative problem-solving assessment than of his or her performance in the science assessment.

The intra-class correlation for collaborative problem-solving performance is particularly low in the Nordic countries of Finland, Iceland and Norway, where less than 10% of the total variation in collaborative problem-solving performance can be explained by differences between schools (Figure V.4.2). All three of these countries perform at or above the OECD average, with Finland ranked between second and seventh among all OECD countries (see Figures V.3.3 and V.3.4 in Chapter 3).

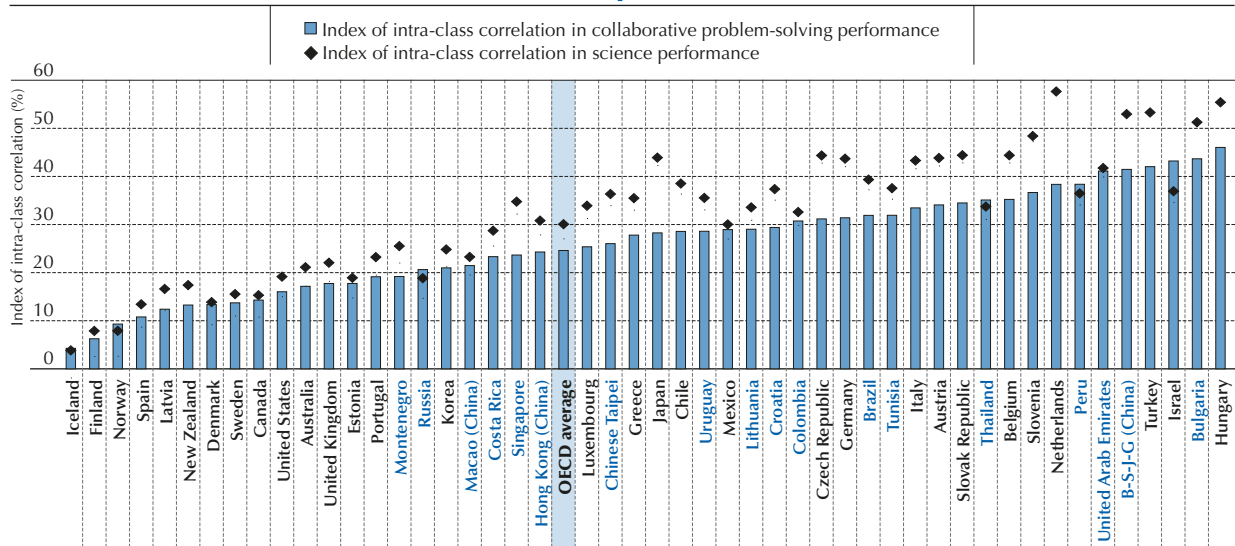
By contrast, the intra-class correlation for collaborative problem-solving performance is above 40% in Beijing-Shanghai-Jiangsu-Guangdong (China) (hereafter “B-S-J-G [China]”), Bulgaria, Hungary, Israel, Turkey and the United Arab Emirates (Figure V.4.2). With the exception of B-S-J-G (China), all of these countries perform below the OECD average in collaborative problem solving (Figure V.3.3).

In most OECD and partner countries and economies, the intra-class correlation for collaborative problem-solving performance is less than that for science performance, indicating that at the level of the individual country or economy, the school that a student attends is more predictive of his or her performance in science than of his or her performance



in collaborative problem solving (Figure V.4.2).⁶ However, this is not the case in Israel (37% vs 43%), and to a lesser extent in Iceland, Norway, Peru, the Russian Federation (hereafter “Russia”) and Thailand. In these countries, school effects are larger in collaborative problem solving than in science.

Figure V.4.2 ■ **Index of intra-class correlation in collaborative problem-solving and science performance**



Notes: The intra-class correlation is the variation in student performance between schools, divided by the sum of the variation in student performance between schools and the variation in student performance within schools, and multiplied by 100.

Only countries and economies with available data for collaborative problem-solving and science performance are shown.

Countries and economies are ranked in ascending order of the index of intra-class correlation in collaborative problem-solving performance.

Source: OECD, PISA 2015 Database, Tables I.6.9 and V.4.1a.

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DIFFERENCES IN COLLABORATIVE PROBLEM SOLVING RELATED TO GENDER

PISA 2015 Results (Volume I) (OECD, 2016) examines gender differences in science, reading and mathematics performance. Unlike the assessments of the core PISA subjects, the PISA 2015 collaborative problem-solving assessment is not a measure of individual differences in academic aptitude; rather, it aims to quantify interpersonal skills. Given that boys and girls are raised differently and face different societal expectations, the genders are likely to develop different collaboration skills by the age of 15.

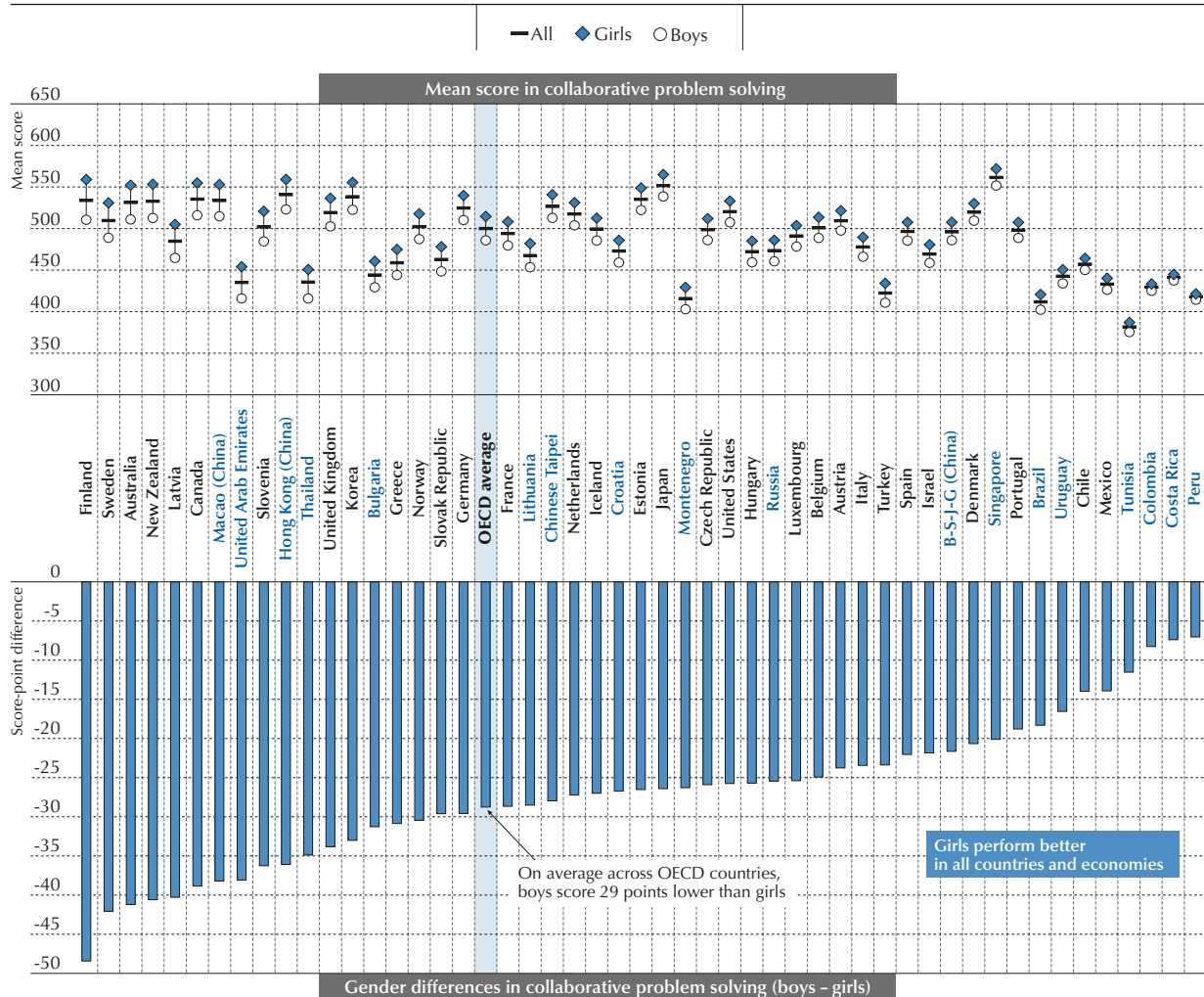
Schmitt et al. (2008) found gender differences in the Big Five personality traits (openness to experience, conscientiousness, extraversion, agreeableness and neuroticism) across a variety of cultures. Co-operative and collaborative behaviour is often explained through agreeableness and conscientiousness.⁷ Students who are agreeable are willing to compromise, while students who are conscientious take the perspectives of other group members into consideration and display responsibility towards others and towards solving the problem.

Women were significantly more agreeable and more conscientious than men in most countries. Among the 55 countries the researchers examined, women were more agreeable than men in 34 countries; only in Korea were men found to be significantly more agreeable than women. Likewise, women were more conscientious than men in 23 countries, while men were more conscientious than women only in India and Botswana (Schmitt et al., 2008). In most countries, the sample was comprised of college students, although some countries also included subjects from the general community.

Figure V.4.3 plots the mean performance of boys and girls in collaborative problem solving and shows the difference in their performance. Girls outperform boys in collaborative problem solving by 29 score points (515 points compared with 486 points, on average across OECD countries). Furthermore, in every country/economy that participated in the collaborative problem-solving assessment, girls significantly outperform boys. The differences are greatest in Australia, Finland, Latvia, New Zealand and Sweden, where girls score over 40 points higher than boys, on average. Girls outperform boys by less than 10 points in Colombia, Costa Rica and Peru, but these differences are still statistically significant.

The standard deviation in collaborative problem-solving performance among boys is also greater (96 score points) than that among girls (91 score points) (Table V.4.3a), similar to what is observed in all subjects tested in PISA. This difference is significant and positive in 24 out of the 51 countries and economies that participated in the collaborative problem-solving assessment. It is greatest in Macao (China), where the standard deviation among boys was 11 points greater than the standard deviation among girls. In no country did girls' performance show a higher standard deviation than boys' performance.


Figure V.4.3 ■ Gender differences in collaborative problem-solving performance



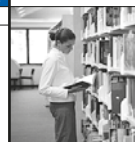
Note: All gender differences in collaborative problem-solving performance are statistically significant (see Annex A3).

Countries and economies are ranked in ascending order of the score-point difference in collaborative problem-solving performance between boys and girls.

Source: OECD, PISA 2015 Database, Tables V.4.1a and V.4.3a.

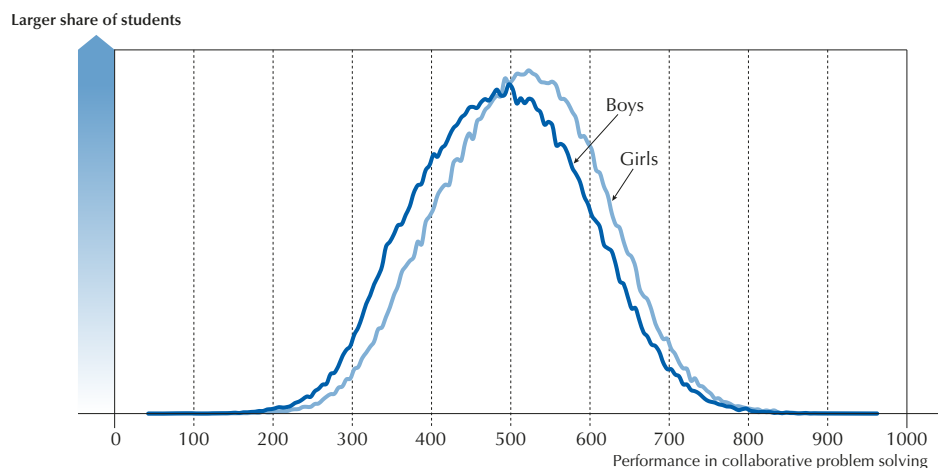
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A greater standard deviation and lower mean performance among boys strongly implies that more boys than girls are found at the bottom range of the performance scale, both across OECD countries and in most countries/economies. This can be seen in Figure V.4.4, which plots the distribution of the scores of boys and girls in OECD countries. Boys have a greater density than girls at lower scores, while the opposite is observed at higher scores. On average across OECD countries, girls are 1.6 times more likely than boys to be top performers (Level 4) in collaborative problem solving, while boys are 1.6 times more likely than girls to be low achievers (below Level 2). The difference is even starker when examining students who score below Level 1: boys are 2.2 times more likely to score at this level than girls. In no country or economy are boys more likely than girls to be top performers, and in every country or economy, boys are more likely than girls to be low performers (Table V.4.2).



These findings contrast with the gender differences observed in individual problem solving as discussed in *PISA 2012 Results: Creative Problem Solving (Volume V)* (OECD, 2014). In that assessment, boys scored 7 points higher than girls in individual problem solving, on average across OECD countries, and were 1.5 times more likely than girls to be top performers. Although different groups of students were measured in 2012 and 2015 and the assessments are not directly comparable to one another, the results suggest that it is the collaborative component of the PISA 2015 collaborative problem-solving assessment that favours girls.

Figure V.4.4 ■ **Distribution of proficiency in collaborative problem solving, by gender**
OECD average



Note: This figure is a histogram of performance using an interval size of five score points.

Source: OECD, PISA 2015 Database.

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How gender differences in collaborative problem-solving performance compare to gender differences in science, reading and mathematics performance

The larger variation in performance among boys, compared to the variation observed among girls, is not unique to collaborative problem solving; it is observed across all PISA assessments. The performance variation observed among boys is between 6 and 9 points wider than that among girls in the three core domains (Table V.4.3a and Tables I.2.7, I.4.7 and I.5.7 from PISA Volume I).

Given that the variation in scores differs both across countries and across subjects, absolute differences in performance related to gender may not be directly comparable across countries. For example, although girls might outperform boys by 20 score points in two different countries, this gap is more substantial when the standard deviation in the entire population of students is only 40 score points than when it is 100 score points, as gender differences explain a larger proportion of the overall variation in performance in the former country.

The gender effect size in each country/economy is thus calculated as the gap between the mean performance of boys and girls divided by the standard deviation in performance among all students in the country/economy. Gender effects will therefore be stronger in countries with low standard deviations in performance.⁸ In the example above, the country with a 40 score-point standard deviation in performance will have a larger gender effect size than the country with a 100 score-point standard deviation.

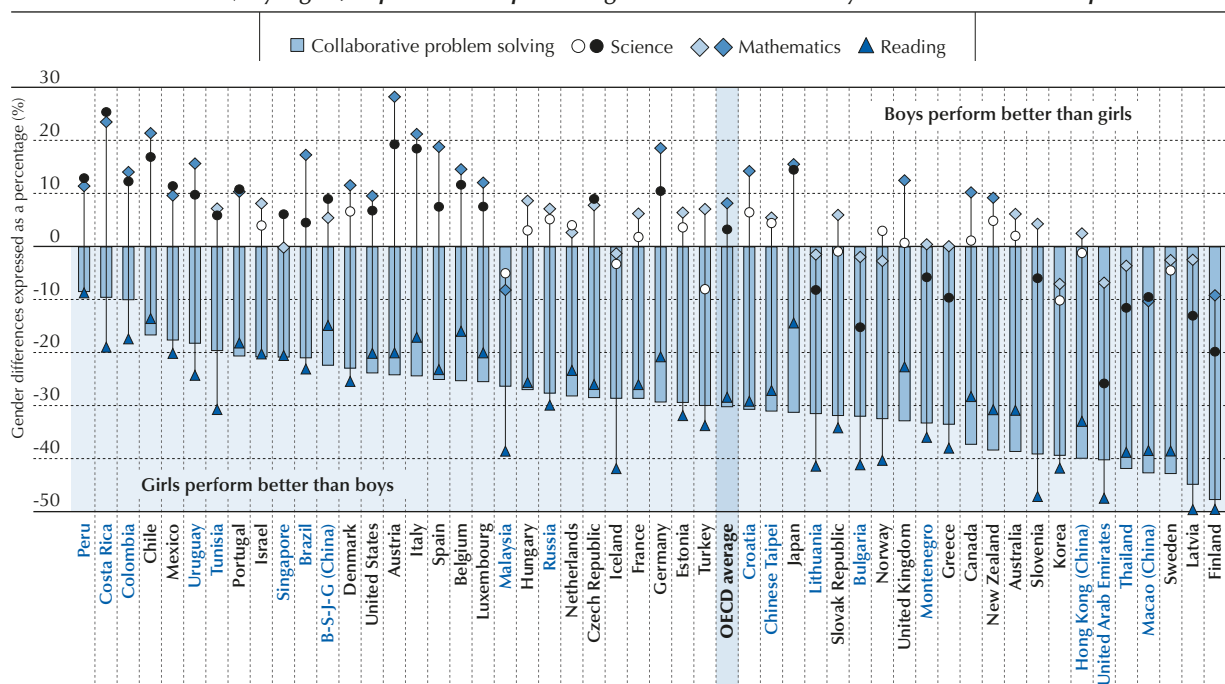
By this measure, the average gender effect size across OECD countries is -0.30; in other words, girls outperform boys by an average of 30% of a within-country standard deviation (Figure V.4.5). As is the case with absolute (score-point) gender gaps in performance, these gender effects are significant and in favour of girls in every country and economy that participated in the PISA 2015 collaborative problem-solving assessment. Gender effects are particularly large in Finland, where girls outperform boys by 48% of a standard deviation. In Latvia, Macao (China), Sweden, Thailand and the United Arab Emirates, girls also outperform boys by over 40% of a standard deviation. By contrast, girls outperform boys by less than 10% of a standard deviation in the Latin American countries of Colombia, Costa Rica and Peru (Table V.4.5).

Across the core subjects assessed by PISA, gender differences in mean performance vary greatly. Girls outperform boys in reading but boys outperform girls in mathematics and science. The advantage of girls in reading is 28% of the standard deviation in performance, on average across OECD countries, while the advantage of boys in science is 4% and in mathematics 9% of the standard deviation (Table V.4.5 and Figure V.4.5).⁹ The gender effect between boys and girls is also significantly more pronounced in favour of girls in collaborative problem solving than in reading.

Given the high correlations between performance in the three core PISA subjects and performance in collaborative problem solving, and the far larger magnitude of the gender effect in reading than in either science or mathematics, it might be tempting to view gender differences in collaborative problem-solving performance as related to gender differences in reading. But the gender gaps are still large and significant in favour of girls after accounting for performance in science, reading and mathematics (Table V.4.3b). In other words, girls' advantage in reading literacy does not fully explain their advantage in collaborative problem solving.

Figure V.4.5 ■ Gender differences in collaborative problem-solving, science, reading and mathematics performance

Gender differences (boys-girls) expressed as a percentage of the within-country standard deviation in performance



Notes: Statistically significant gender differences are shown in a darker tone. All gender differences in collaborative problem-solving and reading performance are statistically significant (see Annex A3).

The figure reports negative percentages when girls perform better than boys.

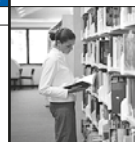
Countries and economies are ranked in descending order of the difference between boys and girls in collaborative problem-solving performance.

Source: OECD, PISA 2015 Database, Table V.4.5.

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After accounting for performance in the three core PISA subjects, girls still outperform boys in collaborative problem solving by 25 score points, on average across OECD countries, and this performance gap is significant and in favour of girls in every country and economy that participated in the assessment (Table V.4.3b). The difference is largest in Australia, Austria, Canada, Germany, Italy and New Zealand, where girls outperform boys by over 30 score points after accounting for performance in the three core domains. However, in, Bulgaria, Costa Rica, Iceland, Malaysia, Peru, Tunisia and the United Arab Emirates, the difference is only between 10 and 15 score points.

Related gender differences have been observed across a variety of cultures. For example, Guiller and Durdell (2006) found that female university students in Scotland are more likely than their male counterparts to make positive statements, attenuated statements (i.e. statements with qualifiers or statements posed as questions), and to agree with their group partners when taking part in online discussion groups, while male students are more likely to use authoritative and

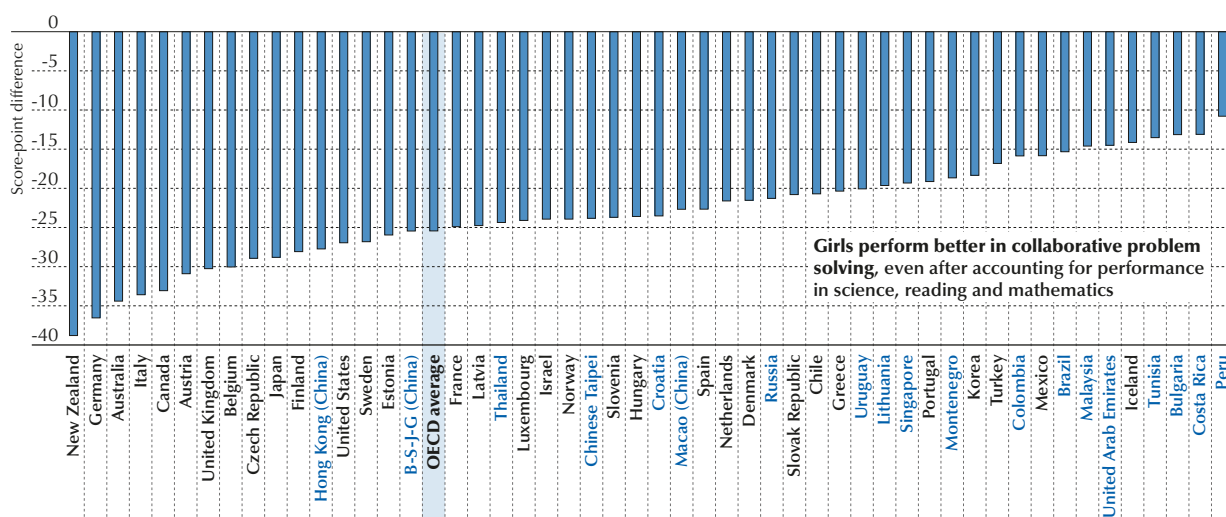


negative language. Strong performance in the PISA 2015 collaborative problem-solving assessment is not synonymous with agreement and using hedging or apologetic language, as some of the released items in the unit *Xandar* required students to monitor and correct group members' actions. However, the credited responses in the released units generally did involve the use of non-aggressive language to advance the situation.

Other studies have examined boys and girls working in same-sex pairs and groups and found that although boys might have been more efficient in completing tasks and emphasised finding the necessary information as quickly as possible, girls exhibited more co-operative behaviour, talked to each other more, and often showed more enthusiasm about the task (Burdick, 1996, with American high school students; Large, Beheshti and Rahman, 2002, with Canadian 11-year-olds; Leong and Al-Hawamdeh, 1999, with Singaporean 11-year-olds).

Gender differences might be even more pronounced in face-to-face instances of collaborative problem solving, where students must decode the facial and emotional responses of their group members. Girls have been found to be more receptive to and better at interpreting nonverbal cues than boys (Hall and Matsumoto, 2004; Klein and Hodges, 2001; Rosip and Hall, 2004), which might give them an advantage when interacting with people.

Figure V.4.6 ■ **Gender differences in relative performance in collaborative problem solving**
Differences in collaborative problem-solving performance (boys–girls) after accounting for performance in science, reading and mathematics



Note: All gender differences are statistically significant (see Annex A3).

Countries and economies are ranked in ascending order of the score-point difference in relative collaborative problem-solving performance between boys and girls.

Source: OECD, PISA 2015 Database, Table V.4.3b.

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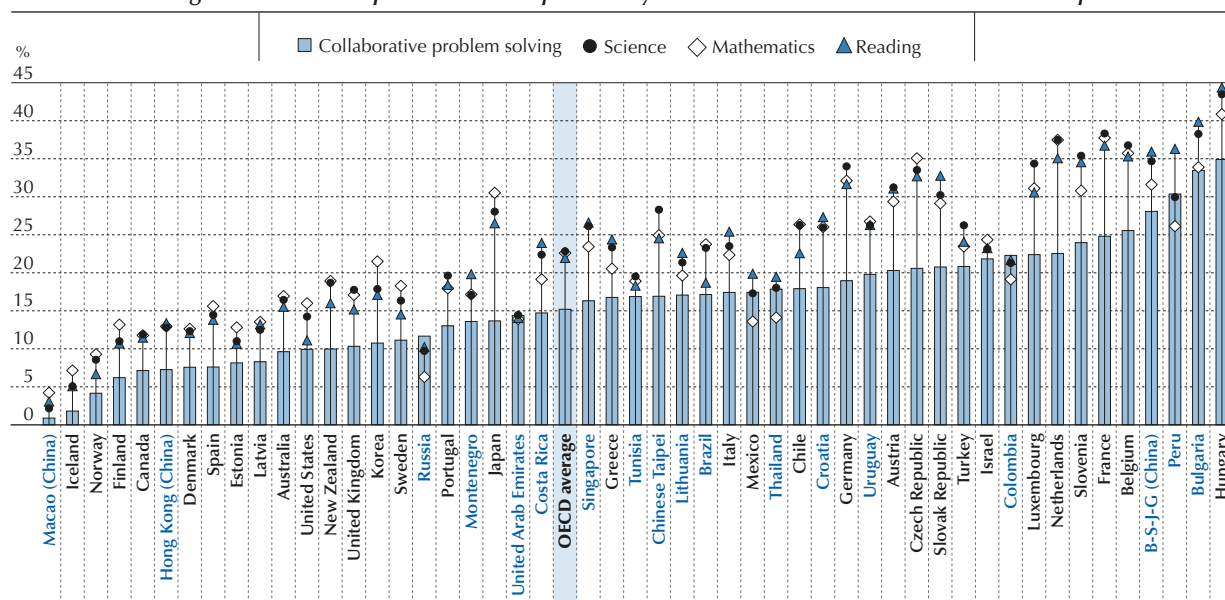
Most research on the interplay between gender and collaboration has focussed on same-gender or mixed-gender groups of students who interact in person. However, in the PISA 2015 collaborative problem-solving assessment, a student interacted with two or more computer agents who, while having been assigned names that reflect a certain gender, are not physically identifiable as boys or girls. This raises questions about the extent to which the gender of one's group members matters when collaborating in an online and somewhat anonymous environment. Unfortunately, this is beyond the scope of the data available from the PISA 2015 assessment, as the computer agents always included at least one boy and one girl, eliminating any variation in group composition.

THE RELATIONSHIP BETWEEN PERFORMANCE IN COLLABORATIVE PROBLEM SOLVING AND SOCIO-ECONOMIC STATUS

Unsurprisingly, socio-economic status – as measured in PISA by the PISA index of economic, social and cultural status (ESCS)¹⁰ – relates positively to performance in problem solving, as it does to performance in all domains assessed in PISA. But does the relationship between socio-economic status and performance differ across domains?

In general, the percentage of the variation in performance explained by socio-economic disparities at both the student and school levels is similar for science (the average across OECD countries that participated in the collaborative problem-solving assessment is 23%), reading (22%) and mathematics (23%).¹¹ Figure V.4.7 shows that this relationship is weaker in collaborative problem solving than in the three other domains. Still, even in collaborative problem solving, about 15% of the variation in performance can be explained by differences in socio-economic status. A higher position on the PISA index of economic, social and cultural status might be associated with greater academic enrichment opportunities, leading to disparities in performance in the cognitive domains. However, opportunities to collaborate and co-operate arise in all social and economic contexts, which could lead to a reduction in the extent to which socio-economic status is related to performance in collaborative problem solving.


Figure V.4.7 ■ **How well socio-economic status predicts performance in four PISA subjects**
Percentage of variation in performance explained by students' and schools' socio-economic profile



Note: The socio-economic status is measured by the PISA index of economic, social and cultural status (ESCS).

Countries and economies are ranked in ascending order of how well socio-economic status predicts performance in collaborative problem solving.

Source: OECD, PISA 2015 Database, Table V.4.13f.

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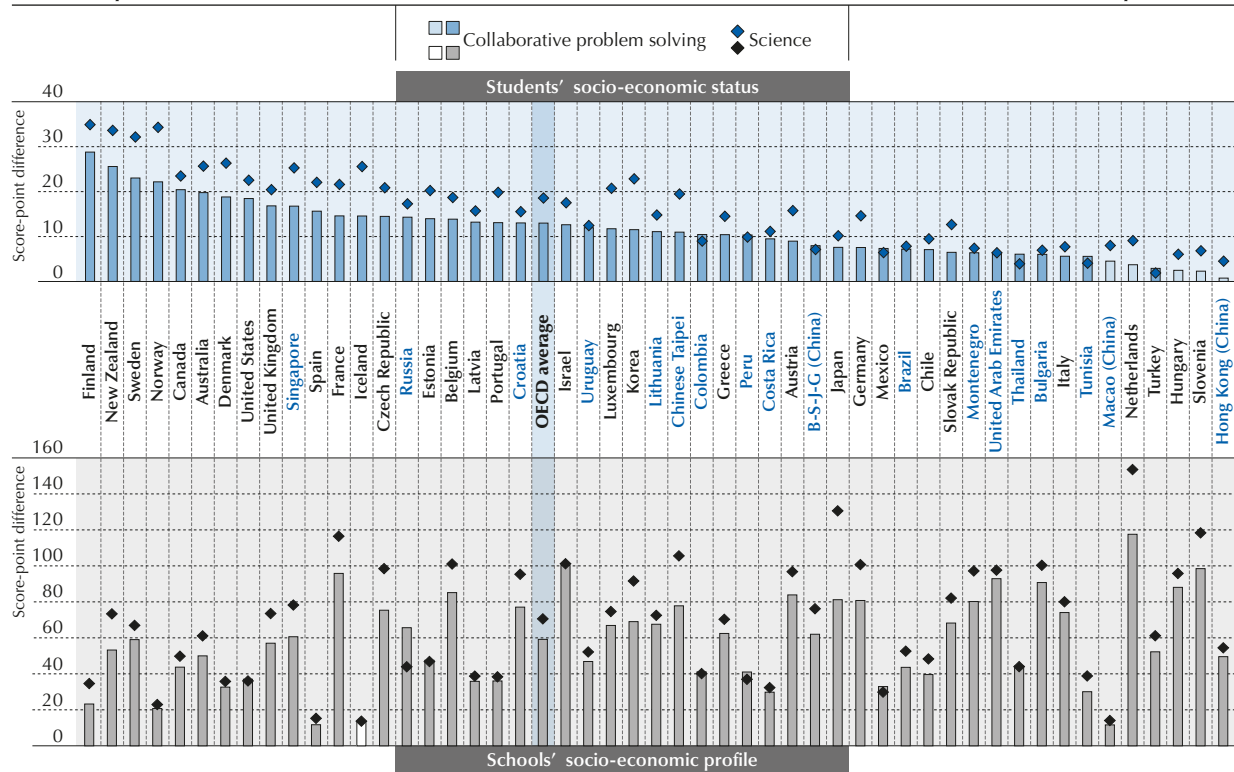
The relationship between socio-economic status and science performance is stronger than that between socio-economic status and collaborative problem-solving performance in 43 out of 51 countries/economies for which data are available. In the remaining countries, the difference in the strengths of the relationships is not statistically significant (Table V.4.13f).

On average across OECD countries, a one-unit increase in a student's socio-economic status – while holding the school socio-economic profile constant – is associated with an increase in his or her collaborative problem-solving score of 13 points, while a one-unit increase in the average socio-economic profile of the student's school is associated with a 59 score-point increase in his or her score (Figure V.4.8 and Table V.4.13e). In other words, within the same school, students score 13 score points higher, on average, when their socio-economic status is one unit higher. However, for two students with the same socio-economic status, there is a 59 score-point increase in collaborative problem-solving performance if the school socio-economic profile is also one unit higher.¹²

The relationship between collaborative problem-solving performance and socio-economic status is positive in almost every country/economy that participated in the assessment. In Hong Kong (China), Hungary, Macao (China), the Netherlands and Slovenia, the relationship between collaborative problem-solving performance and student socio-economic status is insignificant when simultaneously accounting for school socio-economic profile. In other words, in these countries and economies, there is no significant relationship between collaborative problem-solving performance and student socio-economic status within schools, but there are differences between schools with different socio-economic profiles.

Figure V.4.8 ■ **Impact of socio-economic status on performance in collaborative problem solving and in science**

Score-point difference associated with a one-unit increase in students' and schools' socio-economic profile¹



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).

Notes: Statistically significant score-point differences are shown in a darker tone (see Annex A3).

All score-point differences in science performance are statistically significant.

Countries and economies are ranked in descending order of the score-point difference in collaborative problem-solving performance associated with students' socio-economic status.

Source: OECD, PISA 2015 Database, Table V.4.13e.

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By contrast, in Iceland, the relationship between collaborative problem-solving performance and school socio-economic profile, when simultaneously accounting for student socio-economic status, is insignificant. In other words, in Iceland, there are no significant between-school differences in collaborative problem-solving performance related to socio-economic status. All such differences can be attributed to disparities between students in the same school.

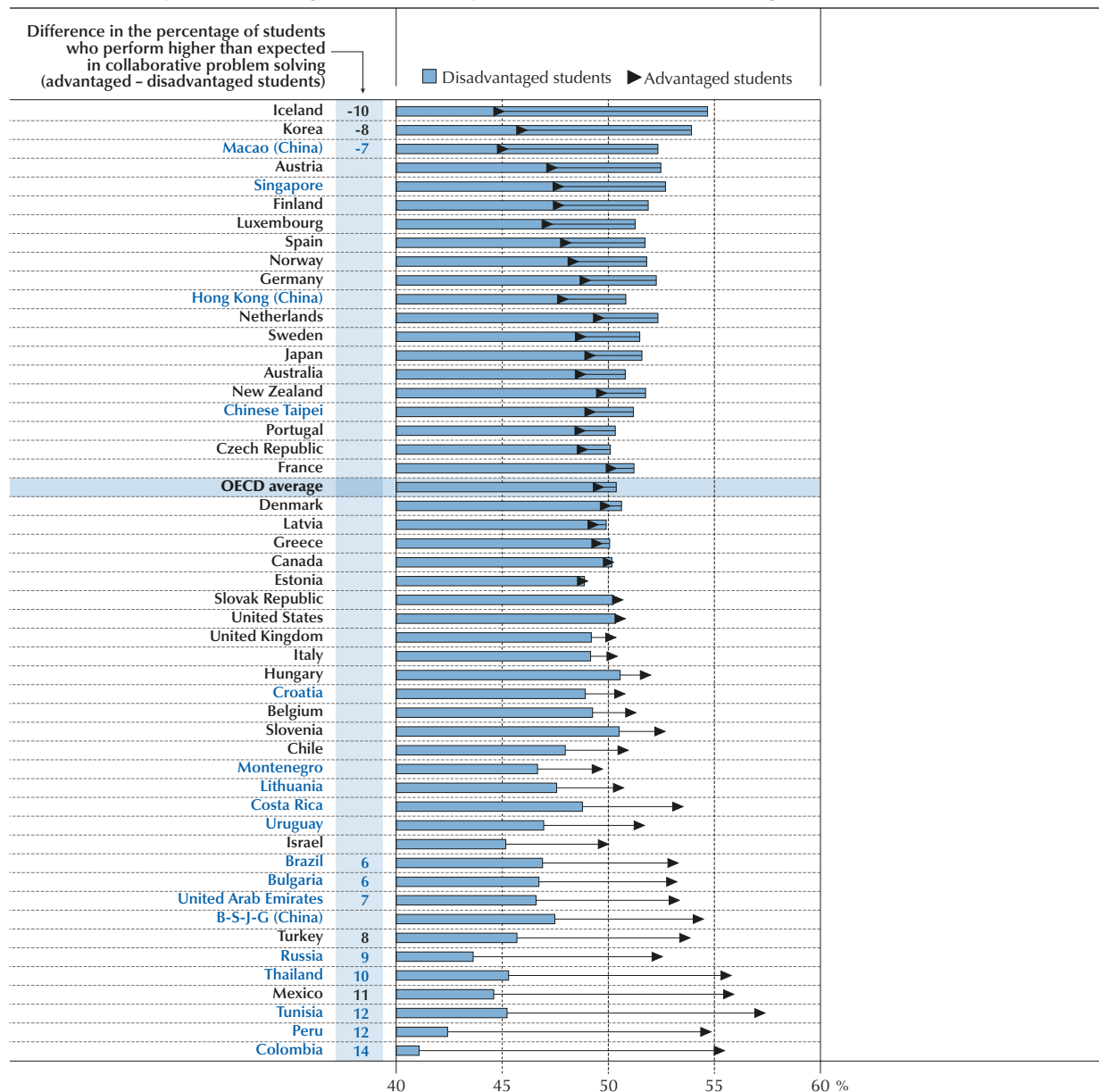
The score-point improvements associated with a one-point increase in the PISA index of economic, social and cultural status are smaller in collaborative problem solving than in science, reading and mathematics. On average across OECD countries (that participated in the collaborative problem-solving assessment), a one-point increase in students' socio-economic status is associated with a 13-point improvement in collaborative problem-solving performance, compared to between 17 and 19 points in the three core PISA subjects. A one-point increase in schools' socio-economic profile is associated with a 59-point improvement in collaborative problem-solving performance compared to between 66 and 73 points in the three core PISA subjects (Table V.4.13e and Figure V.4.8).

The weaker magnitude of the relationship is also reflected in the socio-economic effect size, which scales the score-point difference associated with differences in socio-economic status by the variation in performance observed in each country. In other words, socio-economic status is associated with a smaller increase in performance in collaborative problem solving, relative to the performance of other students in the same country or economy, than in the three core PISA subjects. The one exception is in Russia, where the school socio-economic effect size in collaborative problem solving is significantly larger than that in science and mathematics. There, a one-unit increase in school socio-economic profile results in a relatively larger improvement in collaborative problem-solving performance than in science and mathematics performance (Table V.4.13e).

It is not immediately obvious whether differences in collaborative problem-solving performance related to socio-economic status are unique to the domain or whether they are common across the three core PISA domains. The relationships between the distinctive aspects of collaborative problem solving and socio-economic status can be elucidated using the relative scores in collaborative problem solving after accounting for performance in science, reading and mathematics.

On average across OECD countries, there is no significant difference in collaborative problem-solving performance between advantaged and disadvantaged students – defined as those students who are in the top and bottom quarter of socio-economic status within a country – once performance in science, reading and mathematics has been accounted for (Figure V.4.9).

Figure V.4.9 ■ **Relative performance in collaborative problem solving, by socio-economic status**
Percentage of advantaged¹ and disadvantaged² students who score higher than expected in collaborative problem solving, based on their performance in science, reading and mathematics




1. Advantaged students are those who rank in the top quarter nationally of the PISA index of economic, social and cultural status (ESCS).

2. Disadvantaged students are those who rank in the bottom quarter nationally of the PISA index of economic, social and cultural status (ESCS).

Countries and economies are ranked in ascending order of the difference between advantaged and disadvantaged students who score higher than expected in collaborative problem solving (advantaged - disadvantaged), based on their scores in science, reading and mathematics.

Source: OECD, PISA 2015 Database, Table V.4.10.

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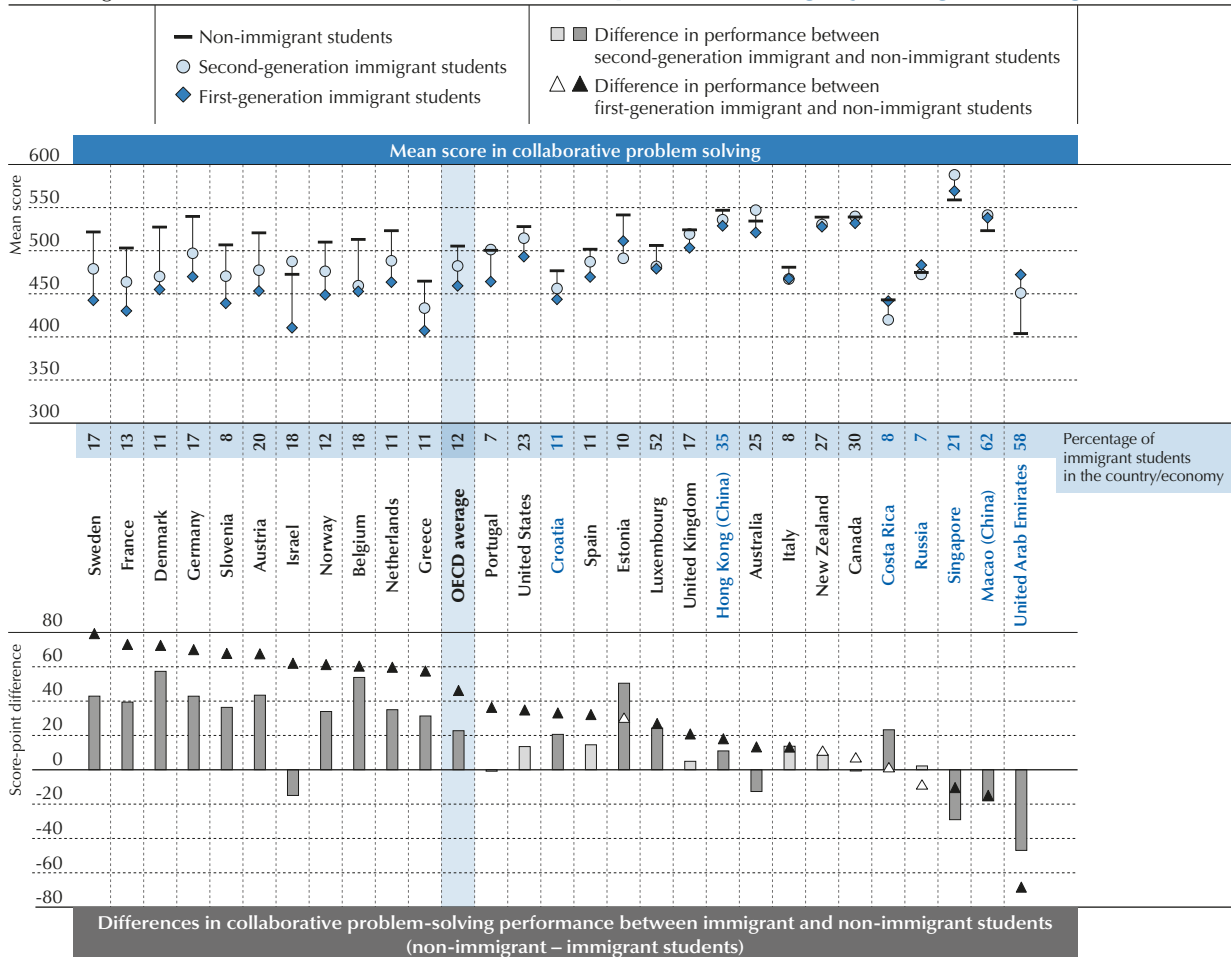


Some 50% of both advantaged and disadvantaged students perform better in collaborative problem solving than would have been expected on the basis of their science, reading and mathematics scores. Significant differences are observed in Iceland, Korea and Macao (China), where disadvantaged students are between 7 and 10 percentage points more likely than advantaged students to perform above expectations; and in Brazil, Bulgaria, Colombia, Mexico, Peru, Russia, Thailand, Tunisia, Turkey and the United Arab Emirates, where advantaged students are between 6 and 15 percentage points more likely than disadvantaged students to perform above expectations.

IMMIGRANT BACKGROUND AND COLLABORATIVE PROBLEM-SOLVING PERFORMANCE

In many countries and economies, children of immigrants are more at risk of low performance in academic subjects than the children of parents who were born in the country or economy. A gap in collaborative problem-solving performance between immigrant and non-immigrant students is also observed: on average across OECD countries, the children of immigrants score 36 points lower than non-immigrant students. However, in Macao (China), Singapore and the United Arab Emirates, immigrant students score better than non-immigrant students in collaborative problem solving (Table V.4.14a). The largest gaps in performance are observed in Denmark, where immigrant students score more than 60 points lower than non-immigrant students, and in Austria, Belgium, France and Sweden, where immigrant students score between 50 and 60 points lower than non-immigrant students.¹³

Figure V.4.10 ■ Performance in collaborative problem solving, by immigrant background



Notes: Only countries and economies where the percentage of immigrant students is higher than 6.25% in 2015 are shown.

Statistically significant differences between first- and second-generation immigrant students and non-immigrant students are shown in darker tones (see Annex A3).

Countries and economies are ranked in descending order of the score-point difference in collaborative problem solving between first-generation immigrant students and non-immigrant students.

Source: OECD, PISA 2015 Database, Table V.4.14a.

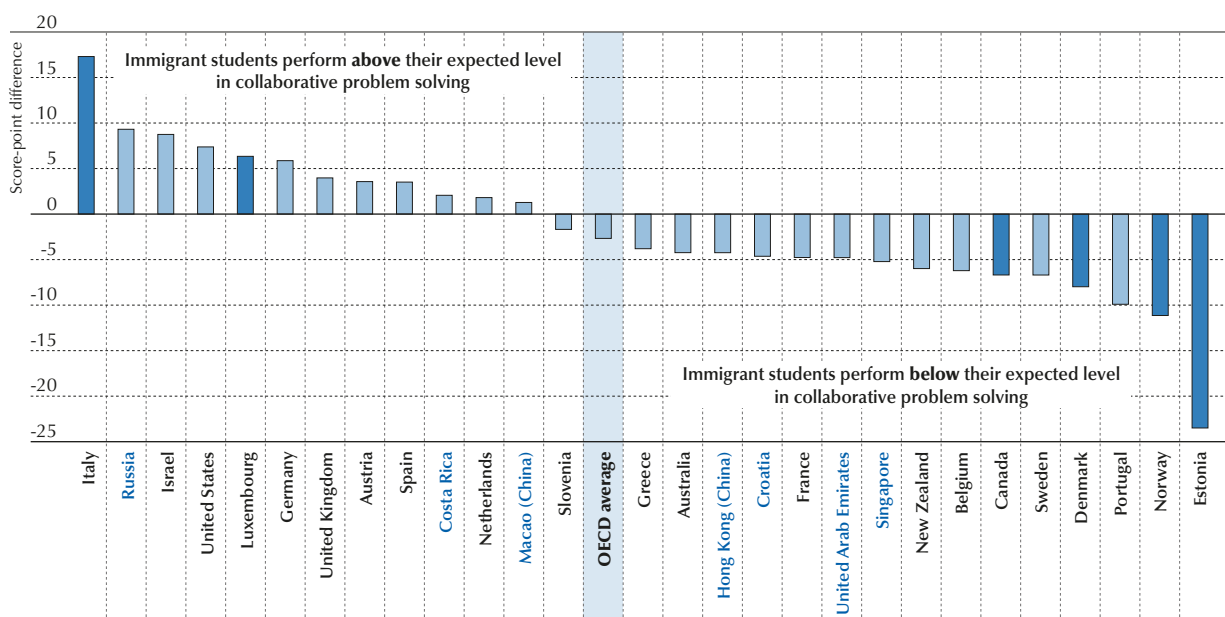
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Performance differences are particularly large between non-immigrant and first-generation immigrant students, where the average gap across OECD countries is 46 score points. In comparison, non-immigrant students score 23 points higher in collaborative problem solving than second-generation immigrant students (Figure V.4.10).

Performance differences related to immigrant background are observed even after accounting for gender and socio-economic status. After accounting for these two factors, immigrant students still score 26 points below non-immigrant students, on average across OECD countries. A 14-point performance gap remains after further accounting for the language spoken at home.

However, accounting for performance in science, reading and mathematics produces inconclusive results. On average across OECD countries, there is no significant difference between immigrant and non-immigrant students after accounting for performance in the three core PISA subjects. Immigrants in Canada, Denmark, Estonia and Norway still perform worse than non-immigrant students, while in Italy and Luxembourg, they perform better than non-immigrant students. The significant performance gap in favour of immigrant students in Macao (China), Singapore and the United Arab Emirates disappears as immigrant students in these countries also perform better in science, reading and mathematics (Figure V.4.11). These results imply that in many participating countries and economies, a large part of the difference in collaborative problem-solving performance between immigrant and non-immigrant students can be attributed to factors related to differences in performance in science, reading and mathematics and not to factors unique to collaborative problem solving.

Figure V.4.11 ■ **Relative performance in collaborative problem solving, by immigrant background**
Score-point difference in collaborative problem-solving performance between immigrant and non-immigrant students who perform similarly in science, reading and mathematics



Notes: Only countries and economies where the percentage of immigrant students is higher than 6.25% in 2015 are shown.

Statistically significant differences are shown in a darker tone (see Annex A3).

Countries and economies are ranked in descending order of the score-point difference in collaborative problem-solving performance between immigrant and non-immigrant students who perform similarly in science, reading and mathematics.

Source: OECD, PISA 2015 Database, Table V.4.14b.

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The immigrant effect, as calculated by dividing the performance gap between immigrant and non-immigrant students by the standard deviation in performance in each country and for each subject, is 0.38 standard deviation, on average across OECD countries, for collaborative problem solving. This is below the immigrant effect size observed in science (0.47 standard deviation), reading (0.42 standard deviation) and mathematics (0.42 standard deviation).¹⁴ In other words, the relative difference in performance between immigrants and non-immigrants is significantly larger in science, reading and mathematics performance than in collaborative problem-solving performance (Table V.4.17a).



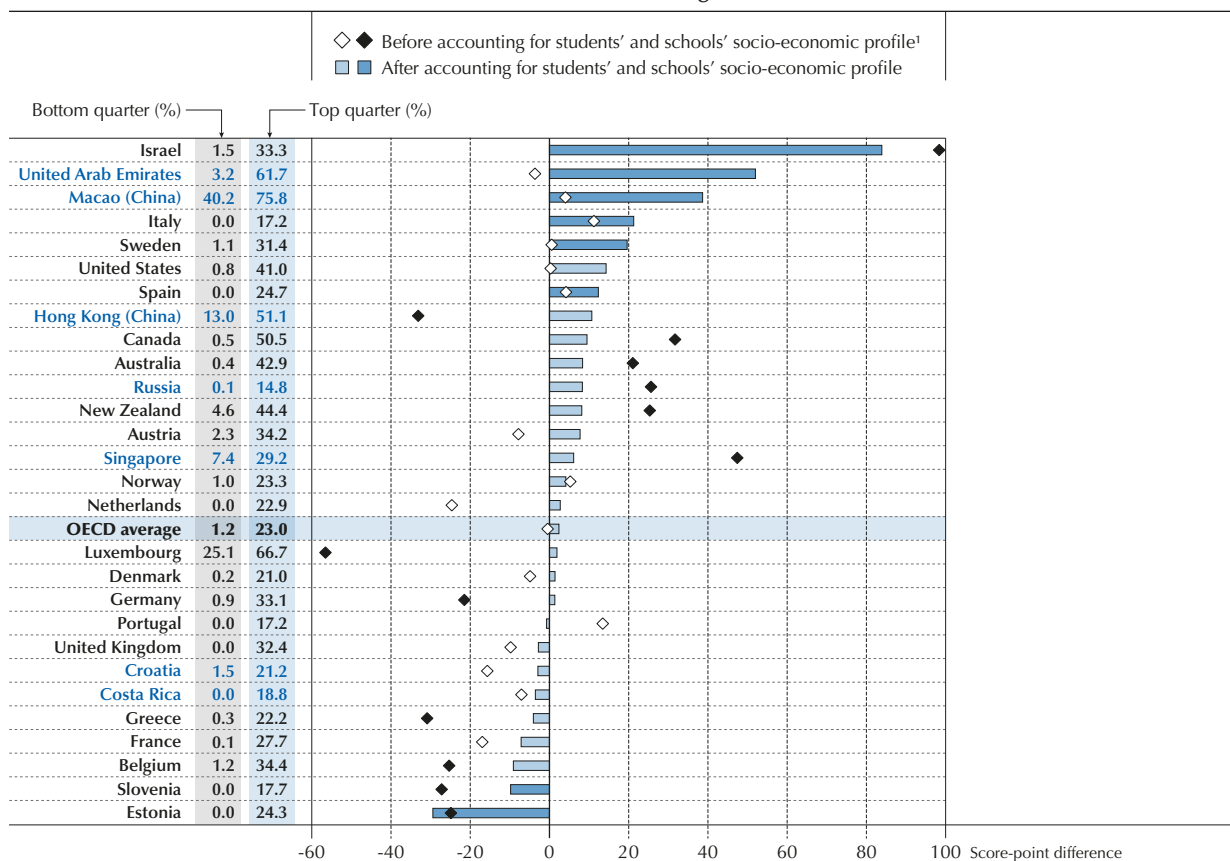
DIVERSITY WITHIN SCHOOLS AND PERFORMANCE IN COLLABORATIVE PROBLEM SOLVING

A student's performance in collaborative problem solving is not necessarily only related to his or her own characteristics. Collaboration and co-operation are practical skills that students develop through interactions with other students. It is possible that students who are exposed to a variety of backgrounds unlike their own might develop a greater range of interpersonal skills and perform better in the PISA 2015 collaborative problem-solving assessment. Such diversity in backgrounds might include both socio-economic and immigrant diversity.

On average across OECD countries, the average non-immigrant student attends a school where 10%¹⁵ of 15-year-old students are immigrant students (Table V.4.22). This proportion varies from over 40% of students in Luxembourg and Macao (China) and over 30% in Hong Kong (China) and Qatar to less than 0.5% of students in B-S-J-G (China), Japan, Korea, Peru, Poland and Chinese Taipei. In addition, immigrant students are not distributed uniformly across schools in a system. In schools that are in the top quarter in their country in the concentration of immigrant students, a non-immigrant student attends a school where an average of 23% of the students are immigrants; but in schools that are in the bottom quarter in this measure, only 1.5%¹⁶ of the students are immigrants.

Figure V.4.12 ■ Performance in collaborative problem solving, by concentration of immigrants in school

Difference in collaborative problem-solving performance between the top and the bottom quarters of the concentration of immigrant students



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).

Notes: The school-level proportion of immigrant students is the proportion of students in each school who have an immigrant background. The percentages of students in the top and the bottom quarters of the concentration of immigrant students are shown next to the country/economy name. Only countries and economies where the percentage of immigrant students is higher than 6.25% are shown.

Statistically significant score-point differences are shown in a darker tone (see Annex A3).

Countries and economies are ranked in descending order of the difference in collaborative problem-solving performance, after accounting for students' and schools' socio-economic profile.

Source: OECD, PISA 2015 Database, Table V.4.22.

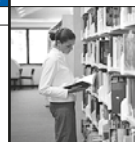
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On average across OECD countries, there is no difference in the performance of non-immigrant students between those in schools with large numbers of immigrant students and those in schools with low numbers of immigrant students (Figure V.4.12). However, this difference becomes significant after accounting for performance in science, reading and mathematics: non-immigrant students in a more diverse environment score higher than their non-immigrant peers with similar performance in science, reading and mathematics but in a less diverse environment. At the country level, the difference after accounting for performance in the three core subjects is significant only in Israel and Russia, both of which have sizeable immigrant populations (Table V.4.22).

Perhaps surprisingly, given the paucity of significant results regarding immigrant concentration in schools, non-immigrant students who speak the language of assessment at home perform worse in collaborative problem solving if they attend schools with large numbers of students who do not speak the test language at home (Table V.4.23). On average across OECD countries, there is a 15-point gap in favour of students exposed to less linguistic diversity, before accounting for gender and students' and schools' socio-economic profile. The gap is particularly large in Belgium, Bulgaria, Italy and Singapore, where it exceeds 50 points. However, the gap is reduced to only 3 points after accounting for gender and students' and schools' socio-economic profile, indicating that it is not linguistic diversity itself but rather the tendency that such diversity is correlated to a lower socio-economic profile that accounts for much of this performance discrepancy. In Canada, Sweden and the United Arab Emirates, greater linguistic diversity at school is associated with higher collaborative problem-solving performance among non-immigrant students who speak the test language at home, after accounting for gender and students' and schools' socio-economic profile.

Similar results are seen when diversity is measured as the school-level variation in socio-economic status, or the proportion of advantaged or disadvantaged students, or students with special needs in individual schools (Tables V.4.20, V.4.21a, V.4.21b and V.4.24). There appears to be no significant relationship between diversity and the uniquely collaborative aspects of the collaborative problem-solving assessment, after the relationship between diversity and socio-economic profile has been accounted for.¹⁷



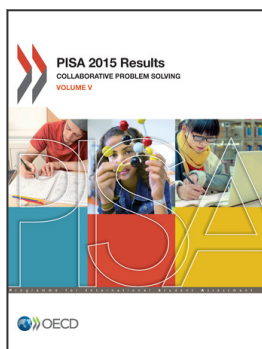
Notes

1. Scores in collaborative problem solving were scaled so as to set the mean across all OECD countries at 500 score points and the standard deviation across all OECD countries at 100 score points. This standard deviation combines the within-country variation in performance with the between-country variation in mean performance. As OECD countries differ in mean collaborative problem-solving performance, the within-country variation in performance is therefore expected to be, for most countries, below 100 score points.
2. The standard deviation in performance within a country/economy is the square root of the variation (also called the variance) of performance in the country/economy.
3. Due to the unbalanced and clustered nature of the data, the sum of the between- and within-school components of variation in performance, as an estimate from a sample, does not necessarily add up to the total variation in performance.
4. Relative collaborative problem-solving performance is calculated by an ordinary least squares regression of collaborative problem-solving performance over performance in science, reading and mathematics. In Chapter 3, the regression is performed at the international level in order to rank countries and economies. In Chapters 4, 5, 6 and 7, the regression is performed at the individual country or economy level, as the focus is on factors related to differential performance within each country/economy. This results in an average residual of 0 for each country/economy.
5. The 25% in this paragraph refers to the ratio of the between-school variation and the sum of the within-school and between-school variation. The 24% referenced earlier is the ratio of the between-school variation and the total variation. Due to the unbalanced and clustered nature of the data, the total variation does not equal the sum of the within- and between-school variations.
6. The significance of the difference in the intra-class correlations in collaborative problem-solving and science performance has not been formally tested.
7. “Collaboration” and “co-operation” are used synonymously throughout this report.
8. This may also make for a fairer comparison between countries at different ends of the performance scale. In particular, countries with low mean performance might have lower standard deviations as they will have few high-achieving students, while countries with higher mean performance will have higher standard deviations because in addition to having large numbers of top performers, they will often have significant numbers of lower performers. As a result, countries with low mean performance will typically have smaller gaps between different groups of students. This is normalised by dividing by the standard deviation.
9. On average across the OECD countries that participated in the collaborative problem-solving assessment, boys out-performed girls by 3% of the standard deviation in science and 8% of the standard deviation in mathematics.
10. The PISA index of economic, social and cultural status (ESCS) is derived from several variables related to students’ family background: parents’ education, parents’ occupations, a number of home possessions that proxy for material wealth, and the number of books and other educational resources available in the home.
11. On average across all OECD countries, disparities in students’ and schools’ socio-economic profile explain 22% of the variation in science, reading and mathematics performance.
12. The score-point increase associated with school socio-economic profile is noticeably larger than that associated with student socio-economic status. However, a one-point increase in school socio-economic profile is equivalent to a one-point increase in each student’s socio-economic status, entailing a more wide-reaching change in demographics.
13. PISA only presents data for countries where at least 1 in every 16 students (or 6.25% of students) have an immigrant background.
14. On average across all OECD countries, the immigrant effect size related to performance in science was 44% of a standard deviation in performance. The immigrant effect sizes related to performance in reading and mathematics were 40% and 39% of a standard deviation, respectively.
15. On average across the OECD countries that participated in the collaborative problem-solving assessment, non-immigrant students attend schools in which 9% of students are immigrants.
16. On average across the OECD countries that participated in the collaborative problem-solving assessment, students in schools that are in the bottom quarter of the concentration of immigrant students attend schools in which 1.2% of students are immigrants.
17. The correlation between school-level diversity in students’ socio-economic status and school-level socio-economic status is -0.32, on average across OECD countries. In other words, schools that have greater levels of socio-economic diversity also tend to be worse off. The negative correlation is particularly strong in Ciudad Autónoma de Buenos Aires (Argentina), Israel, Luxembourg, Qatar and Singapore, where it is stronger than -0.70. Hence, accounting for students’ and schools’ socio-economic profile will already remove much of the variation in school-level socio-economic diversity.



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