Department for Education

Achievement of 15-Year-Olds in England: PISA 2015 Collaborative Problem Solving National Report

Research brief

November 2017

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Executive summary

This research brief reports the performance of pupils in England in the OECD's Programme for International Student Assessment (PISA) 2015 collaborative problem solving assessment. It draws on findings outlined in the international report[1] and places the outcomes for England in the context of those findings.

The PISA 2015 collaborative problem solving assessment measured pupils' abilities to achieve successful outcomes in collaborative settings, requiring pupils to communicate with other people, delegate roles to others, ensure that the group remains focussed on the task at hand, or evaluate whether other team members have performed their assigned tasks, for example.

Key findings

England's performance in Collaborative Problem Solving

- 15-year olds in England perform significantly higher than the OECD average in collaborative problem solving, meaning their ability to achieve successful outcomes in collaborative settings using ICT is higher than that of an average 15-year old across OECD countries.
- Pupils in ten countries perform significantly above England, on average. Five of these are East-Asian countries (Singapore, Japan, Hong Kong, Macao and South Korea), whilst the others include English-speaking countries and EU members (Estonia, Finland, New Zealand, Canada and Australia). Pupils in the majority of these countries outperform their peers in England in the three core PISA subjects (science, reading and maths) as well.
- Whilst our pupils perform well, on average, in the collaborative problem solving assessment, more than one in five (22%) pupils in England does not demonstrate basic collaborative problem solving ability, meaning they are not able to achieve a score at PISA Level 2[2].
- Meanwhile, thirteen per cent of pupils in England demonstrate an advanced level of collaborative problem solving (PISA Level 4), which is more than the figure in some of the highest performing countries, such as South Korea, Estonia or Macao.
- The range of abilities that pupils in England demonstrate in collaborative problem solving is greater than the average for OECD countries. The difference between the scores of pupils in England at the 5th and the 95th percentiles is 343 score points, which is above the average difference across OECD countries (311 score points).

[1] OECD (2017a), PISA 2015 Results (Volume V): Collaborative Problem Solving, PISA, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264285521-en

[2] See table 7 on page 16 for a description of the PISA collaborative problem solving levels

Differences in performance according to pupil characteristics

- In England, girls score 35 points higher than boys on average in collaborative problem solving (539 points compared with 504 points).
- Socio-economic background has a significant impact on pupils' performance in collaborative problem solving: those amongst the most deprived 25% of pupils across the country are 1.7 times more likely to score below Level 2 than their peers from more advantaged backgrounds; and those in the most advantaged 25% of their peer group are 2.1 times more likely to perform at Level 4 than pupils with lower socio-economic statuses.
- On average, pupils in England with an immigrant background score 15 points below non-immigrant pupils, and significant difference is observed between first-generation immigrant and non-immigrant pupils even after accounting for gender and socio-economic status.

Links with performance in mathematics, reading and science

- Across the whole of the UK, performance in collaborative problem solving appears to be slightly less strongly related to performance in the core subjects than performance in core subjects is related to each other.
- In England, 70% of pupils who are top performers in all three core PISA subjects are also top performers in collaborative problem solving.
- Pupils in England are stronger at collaborative problem solving (performing 12 points higher in this domain) than would be expected given their science, reading and mathematics scores.

Pupils' attitudes and their relationships with others

- Pupils' collaborative problem solving performance is significantly higher when they report that their parents are interested in their school activities, and support their educational achievements or encourage them to be confident.
- In England, and on average across the OECD countries as well, pupils who strongly value relationships tend to perform better in collaborative problem solving than those who value them less. The performance gap between the top and bottom quarters of the index of valuing relationships is 50 score-points in England.
- By contrast, both in England and across the OECD countries, pupils who reported that they value teamwork highly score below those who strongly dislike working in teams. The difference between the mean scores in the top and bottom quarters of the index of valuing teamwork is 29 score-points in England.
  Pupils who report never or almost never being threatened by other pupils perform 11 points higher than those who report that they are sometimes threatened by their peers.

1. Introduction

1.1. What is PISA?

The Programme for International Student Assessment (PISA) is organised by the Organisation for Economic Co-operation and Development (OECD). This assessment provides a comparison of what 15-year-olds across the world know and can do in the core subjects of science, reading and mathematics. It is carried out on a three-year cycle with an alternating focus on the three core subjects. In 2015 the main focus of the assessment was science. An innovative domain is also assessed each cycle, the innovative domain in 2015 was collaborative problem solving, while in 2012 it was individual problem solving.

The first PISA study took place in 2000 and was undertaken in 43 countries. In 2015, 72 countries and territories participated in the PISA core subjects, including all OECD member states, and 51 countries and territories took part in the collaborative problem solving test. For the first time, PISA 2015 was conducted on a computer-based platform in the majority of the participating countries, and in all countries participating in the collaborative problem solving assessment. In England, PISA was conducted between November and December 2015. A total of 206 schools and 5,194 pupils took part.

1.2. What is Collaborative Problem Solving?

PISA 2015 defines collaborative problem solving competency as:

> *"the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution."* [3]

This definition highlights that in order to collaborate, at least two parties need to be involved and work together to solve a problem or task. In this context, a problem is not necessarily a cognitive task, like planning the construction of a bridge, rather it may be managing group organisation, communicating with other people, delegating roles to others, ensuring that the group remains focussed on the task at hand, or evaluating whether other team members have performed their assigned tasks, among other examples. The collaborating parties can either be all humans or some of them can be computerised simulations. Further discussion on the development and types of problems used in the assessment can be found in the PISA 2015 framework for assessing collaborative problem solving competence[4].

[3, 4] OECD (2017b), *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264281820-en.

1.2.1. How was Collaborative Problem Solving assessed?

PISA measures individual competency and, in the domain of collaborative problem solving, it measures the ability of individuals to work in collaborative settings. Since collaboration can only happen among multiple people, and one's performance is directly influenced by the group itself, controlling the characteristics of the group members is especially important. To achieve this, in PISA 2015, the pupils interacted with computers instead of other humans.

The PISA 2015 framework for collaborative problem solving identifies two components of collaborative problem solving: the four cognitive processes identified for individual problem solving in 2012, and three competencies unique to collaborative problem solving. These three competencies are crossed with the four problem solving processes to form a matrix of twelve specific skills, as illustrated in Table 1 below.

Each item within the collaborative problem solving evaluation assesses one (or sometimes more than one) of these specific skills. The assessment as a whole is developed to measure all 12 specific skills over the various tasks.

Table 1 Skills evaluated in the PISA 2015 Collaborative Problem Solving assessment

		Collaborative problem solving competencies		
		(1) Establishing and maintaining shared understanding	(2) Taking appropriate action to solve the problem	(3) Establishing and maintaining team organisation
Problem solving processes	(A) Exploring and understanding	(A1) Discovering perspectives and abilities of team members	(A2) Discovering the type of collaborative interaction to solve the problem, along with goals	(A3) Understanding roles to solve the problem
	(B) Representing and formulating	(B1) Building a shared representation and negotiating the meaning of the problem (common ground)	(B2) Identifying and describing tasks to be completed	(B3) Describe roles and team organisation (communication protocol/rules of engagement)
	(C) Planning and executing	(C1) Communicating with team members about the actions to be/being performed	(C2) Enacting plans	(C3) Following rules of engagement (e.g. prompting other team members to perform their tasks)
	(D) Monitoring and reflecting	(D1) Monitoring and repairing the shared understanding	(D2) Monitoring results of actions and evaluating success in solving the problem	(D3) Monitoring, providing feedback and adapting the team organisation and roles

Source: OECD (2017), PISA 2015 Results (Volume V)

PISA uses several different types of collaborative problem solving tasks:

- *Jigsaw* or hidden-profile tasks: each group member is given different information or skills and groups need to pool each member's information and skills together in order to solve the problem.
- *Consensus-building* tasks: a group must agree on a decision after considering the views, opinions and arguments of all other group members.
- *Negotiation* tasks: a group must agree on next steps or a decision in a situation where not all group members share the same individual goals.

An example unit included in the PISA 2015 assessment is described in APPENDIX A.

PISA measures pupils' performance in collaborative problem solving on a single scale that provides an overall assessment of 15-year-old pupils' collaborative problem solving competence. Since collaborative problem solving was a new domain in PISA 2015, the OECD average performance was set at 500 score points and the standard deviation across OECD countries at 100 score points. This established the benchmark against which each country's collaborative problem solving performance in PISA 2015 can be compared.

1.3. Comparison countries

There are many possible countries that might be interesting to compare to England. The 18 countries and territories forming the comparison group in this report (shown in Table 2) include the countries significantly outperforming England, the countries not performing significantly differently from England and the other three countries of the United Kingdom.

The average across the OECD countries is also included in the comparisons. A full set of comparisons across all participating countries can be found in the international report for PISA 2015 Collaborative Problem Solving[5].

Table 2 Countries compared with England

Australia	Estonia*	South Korea	OECD average
Canada	Finland*	*Macao*	Scotland*
Taiwan	Germany*	Netherlands*	*Singapore*
Denmark*	*Hong Kong*	New Zealand	United States
England*	Japan	Northern Ireland*	Wales*

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries UK countries (underlined)

[5] OECD (2017a), PISA 2015 Results (Volume V): Collaborative Problem Solving, PISA, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264285521-en

1.3.1. Interpreting differences between countries

To acknowledge that the findings are taken from samples of pupils responding to a selection of assessment items rather than comprehensive assessments of all pupils in each country, two sources of uncertainty have to be taken into account:

Sampling error refers to the error around estimates derived from the sample that arise from possible unrepresentativeness of the sample taken. Since only a sample of 15-year-olds took part in PISA, the results cannot be stated to be totally representative of the population, they are only our best estimation of how the total population of 15-year-olds could be expected to perform in these tests.

Measurement error refers to the error in one individual pupil's performance in the test that are not directly due to the pupil's ability in the subject, rather they are influenced by factors related to individuals or to the nature of the tests or testing conditions, such as sickness on the day of testing.

This report focuses on statistically significant differences between mean scores, as such differences are unlikely to be caused by the effects of sampling and measurement error. All statistically significant results reported here are significant at the 95% confidence level, meaning that if the survey were repeated over and over again, the results would match the results from the actual population 95 percent of the time.

2. Collaborative Problem Solving in England

England's pupils achieved the mean score of 521 in collaborative problem solving in PISA 2015, which was significantly higher than the OECD average set at 500.

There were ten countries whose mean score was significantly higher than England (see Table 3). Five of these are East Asian countries or territories: Singapore, Japan, Hong Kong, South Korea and Macao, who also outperformed England in PISA 2012 individual problem solving. In PISA 2015 all of these East Asian countries significantly outperformed England in the core subjects, apart from South Korea in science. The other countries with significantly higher mean scores than England in collaborative problem solving include three English-speaking countries (Canada, New Zealand and Australia) and two EU member states (Estonia and Finland), neither of which performed significantly differently from England in the 2012 assessment of individual problem solving. While New Zealand and Australia performed similarly to England in all three core subjects in PISA 2015, pupils in Canada, Finland and Estonia achieved significantly higher scores than pupils in England in science, mathematics and reading as well as collaborative problem solving.

Table 3 Countries in which 15-year olds score significantly higher in Collaborative Problem Solving than their peers in England

Country	Mean score	Country	Mean score
Singapore	561	Estonia*	535
Japan	552	Finland*	534
Hong Kong	541	*Macao*	534
South Korea	538	New Zealand	533
Canada	535	Australia	531

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

Five countries performed at a level not significantly different from England's result. These countries (shown in Table 4) include Taiwan, the United States and three countries that are both EU and OECD members.

Table 4 Countries not significantly different from England in Collaborative Problem Solving

Country	Mean score
Taiwan	527
Germany*	525
England	521
United States	520
Denmark*	520
Netherlands*	518

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

The remaining countries, including the three other countries of the United Kingdom, performed significantly below England. Their mean scores are presented in Table 5 below. The OECD average in collaborative problem solving was set to 500 points, there are eight countries whose mean scores were not significantly different from this number. These are Norway, Slovenia, Belgium, Iceland, Czech Republic, Portugal, Wales, Spain and B-S-J-G China[6].

Table 5 Countries performing significantly below England in Collaborative Problem Solving

Country	Mean score	Country	Mean score
Northern Ireland*	514	Hungary*	472
Scotland*	513	Israel	469
Sweden*	510	Lithuania*	467
Austria*	509	Slovak Republic*	463
Norway	502	Greece*	459
Slovenia*	502	Chile	457
Belgium*	501	Cyprus*	444
OECD average	500	Bulgaria*	444
Iceland	499	*Uruguay*	443
Czech Republic*	499	*Costa Rica*	441
Portugal*	498	*Thailand*	436
Spain*	496	*United Arab Emirates*	435
Wales*	496	Mexico	433
B-S-J-G (China)	496	*Colombia*	429
France*	494	Turkey	422
Luxembourg*	491	*Peru*	418
Latvia*	485	*Montenegro*	416
Italy*	478	*Brazil*	412
Russian Federation	473	*Tunisia*	382
Croatia*	473		

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries UK countries

2.1. Differences between highest and lowest attainers

In addition to knowing how well pupils in England performed overall, it is useful to examine the range of performance between the highest and lowest achievers. Amongst countries with the same or similar mean scores there can be differences in the distribution of high- and low-scoring pupils. A wide range of attainment means that the country has a large number of pupils who are performing at a low level and also a large number performing at a very high level, while in a country with a smaller range of attainment, fewer pupils may score very high but there are probably fewer underachievers as well.

[6] Beijing and Shanghai joined with two other Chinese provinces (Jiangsu and Guangdong) to become B-S-J-G (China).

2.1.1. Distribution of scores

One way to examine the spread of performance in each country is by looking at the range of scores achieved by pupils. Rather than comparing the lowest and highest scores, which could be affected by a small number of pupils with unusually high or low scores, we compare the difference in performance between pupils at the 5th and 95th percentiles. The 5th percentile is the score at which only five per cent of pupils score lower, while the 95th percentile is the score at which only five per cent score higher.

In collaborative problem solving, the score of pupils in England at the 5th percentile was 347, while the score of those at the 95th percentile was 690; a difference of 343 score points. This is larger than the average difference across the OECD (311 score points) indicating a greater variation in pupils' collaborative problem solving ability across England than on average across OECD countries. Only four comparison countries had a greater difference between the performance of their highest and lowest attainers. These were all English-speaking countries - United States, Australia, New Zealand and Canada. The largest difference was found for the United States (355 score points). Interestingly, the countries that outperformed England in collaborative problem solving were either at the top of the list with some of the widest ranges in performance, such as Australia, New Zealand, Canada or Finland, or they were towards the bottom of the list, with much smaller ranges than the OECD average, such as Estonia, Japan or South Korea (with the smallest range at 276 score points).

England also had a relatively large range of performance in the three core subjects. In science and mathematics, the differences between scores at the 5th and 95th percentiles were 329 and 310 points respectively, which places England towards the top of the list of countries with a wide range of performance across the participating countries. The results were closer to the average across the OECD countries in reading, where the range of performance was 322 points, compared with the average of 315 points across the OECD.

Table 6 contains the mean scores, the scores at the 5th and 95th percentiles and the spread of attainment of the comparison countries.

Table 6 The range of Collaborative Problem Solving performance in England and the comparison countries

Country	Mean score	Percentiles		Range of performance
		5th	95th	
		Score	Score	
United States	520	341	696	355
Australia +	531	347	698	351
New Zealand +	533	353	700	347
Canada +	535	358	702	344
England*	521	347	690	342
Finland* +	534	359	693	334
Germany*	525	354	686	332
Scotland*	513	347	670	323
Singapore +	561	392	709	318
Netherlands*	518	355	672	317
OECD average	500	341	652	311
Hong Kong +	541	382	681	299
Taiwan	527	370	667	298
Denmark*	520	367	663	297
Estonia* +	535	382	679	297
Macao +	534	377	672	295
Wales*	496	349	639	290
Northern Ireland*	514	366	654	288
Japan +	552	402	680	278
South Korea +	538	390	667	276

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries UK countries
+Countries performing significantly above England

2.1.2. Performance across PISA proficiency levels

Another way of examining the spread of performance in a country is by looking at the share of pupils performing at each proficiency level. To help interpret what pupils' scores in PISA relate to, the scale measuring collaborative problem solving is divided into five proficiency levels. Level 1 is the lowest described level and corresponds to an elementary level of collaborative problem solving skills while Level 4 corresponds to the highest level of collaborative problem solving skills.

Table 7 summarises what pupils at each of the four levels of proficiency in collaborative problem solving can typically be expected to do. The fifth proficiency level called *below Level 1* is defined based on the absence of the skills observed at Level 1. In all participating countries there were some pupils performing below Level 1 and at least some pupils that achieved Level 4.

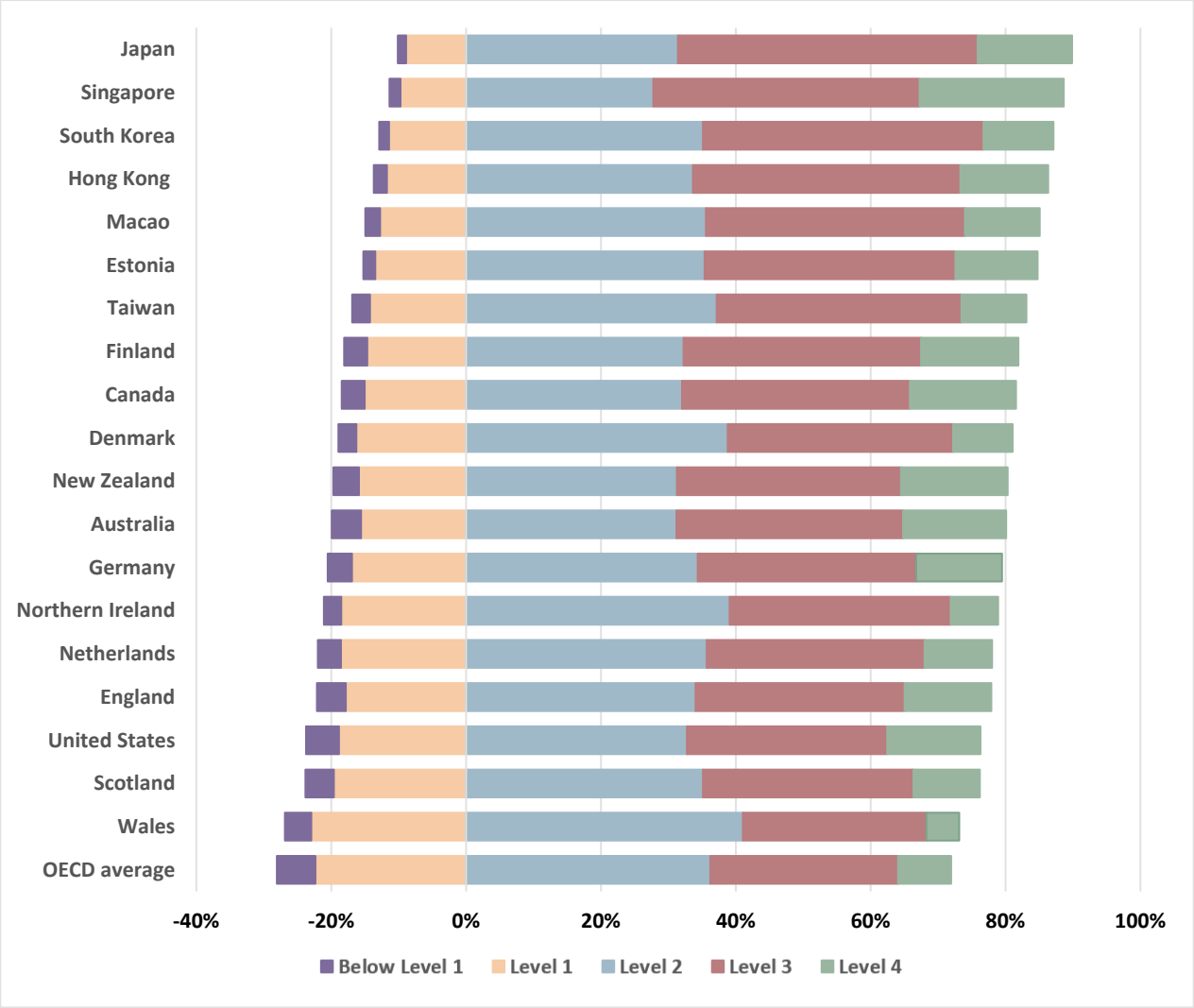
Table 7 Summary descriptions of the four levels of proficiency in Collaborative Problem Solving

Level	Score range	What pupils can typically do
4	**Equal to or higher than 640 score points**	At Level 4, pupils can successfully carry out complicated problem solving tasks with high collaboration complexity. They can take initiative and perform actions or make requests to overcome obstacles and to resolve disagreements and conflicts. They can balance the collaboration and problem solving aspects of a presented task, identify efficient pathways to a solution, and take actions to solve the given problem.
3	**540 to less than 640 score points**	At Level 3, pupils can complete tasks with either complex problem solving requirements or complex collaboration demands. These pupils can recognise the information needed to solve a problem, request it from the appropriate team member, and identify when the provided information is incorrect. When conflicts arise, they can help team members negotiate a solution.
2	**440 to less than 540 score points**	At Level 2, pupils can contribute to a collaborative effort to solve a problem of medium difficulty. They can understand that not all team members have the same information and can consider differing perspectives in their interactions. They can help the team establish a shared understanding of the steps required to solve a problem. These pupils can request additional information required to solve a problem and solicit agreement or confirmation from team members about the approach to be taken.
1	**340 to less than 440 score points**	At Level 1, pupils can complete tasks with low problem complexity and limited collaboration complexity. They can confirm actions or proposals made by others. They tend to focus on their individual role within the group. With support from team members, and when working on a simple problem, these pupils can help find a solution to the given problem.
Below 1	**Less than 340 score points**	Below Level 1, pupils are not expected to be able to complete tasks at Level 1 or above.

Source: OECD (2017), PISA 2015 Results (Volume V)

Figure 1 demonstrates what percentage of pupils in the 18 comparison countries performed at each PISA proficiency level in collaborative problem solving. Countries are ranked in descending order of the percentage of pupils at or above Level 2.

Figure 1 Percentage of pupils scoring at each PISA proficiency level in the comparison countries



Source: OECD, PISA 2015 Database

Twenty-two per cent of the participating pupils in England performed below proficiency Level 2, 4% performing even below Level 1. There were in total 15 countries that had fewer pupils than England performing below Level 2, and the figure was lower than the OECD average (28%) in all 18 comparison countries. The highest performing East-Asian countries had less than 14% of pupils performing below Level 2, and less than 2% performing below Level 1.

Thirteen per cent of pupils in England performed at Level 4, which is more than the figure in some of the highest performing countries, such as South Korea, Estonia or Macao. Only eight of the comparison countries had more pupils achieving Level 4 than England, including those with the highest mean scores. The OECD average at the highest level was 8%. It is notable that in the highest performing country in collaborative problem solving, Singapore, 21% of pupils performed at the highest level, and 89% performed at or above Level 2.

2.2. Differences by pupil characteristics

This section examines the relationship between performance in collaborative problem solving and pupil characteristics, such as gender, socio-economic status and immigrant background.

2.2.1. Difference between boys and girls

In England, girls on average scored 35 points higher than boys in collaborative problem solving (539 points compared with 504 points). In all participating countries girls performed significantly better than boys, the average difference between the genders in the OECD countries was 29 points. There were 12 countries with bigger gaps between boys' and girls' performance than England, Finland leading the list with 48 points. The smallest difference between genders occurred in Peru and Costa Rica, where girls only performed 7 points above boys on average. However, even this difference was statistically significant in both countries.

Table 8 shows the mean scores and standard deviations of boys and girls in the comparison countries as well as the difference between the genders. Of those countries significantly outperforming England in collaborative problem solving, Singapore has the smallest gender gap, with girls performing on average 20 points higher than boys.

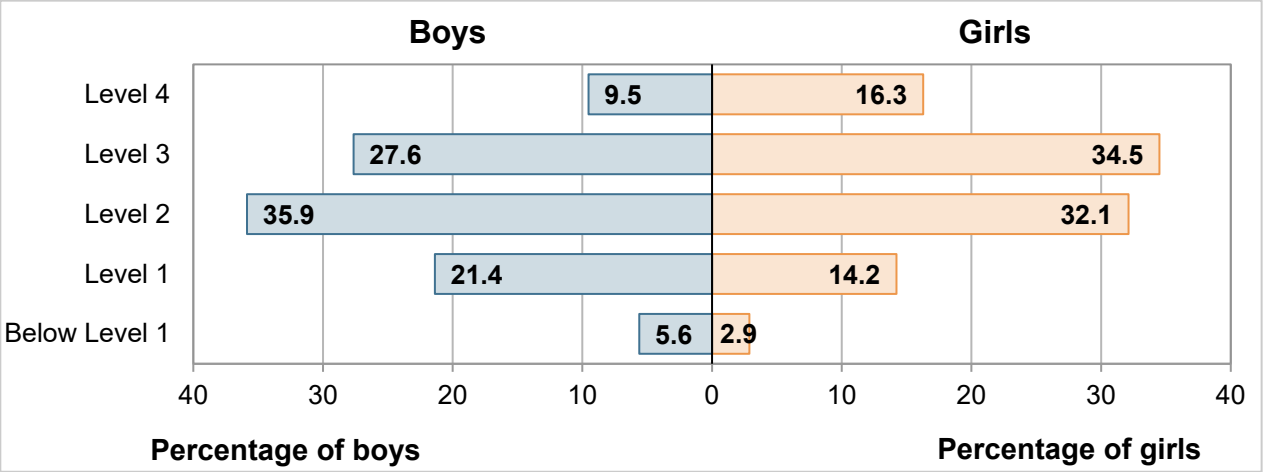
Table 8 Mean score and gender difference in Collaborative Problem Solving performance by gender

Countries	Boys		Girls		Gender difference
	mean score	S.D.	mean score	S.D.	(girls-boys)
Finland* +	511	103	559	94	**48**
Australia +	511	109	552	100	**41**
New Zealand +	513	108	553	99	**41**
Canada +	516	104	555	100	**39**
Macao +	515	93	553	82	**38**
Hong Kong +	523	91	559	86	**36**
England*	504	103	539	103	**35**
South Korea +	522	87	556	77	**33**
Scotland*	497	98	530	98	**33**
Germany*	510	101	540	98	**30**
OECD average	486	96	515	91	**29**
Taiwan	513	92	541	86	**28**
Northern Ireland*	500	89	528	85	**27**
Netherlands*	504	98	531	93	**27**
Estonia* +	522	92	549	86	**27**
Japan +	539	87	565	80	**26**
United States	507	111	533	104	**26**
Wales*	485	90	508	87	**23**
Denmark*	509	92	530	88	**21**
Singapore +	552	99	572	93	**20**

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries UK countries
+Countries performing significantly above England **statistically significant differences**

The standard deviation in collaborative problem solving performance is significantly greater among boys than among girls in 25 out of 52 participating countries. This, together with the lower mean scores of boys, implies that more boys tend to perform worse than girls in collaborative problem solving, but also that their performance is more varied. Figure 2 shows the percentage of girls and boys performing at each level in England. Girls in England are 1.7 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 not to have basic proficiency in collaborative problem solving (performing at or below Level 1). Boys are almost twice as likely to perform below Level 1 as girls in England.

Figure 2 Proficiency in Collaborative Problem Solving in England, by gender



Source: OECD, PISA 2015 Database

After accounting for performance in the three core PISA subjects and socio-economic status, girls still outperform boys in collaborative problem solving by 31 score points in England and 25 score points on average across OECD countries. This gender gap is significant and in favour of girls in every country that participated in the assessment.

2.2.2. Relationship between Collaborative Problem Solving and socio-economic status

PISA measures socio-economic status using their ESCS Index (a composite index of pupils' economic, social and cultural status). This is calculated using pupils' responses to questions about their parents' occupation and education, and possessions in their homes. The index is set to a mean of zero across OECD countries, with a standard deviation of one.

In England, a one-unit increase in a pupil's socio-economic status – holding the school socio-economic profile and other pupil characteristics constant – is associated with an increase in a pupil's collaborative problem-solving score of 17 points, while a one-unit

increase in the average socio-economic profile of the pupil's school (and therefore the area in which they live) is associated with a 58 score-point increase in the pupil's score.[7]

Pupils in England who are amongst the most deprived 25% across the country are 1.7 times more likely to score below Level 2 on the collaborative problem solving scale than their peers from more advantaged backgrounds. Those in the most advantaged 25% of their peer group are 2.1 times more likely to perform at Level 4 than pupils with lower socio-economic statuses.

2.2.3. Immigrant background and Collaborative Problem Solving performance

In many countries, children of immigrants are more at risk of low performance in school than the children of parents who were born in the country. A gap in collaborative problem solving performance between immigrant and non-immigrant[8] pupils is also observed and significant in England, where 18% of participating pupils were of immigrant background. On average in England, immigrant children scored 512 points in collaborative problem solving, a statistically significant 15-point difference compared to the 527-point mean score of non-immigrant pupils. This difference is even bigger, 23 points, when comparing only first-generation immigrants, who scored an average of 504 points. Performance differences related to immigrant background are observed between first-generation immigrant and non-immigrant pupils even after accounting for gender and socio-economic status. After accounting for these two factors, first-generation immigrant pupils still scored significantly below non-immigrants: a difference of 20 score-points. However, when accounting for performance in science, reading and mathematics, this performance gap disappears, indeed, immigrant pupils seem to score slightly above non-immigrants even though this difference is not significant.

There is a great variability in relative performance differences related to immigrant background among the comparison countries. Figure 3 shows the score-point difference in relative collaborative problem solving performance[9] between immigrant and non-

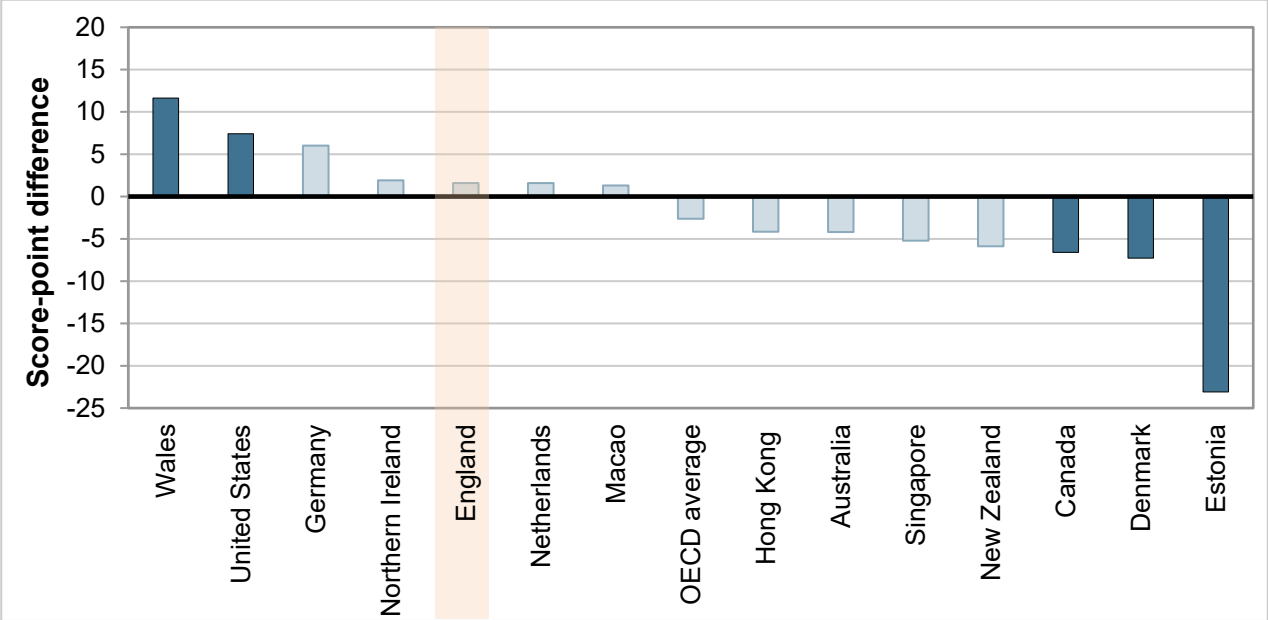
[7] In the United Kingdom, 10% of the variation in collaborative problem solving performance can be explained by differences in socio-economic status at both pupil and school levels. This relationship is weaker than those between socio-economic status and science (18%), reading (15%) and mathematics (17%) performance.

[8] PISA classifies pupils into three categories according to their immigrant background. Immigrant pupils are those, whose parents were both born in a country other than where the pupil sat the PISA test. **First-generation immigrants** are foreign-born pupils whose parents are also foreign born. **Second-generation immigrants** are pupils who were born in the country they sat the PISA test in, whose parents are both foreign-born. **Non-immigrants** are pupils, whose mother or father (or both) were born in the country where the pupil sat the PISA test (regardless of whether the pupil was born in the same country or not.

[9] Performance in collaborative problem solving after accounting for performance in science, mathematics and reading

immigrant pupils in those comparison countries where more than 6% of the participating pupils were immigrants. Immigrant pupils perform significantly above their expected level in collaborative problem solving in the United States and Wales, while in Canada, Denmark and Estonia, immigrant pupils perform significantly below their expected level based on their scores in the three core subjects.

Figure 3 Differences in performance in Collaborative Problem Solving after accounting for performance in science, reading and mathematics, by immigrant background



Source: OECD, PISA 2015 Database

2.2.4. Competence in information and communication technology and performance in Collaborative Problem Solving

The PISA 2015 collaborative problem solving assessment measures the ability of individuals to work in collaborative settings. In order to ensure that all pupils encounter the same characteristics in their group members, these had to be controlled, hence the assessment could only be delivered in a computer-based format. It was assumed that almost all 15-year-olds in 2015 were familiar with computers and other information and communications technology (ICT), especially in countries that chose to conduct the assessment. However, to measure the extent to which pupils use and are comfortable with computers and ICT equipment, they were asked to report on the extent to which they use ICT at school[10] and their self-perceived comfort with ICT[11].

In England, 15-year-olds who rank between the 25th and 75th percentiles in the index of ICT use at school (i.e. those in the second and third quarters) perform better than pupils who use ICT at school the most (those in the top quarter) or the least (those in the

[10] Index of ICT use at school

[11] Index of pupils' self-reported ICT competence

bottom quarter). Those who use ICT the most at school score on average 14 points lower in collaborative problem solving than those who use ICT at school the least. This difference is statistically significant, and the relationship between ICT usage at school and performance in collaborative problem solving is similar across the OECD countries as well. Table 9 shows the mean scores achieved at each national quarter of the index of ICT use at school in England and on average across OECD countries.

Table 9 Performance in Collaborative Problem Solving at the national quarters of the index of ICT use at school

	Bottom quarter	Second quarter	Third quarter	Top quarter
England	521	542	543	507
OECD average	508	523	516	479

Source: OECD, PISA 2015 Database

Interestingly, while pupils' self-reported ICT competence is found to be positively related to performance in collaborative problem solving on average across the OECD countries, there does not seem to be a clear relationship between these two factors in England. Table 10 shows England's mean scores at each national quarter of the index of pupils' self-reported ICT competence together with the OECD average scores. According to the figures, in England, 15-year-olds at the third quarter seem to score the highest in collaborative problem solving, with a mean score of 545 points, while those in the second quarter score the lowest with a mean score of 514 points.

Table 10 Performance in Collaborative Problem Solving at the national quarters of the index of pupils' self-reported ICT competence

	Bottom quarter	Second quarter	Third quarter	Top quarter
England	528	514	545	532
OECD average	502	505	509	512

Source: OECD, PISA 2015 Database

2.3. Relationship between Collaborative Problem Solving and science, mathematics and reading

As it was the case in 2012 with individual problem solving, pupils' scores in the four domains of PISA 2015 are highly correlated. As correlation data are not yet available for England, Table 11 shows the correlations between collaborative problem solving, science, mathematics and reading across the whole United Kingdom. These figures are very similar to the average across all OECD countries, where performance in collaborative problem solving shows a correlation of 0.70, 0.74 and 0.77 with the performance in mathematics, reading and science, respectively. Performance in collaborative problem solving appears to be slightly less strongly related to performance in the core subjects than performance in core subjects are related to each other. Across

the OECD countries the pairwise correlations of the core subjects range from 0.80 to 0.88, while in the UK they are between 0.77 and 0.87.

Table 11 Correlations among performance in the four PISA domains in the United Kingdom

Correlation between:			...and…
Mathematics	**Reading**	**Science**	
0.68	0.74	0.76	**Collaborative problem solving**
	0.77	0.87	**Mathematics**
		0.86	**Reading**

Source: OECD, PISA 2015 Database

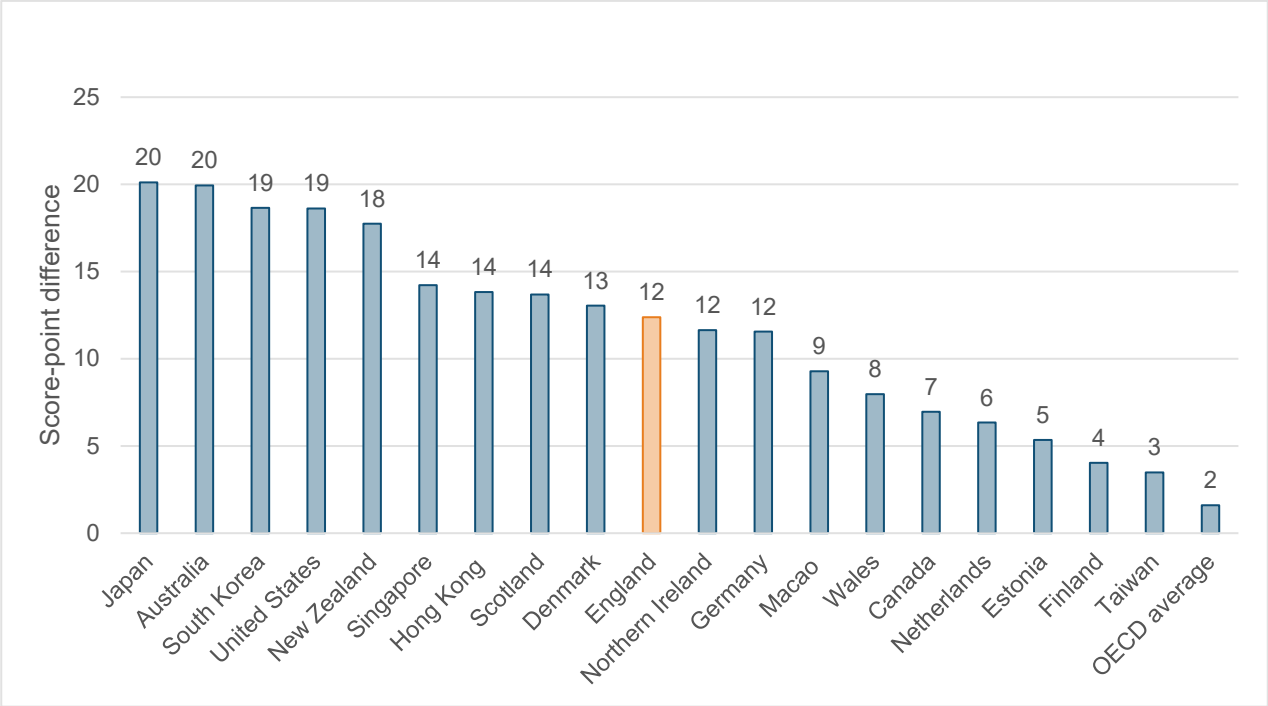
Another way to examine the relationship between performance in collaborative problem solving and the core subjects is by looking at the extent to which top or low performance in the three core domains predicts performance in collaborative problem solving. Top performers are pupils scoring at Levels 5 or 6 in the core subjects and Level 4 in collaborative problem solving, while low performers in all domains are pupils who perform below Level 2.

In England, 55% of top performers in science, 56% of top performers in reading and 48% of top performers in mathematics are also top performers in collaborative problem solving, and 70% of pupils who are top performers in all three core PISA subjects (all-round top performers) are also top performers in collaborative problem solving.

The relationship is similar among low performers as well. Seventy percent of low performers in science, 66% of low performers in reading, and 58% of low performers in mathematics are also low performers in collaborative problem solving, and 78% of low performers in all three core subjects (all-round low performers) are also low performers in collaborative problem solving. The numbers are similar but slightly higher across the OECD countries as well. Hence, it may be that a certain level of functional literacy in the three core domains is a pre-requisite for baseline performance in collaborative problem solving.

After accounting for proficiency in reading, mathematics and science, an average relative score can be calculated for collaborative problem solving. Figure 4 shows the comparison countries in descending order of their average relative performance in collaborative problem solving. The score-point differences mean the difference between actual and expected performance in collaborative problem solving based on a country's mean scores at the three core subjects.

Figure 4 Relative performance in Collaborative Problem Solving of the comparison countries after accounting for performance in science, reading and mathematics



Source: OECD, PISA 2015 Database

All comparison countries performed better in collaborative problem solving than would have been predicted according to their performance in the PISA core subjects. In England's case, this difference is 12 score-points, which can be interpreted as pupils in England perform 12 points higher in collaborative problem solving, on average, than would be expected given their science, reading and mathematics scores.

2.4. Pupils' attitudes towards collaboration, and their perceptions of their relationships with others

To gather contextual information, PISA 2015 asked pupils to respond to questionnaires. This section describes responses to the pupil questionnaires in which they were asked about their attitudes towards collaboration, and the density and quality of the relationships that pupils build in and out of schools, and how they shape their performance in collaborative problem solving.

2.4.1. Attitudes towards collaboration

The PISA 2015 pupil questionnaire asks pupils how strongly they agree with eight statements related to their attitudes towards collaboration. Responses to these statements are combined into two indices of co-operation, as shown in Table 12.

Table 12 Indices of co-operation as measured by the pupil questionnaire of PISA 2015

Index of valuing relationships	Index of valuing teamwork
I am a good listener	I prefer working as part of a team than working alone
I enjoy seeing my classmates be successful	I find that teams make better decisions than individuals
I take into account what others are interested in	I find that teamwork raises my own efficiency
I enjoy considering different perspectives	I enjoy cooperating with peers

In England, and in almost all OECD and partner countries and economies, the majority of pupils reported that they either agree or strongly agree with these statements. In England, the percentage of pupils agreeing or strongly agreeing with the statements in the index of valuing relationships ranges from 87% to 89%, while in the index of valuing teamwork it ranges from 68% to 85%. These results are very similar to the average across OECD countries (86-88% and 67-87% respectively). However, these high proportions may reflect pupils' desire to provide the responses they think are most socially acceptable. It is not possible to determine the extent to which these responses reflect whether pupils actually hold these attitudes towards collaboration and whether they act accordingly in real life.

In England, and on average across the OECD countries as well, pupils who reported that they agree or strongly agree with the statements that comprise the index of valuing relationships score higher than those who reported that they disagree or strongly disagree with those statements. The performance gap between the top and bottom quarters of the index of valuing relationships is 50 score-points, which is very close to the OECD average of 43 points. A change of one unit in the index of valuing relationships corresponds to 16 score-points of change in collaborative problem-solving performance after accounting for pupil's socio-economic status, which is a statistically significant difference.

By contrast, pupils who reported that they agree or strongly agree with the statements comprising the index of valuing teamwork score below pupils who reported that they disagree or strongly disagree with those statements, in England as well as on average across OECD countries. The difference between the mean scores in the top and bottom quarters of the index of valuing teamwork is 29 score-points in England. A change of one unit in the index of valuing teamwork corresponds to -9 score-points of change in collaborative problem-solving performance after accounting for pupil socio-economic status, which is also a statistically significant difference.

2.4.2. Pupils' relationships with other pupils, teachers and parents

Pupils in England feel mostly positive about their relationships with their schoolmates. More than 87% agreed that they seemed to be liked by their peers. However, 38%

reported that other pupils make fun of them at least a few times a year, and only 23% of participating 15-year-olds attend schools whose principal reported that pupils' learning is not hindered by pupils intimidating or bullying each other.

Table 13 shows the change in average score points in collaborative problem solving performance in England and across the OECD countries, when pupils report the following statements, after accounting for their socio-economic background. The percentage of pupils reporting each statement is also shown.

There is a mixed relationship between how well pupils get on with each other and how they perform in collaborative problem solving. While the percentage of pupils reporting each statement in England is broadly similar to the average across the OECD countries, the direction and strength of the relationship between the statements and pupils' performance differs from the OECD average. The most notable difference is that while on average across the OECD countries pupils perform 6 points higher when they report not feeling lonely at school, in England these pupils perform 12 points below those who report feeling lonely at school.

Table 13 Change in Collaborative Problem Solving score when pupils reported the following, after accounting for pupils' socio-economic profile; and percentage of pupils reporting each statement

	OECD average		England	
	Score difference	Percentage	Score difference	Percentage
Agree or strongly agree that I make friends easily at school	**-6**	78%	**-14**	79%
Agree or strongly agree that other students seem to like me	**9**	82%	1	88%
Disagree or strongly disagree that I feel lonely at school	**6**	85%	**-12**	86%
Other students never or almost never make fun of me	**-2**	70%	-4	62%
I am never or almost never threatened by other students	**18**	89%	**11**	82%
I never or almost never get hit or pushed around by other students	**14**	88%	8	85%

Source: OECD, PISA 2015 Database

PISA 2015 asked pupils to report how their science teacher supports and disciplines them, and how pupils behave in these classes. Table 14 demonstrates the changes in mean scores in England and on average across the OECD countries when pupils reported the following statements, after accounting for their socio-economic profile. The percentage of pupils reporting each statement is also shown.

Around 60% of pupils in England reported that their teacher never or almost never disciplines them too harshly or says something insulting to them in front of others. These

pupils perform over 25 points above other pupils in England after accounting for their socio-economic background. The results across the OECD countries are similar to the results in England. One notable difference is that those 15-year-olds in England who report that pupils in their classes almost always pay attention to the teacher, score 20 points higher than their peers not reporting the same. This relationship is weaker, however still significant across the OECD countries as well.

Table 14 Change in Collaborative Problem Solving score according to pupil-teacher relationship, after accounting for pupils' socio-economic profile

	OECD average		England	
	Score difference	Percentage	Score difference	Percentage
In every lesson, the teacher gives extra help when students need it	**3**	40%	**9**	51%
In every lesson, the teacher continues teaching until the students understand	3	38%	5	44%
Teachers never or almost never discipline me more harshly than other students	**25**	69%	**27**	59%
Teachers never or almost never say something insulting to me in front of others	**23**	75%	**25**	64%
Students never or hardly ever *don't* listen to what the teacher says	**4**	18%	**20**	17%
The teacher never or hardly ever has to wait a long time for students to quiet down	**9**	27%	**10**	21%

Source: OECD, PISA 2015 Database

PISA 2015 asked pupils about the strength and quality of their interactions with their parents as well. They were asked whether they talked to them before and after school on the most recent school day, and to rate statements about their parents' emotional support. Almost all pupils reported they had talked to their parents before and after leaving school on the most recent school day; however only 50% reported feeling as though their parents were interested in their school activities.

According to Table 15, pupils' collaborative problem solving performance is significantly higher when their parents are interested in their school activities, support their educational achievements or encourage them to be confident. While the percentage of pupils reporting each statement in England is very similar to that across the OECD countries, there is a stronger relationship between pupils' responses to these questions and their collaborative problem solving performance in England compared to the average across OECD countries. Pupils whose parents show interest in their school activities perform on average 19 points higher in collaborative problem solving than other pupils in England. Those whose parents support their educational efforts perform 24 points higher, while those who are encouraged at home to be confident perform seven points higher than other pupils.

Table 15 Change in Collaborative Problem Solving score according to pupil-parent relationship, after accounting for pupils' socio-economic profile

	OECD average		England	
	Score difference	Percentage	Score difference	Percentage
Talked to parents before going to school on the most recent day	0	86%	-4	88%
Talked to parents after leaving school on the most recent day	**19**	92%	7	95%
Strongly agree that my parents are interested in my school activities	**4**	52%	**19**	50%
Strongly agree that my parents support my educational efforts and achievements	**9**	56%	**24**	64%
Strongly agree that my parents support me when I am facing difficulties at school	1	51%	0	52%
Strongly agree that my parents encourage me to be confident	**2**	52%	**7**	56%

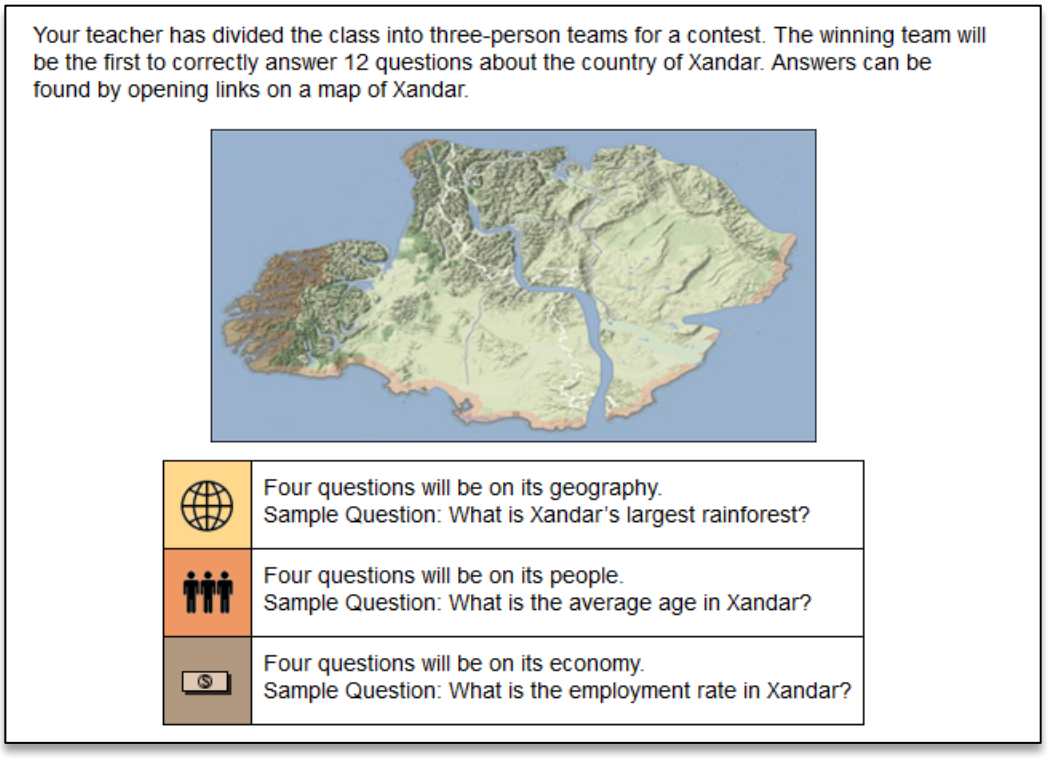
Source: OECD, PISA 2015 Database

APPENDIX A – PISA 2015 Collaborative Problem Solving assessment item

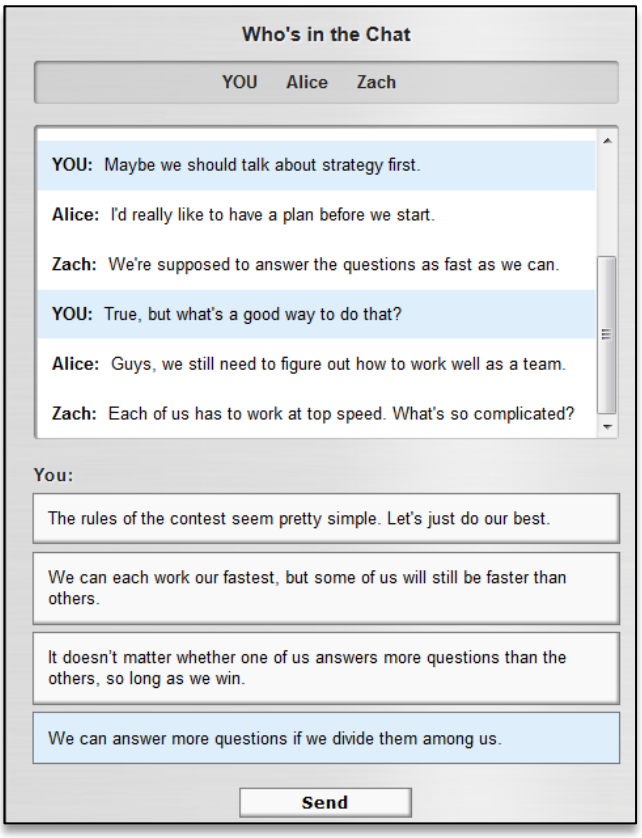
In the assessment unit '*Xandar*', a three-person team consisting of the pupil test-taker and two computer agents take part in a contest where they must answer questions about the fictional country of Xandar. The questions are evenly divided between Xandar's geography, people and economy. This unit involves decision-making and coordination tasks, requires consensus-building collaboration, and is supposed to simulate an in-school group exercise task.

The unit consists of four independent parts; all items and parts are independent of one another. No matter which response a pupil selects for a particular item, the virtual teammates agents respond in a way so that the unit converges, thus all pupils are faced with an identical version of the next item.

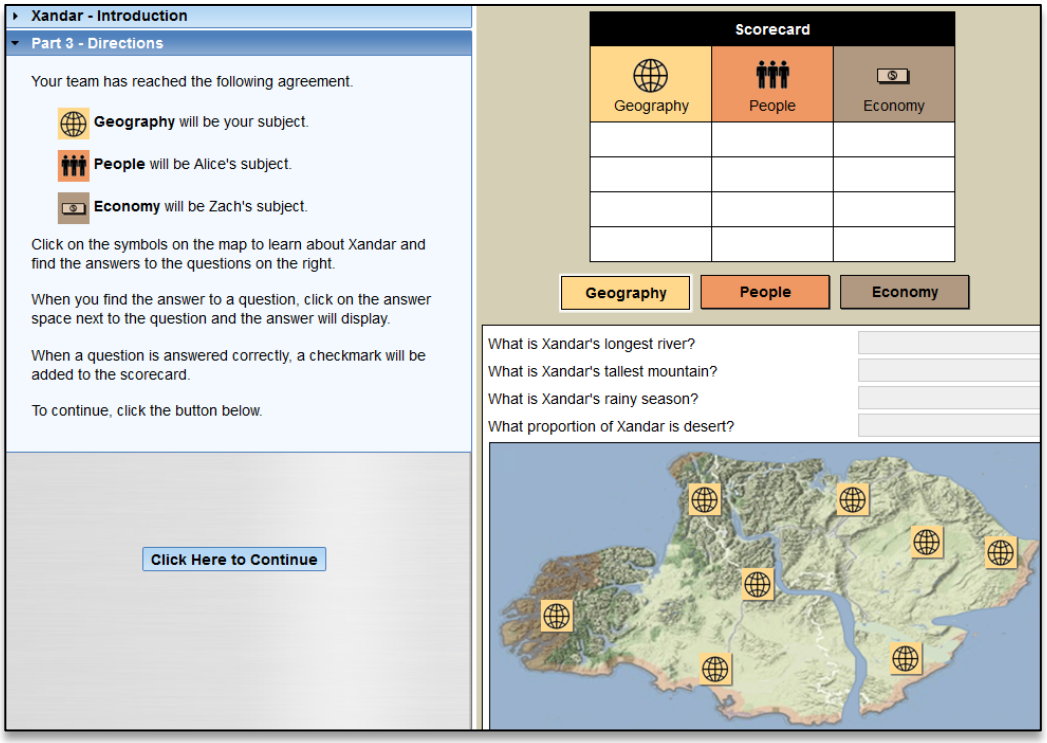
Pupils firstly receive an outline of the task:



And then are led into a chat environment to talk about the task with two (computer-simulated) colleagues, and set up a strategy to answer all questions as quickly as they can.

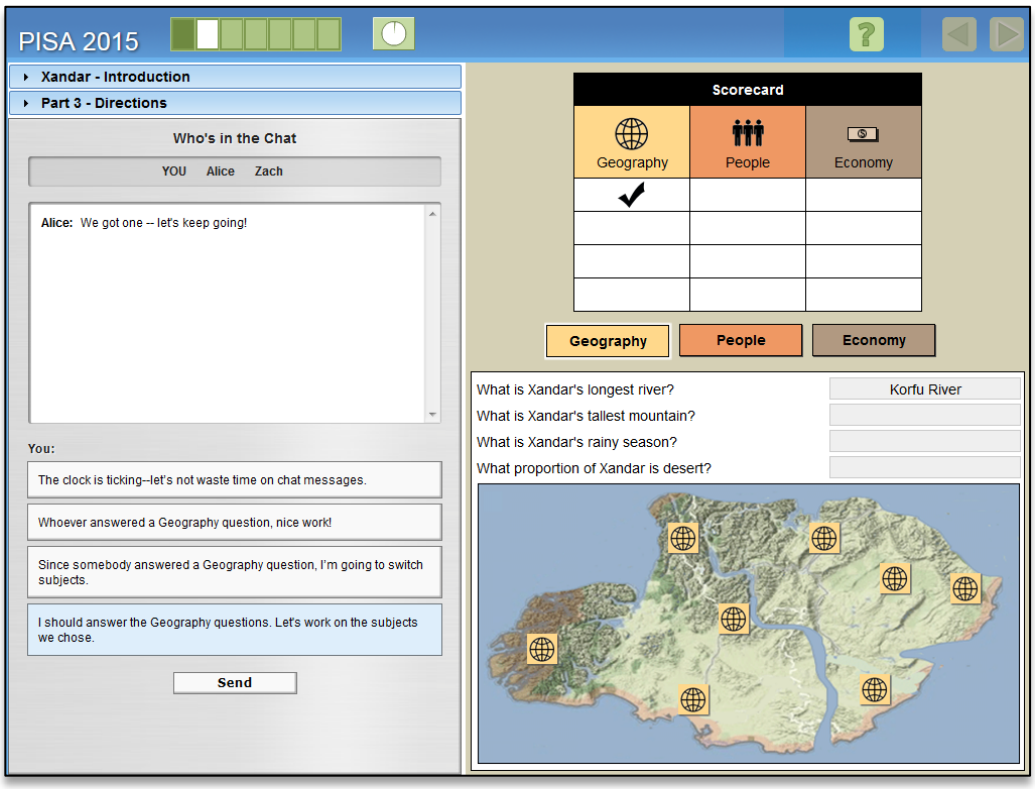


The pupil is then asked to work with the friends to answer questions using the instructions they previously received to access the answers:

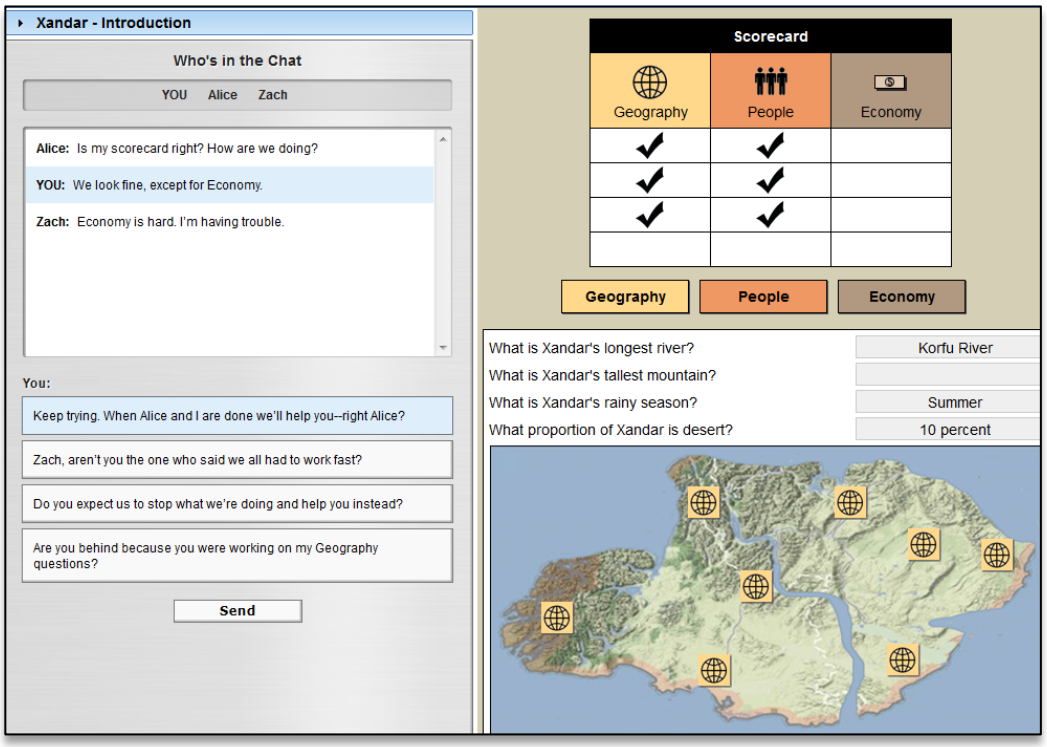


After starting, the pupil is faced with a situation, where one of the questions on Xandar's geography gets answered by one of the team mates even though this topic was assigned

to the pupil. He or she must then come up with an appropriate response. This item tests to see whether the pupil has observed that the previously-agreed rules of engagement are not being followed.



After this, pupils must click on the map of Xandar and the blank space next to the questions in order for a checkmark to be recorded on the scoreboard.



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