Contents

Introduction ........................................................................................................................................................................ 4
Key findings ......................................................................................................................................................................... 6
What is collaborative problem solving? .......................................................................................................................... 7
Collaborative problem solving competencies and processes .......................................................................................... 7
Assessing collaborative problem solving ...................................................................................................................... 8
New Zealand achievement in an international context .................................................................................................... 9
How well did New Zealand students perform in collaborative problem solving? ...................................................... 9
How does a student’s performance in collaborative problem solving relate to their performance in the core PISA subjects? .......................................................................................................................... 11
Relative performance in collaborative problem solving ............................................................................................... 12
ICT and collaborative problem solving .......................................................................................................................... 14
Achievement of different groups ..................................................................................................................................... 15
Collaborative problem solving performance with gender and ethnic groups ........................................................................... 15
Collaborative problem solving performance and socio-economic groups ........................................................................... 17
Collaborative problem solving: differences in relative performance .................................................................................... 19
Attitudes to collaboration .................................................................................................................................................. 21
Attitudes ........................................................................................................................................................................... 21
Further information on PISA Collaborative Problem Solving .......................................................................................... 24
References and further reading ........................................................................................................................................... 25
Appendix 1: Assessing collaborative problem solving ....................................................................................................... 26
Sample questions from the assessment unit: XANDAR® ...................................................................................................... 27
Appendix 2: Proficiency Levels ........................................................................................................................................... 32
Appendix 3: Technical notes ............................................................................................................................................... 33
A note on ethnicity ............................................................................................................................................................. 33
A note on socio-economic status .......................................................................................................................................... 33
Introduction

New Zealand is currently involved in several research projects that compare education between countries. These projects cover different year and age groups as well as different skills and areas of education. The Organisation for Economic Co-operation and Development (OECD) oversees the Programme for International Student Assessment (PISA), which is a three-yearly study assessing the science, mathematics and reading skills and knowledge of 15-year-old students.

New Zealand has been participating in PISA since 2000. Over 4,500 New Zealand students took part in PISA 2015, which included an assessment of their collaborative problem solving abilities and attitudes toward cooperation. Because this group was a representative sample of the 15-year-olds from throughout New Zealand, it reliably indicates patterns across the whole New Zealand population. The results of the study can help us identify where there may be differences between students of different genders, socio-economic groups, or ethnic backgrounds.

Studies like PISA cannot tell us what causes a certain result. However, they do provide helpful information and insight into how different aspects of students’ lives, background, and school context interact with student achievement. They also provide a reliable indication about the differences and similarities between education systems across countries. This helps policy makers and school leaders identify areas for potential development and ideas for innovation.

The assessment of collaborative problem solving in PISA 2015 was the first time that an international assessment attempted to measure students’ ability to solve problems collaboratively by working together with others and sharing understanding and effort to come to a solution.

One of the reasons why collaborative problem solving is important is that there is an ever-increasing demand for collaboration skills in modern workplaces. The skills for which there was the greatest increase in demand in the last decades of the 20th century were non-routine analytical skills (i.e. those involved in problem solving) and, to an even larger extent, non-cognitive (or social) skills, including collaboration skills.¹

Increasingly workplace opportunities will require New Zealand students when they leave school to be able to collaborate not only with the person physically next to them but also with others throughout the world. The ability to work productively, drive engagement, and demonstrate presence as a member of a virtual team has been identified as a key skill for the future workforce.² This may require people being able to form and maintain teams with people they do not know within very short time frames.

The importance of collaboration extends beyond the workplace. Not only are people using collaborative skills in the workplace, their interaction in other settings is also increasingly collaborative. When people interact with government agencies or social agencies they often do so in a collaborative manner, for example through family decision making around health needs. Initiatives for increasing citizen engagement in local and central government often require collaboration amongst interested parties to influence decision makers or the health system, or for restorative justice.

There are increasing opportunities for people to collaborate on education, social and leisure activities. Our students are already interacting collaboratively online through use of social media and other platforms. They organise group activities, participate in discussion groups, and collaborate on schoolwork or on leisure activities such as artistic or musical projects.

The good results from PISA 2015 show that New Zealand students generally have good collaborative problem solving skills compared to students from other countries. Students with these skills and competencies will be well placed to take advantage of the many opportunities they will be faced with in an evolving work environment with more demands to work together and manage team dynamics, and increasingly so in a global digital world.

Data in this report are sourced either from the OECD report PISA 2015 Results (Volume V): Collaborative Problem Solving or from the PISA 2015 database unless otherwise stated.

For more information about PISA or results from PISA 2015 go to the Education Counts website http://www.educationcounts.govt.nz/topics/research/pisa
Key findings

New Zealand students performed very well in the collaborative problem solving assessment (with a mean score of 533, well above the OECD average of 500). Only Singapore, Japan, and Hong Kong China had significantly higher average results.

New Zealand had one of the largest proportions of students that scored at the highest level of collaborative problem solving proficiency (only Singapore had a higher proportion).

New Zealand students perform better in collaborative problem solving than expected given their performance in science, reading, and mathematics in PISA 2015.

Girls outperformed boys in collaborative problem solving across the OECD by 29 points, and in New Zealand this difference was particularly large (41 points).

Within New Zealand, the average score for students who self-identified as Pākehā (549) or Asian (538) was well above the OECD average of 500. The average for students identifying as Māori (499) was around the OECD average, and for students identifying as Pasifika the average score (484) was below the OECD average.

As with the other PISA subjects, there was a large difference in collaborative problem solving achievement between students of high versus low socio-economic status as measured by PISA. Students in the bottom quarter of the PISA socio-economic index scored, on average, 76 points lower in collaborative problem solving than those in the top quarter.

Once performance in science, reading and mathematics was taken into account, there were no significant differences between the scores for students identifying as one ethnic grouping compared with those who do not identify with that group (e.g., Pākehā/non-Pākehā). In contrast, the difference between girls and boys remains large after accounting for performance in the three core subjects.

Students were asked about the value they placed on teamwork and relationships. Across the OECD and within New Zealand once student ability in science, reading and mathematics is taken into account, positive attitudes to collaboration were found to be positively associated with collaborative problem solving achievement.
What is collaborative problem solving?

Collaborative problem solving is how an individual works together with others to solve a problem, through establishing and maintaining shared understanding and team organisation.3

Collaborative problem solving competencies and processes

The PISA 2015 collaborative problem solving assessment evaluated students’ abilities across three competencies. These were:

Establishing and maintaining shared understanding

This involved a student’s ability to identify the knowledge and perspectives held by other group members, and to establish a shared vision of the problem solving activities, and the state of the problem at a given time including past actions and discussion, the present accumulated knowledge and perspectives, and possible future actions.

Taking appropriate action to solve the problem

Students needed to identify the type of collaborative problem solving-related activities that were needed to solve the problem, and carry out these activities to achieve the solution.

Establishing and maintaining team organisation

In the context of a team or group, students needed to understand their own role and the role of other agents, follow the rules of engagement for their own role, monitor group organisation, and facilitate the changes required to optimise performance or to handle obstacles, such as a breakdown in communication.

The above competencies are one of the features of the collaborative problem solving framework that distinguishes it from individual problem solving. The processes required for individual problem solving are still relevant for collaborative problem solving. These processes are:

» gathering information related to the problem
» representing the problem and the various relationships in the problem with tables, graphs, symbols or words
» devising a strategy to solve the problem and carrying out this strategy, and
» ensuring that the strategy has been followed and reacting to feedback obtained during the course of solving the problem.

3 The formal definition in 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.”
Assessing collaborative problem solving

Students in New Zealand and around the world completed the PISA 2015 collaborative problem solving assessment on computers. The problem solving teams consisted of the student plus at least one computer participant, who interacted via a chat box. Using computer agents rather than other students allowed the assessment to control responses and to vary the characteristics of the agents with whom students interacted. Computer participants could be cooperative or uncooperative.

PISA 2015 used several different types of collaborative problem solving tasks. An assessment unit might require students to move through more than one type of task.

In a jigsaw or hidden-profile task, each group member could have different information or possess different skills. Groups therefore needed to collaborate to identify then combine each member’s information and skills to solve the problem. Consensus-building tasks required a group to agree on a decision after considering the views, opinions, and arguments of all group members.

Finally, there were negotiation tasks in which not all group members shared the same individual goals. Groups needed to negotiate in order to achieve a best-case scenario that satisfied their individual goals and overall group goals.

Examples of these types of tasks can be found in Appendix 1.
New Zealand achievement in an international context

How well did New Zealand students perform in collaborative problem solving?

New Zealand students performed very well in collaborative problem solving. The average score (533 points) is well above the OECD average of 500 and only Singapore has a higher proportion of students at the highest level of proficiency in collaborative problem solving.

Figure 1.1 shows that only Singapore (561), Japan (552), and Hong Kong-China (541) had average scores significantly higher than New Zealand. New Zealand’s mean score did not significantly differ from Korea (538), Estonia (535), Canada (535), Finland (534), Macao-China (534), Australia (531) and Chinese Taipei (527). Forty-one countries had significantly lower scores than New Zealand.4

Proficiency levels describe the level of competency students have in collaborative problem solving tasks. Students performing at Level 4, the highest level, can maintain an awareness of group dynamics, ensure team members act in accordance with their agreed-upon roles, and resolve disagreements and conflicts while identifying efficient pathways and monitoring progress towards a solution. Students below Level 2 are only able to complete tasks with low problem difficulty and limited collaborative complexity (Level 1) or have only elementary skills (below Level 1). A summary description of all the proficiency levels are in the definitions and technical notes at the end of this report.5

In New Zealand, 16 percent of students scored at the highest proficiency level in collaborative problem solving, twice the OECD average. Only Singapore (21%) had a higher proportion.6 Four out of five New Zealand students (80%) score at Level 2 or above compared to the OECD average of 72 percent. The proportion of students performing at Level 1 or below (20%) is similar to Australia and Canada (countries with similar mean scores to New Zealand) and lower than the OECD average of 28 percent.

4 Eighteen other countries participated in PISA 2015 and were assessed in science, reading and mathematics but did not participate in the collaborative problem solving assessment. Of these only Vietnam had a higher average science score. All other countries (Albania, Algeria, Buenos Aires (Argentina), Dominican Republic, Former Yugoslav Republic of Macedonia, Georgia, Indonesia, Jordan, Kosovo, Lebanon, Malta, Moldova, Qatar, Romania, Trinidad and Tobago and the OECD countries Ireland and Poland) had a lower science score than New Zealand.

5 A full description is provided in PISA 2015 Assessment and Analytical Framework (revised) (OECD, 2017).

6 Other countries including Canada and Australia had a similar proportion to New Zealand.
Figure 1.1: Average scores and proficiency levels

Notes:
Countries and economies are ranked in descending order of the average country score. Standard errors are presented in parentheses.
* before country name denotes a non-OECD country/economy.
B-S-J-G (China) refers to the four participating China provinces: Beijing, Shanghai, Jiangsu, Guangdong.
Malaysia: Coverage is too small to ensure comparability.

<table>
<thead>
<tr>
<th>Country</th>
<th>Score</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>535</td>
<td>2.4</td>
</tr>
<tr>
<td>Australia</td>
<td>533</td>
<td>1.9</td>
</tr>
<tr>
<td>*Chinese Taipei</td>
<td>527</td>
<td>2.5</td>
</tr>
<tr>
<td>Germany</td>
<td>525</td>
<td>2.8</td>
</tr>
<tr>
<td>United States</td>
<td>520</td>
<td>3.6</td>
</tr>
<tr>
<td>Denmark</td>
<td>520</td>
<td>2.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>519</td>
<td>2.7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>518</td>
<td>2.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>510</td>
<td>3.4</td>
</tr>
<tr>
<td>Austria</td>
<td>509</td>
<td>2.6</td>
</tr>
<tr>
<td>Norway</td>
<td>502</td>
<td>2.5</td>
</tr>
<tr>
<td>Slovenia</td>
<td>502</td>
<td>1.8</td>
</tr>
<tr>
<td>Belgium</td>
<td>501</td>
<td>2.4</td>
</tr>
<tr>
<td>OECD average</td>
<td>500</td>
<td>0.5</td>
</tr>
<tr>
<td>Iceland</td>
<td>499</td>
<td>2.3</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>499</td>
<td>2.2</td>
</tr>
<tr>
<td>Portugal</td>
<td>498</td>
<td>2.6</td>
</tr>
<tr>
<td>Spain</td>
<td>496</td>
<td>2.1</td>
</tr>
<tr>
<td>*B-S-J-G (China)</td>
<td>496</td>
<td>4.0</td>
</tr>
<tr>
<td>*China</td>
<td>496</td>
<td>2.1</td>
</tr>
<tr>
<td>*Brazil</td>
<td>498</td>
<td>2.6</td>
</tr>
<tr>
<td>Vietnam</td>
<td>497</td>
<td>2.3</td>
</tr>
<tr>
<td>*Thailand</td>
<td>495</td>
<td>3.5</td>
</tr>
<tr>
<td>*Malaysia</td>
<td>495</td>
<td>3.3</td>
</tr>
<tr>
<td>*Costa Rica</td>
<td>492</td>
<td>2.4</td>
</tr>
<tr>
<td>*Brasil</td>
<td>489</td>
<td>2.3</td>
</tr>
<tr>
<td>*Israel</td>
<td>488</td>
<td>3.6</td>
</tr>
<tr>
<td>*Israel</td>
<td>488</td>
<td>3.6</td>
</tr>
<tr>
<td>*Italy</td>
<td>478</td>
<td>2.5</td>
</tr>
<tr>
<td>*Croatia</td>
<td>473</td>
<td>3.5</td>
</tr>
<tr>
<td>Hungary</td>
<td>472</td>
<td>2.4</td>
</tr>
<tr>
<td>Ireland</td>
<td>469</td>
<td>3.6</td>
</tr>
<tr>
<td>*Lithuania</td>
<td>467</td>
<td>2.5</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>463</td>
<td>2.5</td>
</tr>
<tr>
<td>Greece</td>
<td>459</td>
<td>3.6</td>
</tr>
<tr>
<td>Chile</td>
<td>457</td>
<td>2.7</td>
</tr>
<tr>
<td>*Cyprus</td>
<td>444</td>
<td>1.7</td>
</tr>
<tr>
<td>*Bulgaria</td>
<td>444</td>
<td>3.9</td>
</tr>
<tr>
<td>*Uruguay</td>
<td>443</td>
<td>2.3</td>
</tr>
<tr>
<td>*Costa Rica</td>
<td>441</td>
<td>2.4</td>
</tr>
<tr>
<td>*Malaysia</td>
<td>440</td>
<td>3.3</td>
</tr>
<tr>
<td>*Thailand</td>
<td>436</td>
<td>3.5</td>
</tr>
<tr>
<td>*United Arab Emirates</td>
<td>435</td>
<td>2.4</td>
</tr>
<tr>
<td>Mexico</td>
<td>433</td>
<td>2.5</td>
</tr>
<tr>
<td>*Colombia</td>
<td>429</td>
<td>2.3</td>
</tr>
<tr>
<td>Turkey</td>
<td>422</td>
<td>3.4</td>
</tr>
<tr>
<td>*Peru</td>
<td>418</td>
<td>2.5</td>
</tr>
<tr>
<td>*Montenegro</td>
<td>416</td>
<td>1.3</td>
</tr>
<tr>
<td>*Brazil</td>
<td>412</td>
<td>2.3</td>
</tr>
<tr>
<td>*Tunisia</td>
<td>382</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Countries scoring significantly above NZ: Singapore, China, Japan, Hong Kong (China).
Countries scoring significantly below NZ: China, Japan, Singapore.
How does a student’s performance in collaborative problem solving relate to their performance in the core PISA subjects?

The assessment of a non-traditional area such as collaborative problem solving is one of the innovative features of PISA 2015. However this has some challenges as in most cases there is no specific curriculum area across countries that deliberately aims to teach (and therefore assess) it as a subject. It is important to consider if collaborative problem solving is something that can be separated from other areas of knowledge and skills as a discrete standalone domain or if it is intrinsically linked to competence in the more traditional subjects.

One way to examine the relationship between collaborative problem solving and the other PISA subjects is a correlation analysis. This measures the strength of association between pairs of subjects. The results of this for New Zealand students show high correlations which indicate that students who do well in collaborative problem solving are also likely to do well in other subjects and vice versa. Similarly lower performing students in collaborative problem solving are also likely to be lower performing students in other subjects.7

The correlations of collaborative problem solving with science, reading and mathematics are generally lower than the correlations between each of science, reading and mathematics. This is an indication that collaborative problem solving is measuring something unique and different from the general cognitive skills required in the traditional subject areas.

Compared to other countries, top performing students in science, reading and mathematics in New Zealand are more likely to also be top performers in collaborative problem solving. For example, Table 1.1 shows that in New Zealand 72 percent of all-round top performers scoring at Level 5 or 6 in science, reading and mathematics, also scored at Level 4 in collaborative problem solving. This percentage of all-round top performers compares to the OECD average of 55 percent and was second only to the United States.

Low achievers in collaborative problem solving and in science, reading and mathematics were defined as students who scored below Level 2. In New Zealand, students with low performance in the core PISA subjects were less likely to have low performance in collaborative problem solving than students in other countries. For example, the proportion of students who were low performers in all of the three core PISA subjects and also low performers in collaborative problem solving was 78 percent in New Zealand compared to the OECD average of 83 percent.

Table 1.1: Top and low performing students

| Percentage of top performers in each subject that are also top performers in collaborative problem solving |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Science                                         | Reading                                         | Mathematics                                     | Science, reading and mathematics                  |
| New Zealand                                     | 61                                              | 56                                              | 56                                              | 72                                              |
| OECD average                                    | 44                                              | 39                                              | 34                                              | 55                                              |

| Percentage of low performers in each subject that are also low performers in collaborative problem solving |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Science                                         | Reading                                         | Mathematics                                     | Science, reading and mathematics                  |
| New Zealand                                     | 68                                              | 67                                              | 56                                              | 78                                              |
| OECD average                                    | 74                                              | 74                                              | 67                                              | 83                                              |

7 The reverse is also true in that lower performing students in the core PISA subjects are also likely to be lower performing students in collaborative problem solving.
Overall, the findings for top and low performers reveal that New Zealand students at a particular level of proficiency in reading, mathematics or science were more likely to do as well, if not better, on collaborative problem solving than their counterparts with similar levels of proficiency in other countries.

The OECD suggest that for New Zealand along with the United States, Australia, Singapore, Canada and the United Kingdom, “the development of collaborative problem solving skills in these countries is more strongly linked to the development of science, reading and mathematics literacy”.

### Relative performance in collaborative problem solving

Calculating students’ collaborative problem solving scores in a way that accounts for their performance in science, reading and mathematics is one way of exploring and teasing out the independence of collaborative problem solving. At a country level this provides a score relative to a country’s performance in science, reading and mathematics.

On this measure, countries with positive values did better on collaborative problem solving than their average scores in science, reading and mathematics would predict. New Zealand students scored, on average, 20 points higher than would be expected in the collaborative problem solving assessment given their performance in science, reading and mathematics. This score is not significantly different from the highest relative country scores for the United States (22 points), Korea (20 points), Australia (23 points) and Japan (23 points). See Figure 1.2.

These findings would also suggest that as a country, New Zealand does better than most countries in developing collaborative problem solving skills over and above the development of science, reading and mathematics literacy.

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8 PISA 2015 Results (Volume V): Collaborative Problem Solving (OECD, 2017)
9 More technically, this is the residual score of a linear regression of performance in collaborative problem solving over performance in science, reading and mathematics.
Notes: A student’s relative performance in collaborative problem solving is defined as the residual obtained upon an ordinary least-squares regression of the student’s performance in collaborative problem solving over his or her performance in science, reading and mathematics. The regression is performed at an international level, pooling data from all countries and economies that participated in the collaborative problem solving assessment.

Countries and economies are ranked in descending order of the relative performance in collaborative problem solving.

* before country name denotes a non-OECD country/economy

B-S-J-G (China) refers to the four participating China provinces: Beijing, Shanghai, Jiangsu, Guangdong.

Malaysia: Coverage is too small to ensure comparability.
ICT and collaborative problem solving

The PISA 2015 collaborative problem solving assessment was administered in a computer-based format. The extent to which students use and are comfortable with computers and digital devices may therefore have affected their performance in the collaborative problem solving assessment compared to their performance if a similar test were conducted without the use of computers.

In New Zealand and across the OECD, increased usage of computers at school does not always mean higher collaborative problem solving achievement. In fact, the quarter of students who used computers at school the most scored lower, on average, than other students.¹⁰

While there was a positive relationship with student self-reported competency in ICT for New Zealand and the OECD, once student performance in science, reading and mathematics was accounted for there was no observable relationship. The OECD conclude “the collaborative aspects of this assessment show little relationship to students’ comfort with ICT.”¹¹

¹⁰ Within a country, students with a relatively moderate use at school had the highest average collaborative problem solving score.
¹¹ PISA 2015 Results (Volume V): Collaborative Problem Solving (OECD, 2017)
Achievement of different groups

This section looks at the collaborative problem solving performance of different groups of the New Zealand population. In particular the performance of boys and girls, Māori, Pasifika, Asian, Pākehā/European, and of different socio-economic groups of students.\(^\text{12}\)

Collaborative problem solving performance with gender and ethnic groups

On average, girls consistently outperformed boys in the collaborative problem solving assessment across the OECD. In New Zealand, the difference between the performance of girls and boys was particularly high. New Zealand girls scored an average of 553 points in collaborative problem solving compared to the average score for boys of 513 points. This difference of 41 points\(^\text{13}\) was one of the largest among participating countries.\(^\text{14}\)

New Zealand also collects information relating to ethnic groups within our population. While the performance of girls and boys can be compared internationally, results relating to ethnicity can only be considered within the New Zealand context. Additionally, 17 percent of New Zealand students reported more than one ethnicity, meaning these groups cannot be compared directly with each other as students can appear in more than one group. Table 2.1 lists the average score of each group. The group of students who included Māori identity in their response scored 499 in collaborative problem solving (essentially the same as the OECD average of 500). Students who included a Pasifika identity in their response scored 484 points, which was significantly lower than the OECD average. Students including an Asian (538 points) or Pākehā (549 points) identity scored significantly above the OECD average.

Table 2.1: Average score by gender and by ethnic group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean score with standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>513 (3.2)</td>
</tr>
<tr>
<td>Girls</td>
<td>553 (3.0)</td>
</tr>
<tr>
<td>Māori</td>
<td>499 (4.8)</td>
</tr>
<tr>
<td>Pākehā</td>
<td>549 (2.6)</td>
</tr>
<tr>
<td>Pasifika</td>
<td>484 (6.1)</td>
</tr>
<tr>
<td>Asian</td>
<td>538 (5.4)</td>
</tr>
</tbody>
</table>

Note: Average scores for ethnic groups cannot be compared with each other as 17% of New Zealand students reported more than one ethnicity, meaning those students will appear in more than one of the above groups.

12 See Appendix 3 for technical notes on ethnicity and socio-economic status.
13 Any apparent inconsistencies are due to rounding.
14 The New Zealand difference was not significantly different from Australia (41 points), Sweden (42 points) and Finland (48 points).
Another way to describe the performance of girls and boys in New Zealand is to look at the percentage of students at each of the collaborative problem solving proficiency levels (See Figure 2.1). The differences in performance for boys and girls were more marked at the upper and lower levels of proficiency. Twenty percent of girls were top performers, achieving at Level 4 or above, compared to 12 percent of boys, and 13\textsuperscript{th} percent of girls achieved at Level 1 or below, compared to 26 percent of boys.

**Figure 2.1: Proficiency levels for gender and for ethnic groups**

Figure 2.1 also shows these proportions for Asian, Māori, Pākehā and Pasifika students, along with the New Zealand average. Scoring at Level 3 or above means that a student has scored at least 540 points in collaborative problem solving, compared with the New Zealand average score of 533. Students at this level can complete tasks with complex problem and collaboration demands. They can integrate multiple pieces of information, and help team members negotiate solutions to conflicts. For the group of students identifying as Māori, over a third score at Level 3 or above, with 30 percent of Pasifika students attaining this level. More than half of students who included Pākehā or Asian identities score at Level 3 or above.

The differences are more pronounced at the lower and upper levels of proficiency. Scoring at or below Level 1 means a student has less than 440 score points. Students who attain Level 1 can complete collaborative problem solving tasks with low problem complexity and less collaboration complexity, and can find solutions to the given problem with support from team members. Approximately 15\textsuperscript{th} percent of Pākehā students scored at or below Level 1, with 18 percent of Asian students at this level, below the New Zealand average of 20 percent. The proportion of Māori students who scored at or below Level 1 was 29 percent, with just over a third of Pasifika students scoring at this level.

\textsuperscript{15} Any apparent inconsistencies are due to rounding.

\textsuperscript{16} Any apparent inconsistencies are due to rounding.
Collaborative problem solving performance and socio-economic groups

The relationship between socio-economic status and performance is not as strong for collaborative problem solving as it is for science, reading, and mathematics. For example, socio-economic status of students and schools in New Zealand, as measured by the PISA Index of Economic, Social and Cultural Status (ESCS), explains less of the variation in performance in collaborative problem solving than in the other PISA subjects.\(^{17}\)

<table>
<thead>
<tr>
<th>Table 2.2: Variance in student performance explained by student and school ESCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage variance in student performance explained by the student and school ESCS index(^{18})</strong></td>
</tr>
<tr>
<td>Collaborative problem solving</td>
</tr>
<tr>
<td>New Zealand</td>
</tr>
<tr>
<td>OECD average</td>
</tr>
</tbody>
</table>

Despite the relationship between collaborative problem solving and socio-economic status not being as strong as in the core PISA subjects there is still a large difference in collaborative problem solving performance between students in the top quarter and the bottom quarter of the PISA index of measure of socio-economic status. Table 2.3 shows that students in the bottom quarter of ESCS in New Zealand scored, on average, 76 points lower in collaborative problem solving than students in the top quarter.

<table>
<thead>
<tr>
<th>Table 2.3: Student performance by quarters of the PISA Index of ESCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average collaborative problem solving score with standard error</strong></td>
</tr>
<tr>
<td><strong>Difference between top and bottom quarter</strong></td>
</tr>
<tr>
<td>OECD average</td>
</tr>
<tr>
<td>New Zealand</td>
</tr>
</tbody>
</table>

Notes: Standard errors are in parentheses.

\(^{17}\) This analysis includes variance explained by school average ESCS and hence explains more of the variance than that reported in PISA 2015: New Zealand Summary Report (Ministry of Education, 2016).

\(^{18}\) See Appendix 3 for a technical note on socio-economic status.
Another way to look at performance across different levels of socio-economic status is to compare the proportion of students at the proficiency levels of collaborative problem solving. In New Zealand, 11 percent of students in the top quarter of ESCS scored below Level 2, compared with 29 percent of students in the bottom quarter of ESCS. Twenty-six percent of students in the top quarter of ESCS reached Level 4 compared with only eight percent of students in the bottom quarter of ESCS.

These large differences between the top and bottom quarters of ESCS for the average score, and the proportion of top and low achievers have been seen in the core PISA subject areas of science, reading and mathematics over many years.

**Figure 2.2:** Proportion of New Zealand students at proficiency levels by student quarters of the PISA Index of Economic, Social and Cultural Status
Collaborative problem solving: differences in relative performance

The comparison of collaborative problem solving performance between boys and girls, or between socio-economic groups, may merely be reflecting underlying achievement levels or other factors. One way to examine this is to calculate the relative score difference. This enables us to identify how gender or socio-economic status may be related to the unique aspects of collaborative problem solving independent of performance in science, reading and mathematics. However the OECD report that this type of analysis has notable limitations and as such it is more exploratory than descriptive.

Are the differences between girls and boys or between Māori and non-Māori in collaborative problem solving due to their differences on the core PISA subjects?

On the core PISA subjects New Zealand boys did slightly better than girls did in mathematics. There was no significant difference in science, but girls did much better than boys in reading. However when the performance in the core PISA subjects is taken into account, girls still outperformed boys (by 39 score points) on the relative score in collaborative problem solving, meaning that the difference between boys’ and girls’ collaborative problem solving scores (41 score points) cannot be accounted for by girls’ higher performance in reading. This gender difference for New Zealand in relative performance in collaborative problem solving is the largest among the participating countries (see Figure 2.3).

Figure 2.3: Gender differences in relative performance in collaborative problem solving

Note: Countries and economies are ranked in descending order of the score-point difference in relative performance in collaborative problem solving.

* before country name denotes a non-OECD country/economy
B-S-J-G (China) refers to the four participating China provinces: Beijing, Shanghai, Jiangsu, Guangdong.
Malaysia: Coverage is too small to ensure comparability.
Table 2.4 shows the relative score point difference between students that identify with an ethnic group and those who do not identify with that group. The score point difference in their collaborative problem solving scores provides a point of comparison.

### Table 2.4: Collaborative problem solving score point difference and relative score point difference for ethnic groups

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Score point difference in collaborative problem solving</th>
<th>Relative score point difference accounting for science, reading and mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Māori/non-Māori</td>
<td>-44 (5.4)</td>
<td>6 (4.2)</td>
</tr>
<tr>
<td>Pākehā/non-Pākehā</td>
<td>49 (4.5)</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Pasifika/non-Pasifika</td>
<td>-57 (6.4)</td>
<td>6 (3.6)</td>
</tr>
<tr>
<td>Asian/non-Asian</td>
<td>4 (5.6)</td>
<td>-6 (3.7)</td>
</tr>
</tbody>
</table>

**Note:** Ethnic groups cannot be compared with each other as 17% of New Zealand students reported more than one ethnicity, meaning those students will appear in more than one of the above groups. Statistically significant differences are in bold. Standard errors are in parentheses.

The relative score point differences indicate that no ethnic grouping does better or worse than expected given their achievement in science, reading and mathematics.

In summary the relative score point difference for boys and girls indicates that there is a difference in performance over and above their differences in the core PISA subjects whereas it appears the differences for ethnic groupings are reflecting their differences in the core subjects.
Attitudes to collaboration

Students were asked about the value they placed on teamwork and relationships. Across the OECD and within New Zealand once student ability in science, reading and mathematics is taken into account, positive attitudes to collaboration were found to be positively associated with collaborative problem solving achievement.

Attitudes

Students were asked about the value they placed on relationships through their level of agreement with the following four statements:

» I enjoy seeing my classmates be successful.
» I enjoy considering different perspectives.
» I take into account what others are interested in.
» I am a good listener.

Similarly, the value placed on teamwork was measured through agreement with these four statements:

» I prefer working as part of a team to working alone.
» I enjoy co-operating with peers.
» I find that teams make better decisions than individuals.
» I find that teamwork raises my own efficiency.

19 Students were asked whether they strongly agree, agree, disagree or strongly disagree with the statements.
Figure 3.1 shows that agreement with statements about valuing relationships was positively related to collaborative problem solving achievement whereas valuing teamwork was generally negatively related to collaborative problem solving.

Figure 3.2 shows that the relative performance (accounting for performance in science, reading and mathematics) reduces the difference between the groups for valuing relationships, and reverses the relationship with valuing teamwork.
Figure 3.2: Attitudes towards collaboration and relative performance in collaborative problem solving

The relationship of these statements with collaborative problem solving achievement is complicated. Students with lower academic achievement (as measured by their score on the PISA science, reading and mathematics assessment) are more likely than their higher achieving peers to agree with statements about the value of teamwork. This may be because lower achieving students perceive more personal benefit from teamwork where they may be able to complete tasks in collaboration that they would otherwise struggle with unassisted.

However, for students in New Zealand and across the OECD, once their achievement in science, reading and mathematics is taken into account, positive attitudes to collaboration were found to be positively associated with collaborative problem solving achievement. In other words, for two students of similar academic achievement, the one who has positive attitudes to collaboration (valuing relationships and valuing teamwork) is more likely to score higher on the collaborative problem solving assessment than the one who does not.
Further information on PISA Collaborative Problem Solving

This report accompanies the release of the international report *PISA 2015 Results (Volume V): Collaborative Problem Solving* (OECD, 2017) and provides a summary of collaborative problem solving achievement findings including NZ specific analysis.

In addition to the analysis of the achievement and the attitudes described in this report, the OECD report provides further and more in-depth analysis.

This includes an exploration of how other student and school factors relate to collaborative problem solving, relative collaborative problem solving and to collaborative problem solving attitudes. These factors include a range of student activities that may be related to student achievement in collaborative problem solving as well as the impact of positive relationships among students, teachers, principals, parents and the wider community.

In general factors that relate to the students themselves have a stronger relationship than factors at a school level. However the OECD advise some caution in interpretation as the direction of causality is unclear.

In addition analysis of the relative performance with these student and school factors is non-significant for many factors but this may be due to accounting for science, reading and mathematics resulting in an overcorrection for cognitive skills.

This international report and others in the series as well as further information on PISA in an international context can be found on the OECD PISA webpage [www.oecd.org/pisa/](http://www.oecd.org/pisa/).

Further information from PISA 2015 is also available from the Ministry of Education, Education Counts website at: [www.educationcounts.govt.nz/goto/pisa](http://www.educationcounts.govt.nz/goto/pisa)
References and further reading

https://doi.org/10.1162/003355303322552801


http://dx.doi.org/10.1787/9789264281820-en

Appendix 1: Assessing collaborative problem solving

Students in New Zealand and around the world completed the PISA 2015 collaborative problem solving assessment on computers. The problem solving teams consisted of the student plus at least one computer participant, who interacted via a chat box. Using computer agents rather than other students allowed the assessment to control responses and to vary the characteristics of the agents with whom students interacted. Computer participants could be cooperative or uncooperative. Most actions in the assessment required the student to select one out of four possible responses to engage in conversation with the computer agents; others required the students to complete some aspect of the task using information gathered with the computer participants.

PISA 2015 used several different types of collaborative problem solving tasks. An assessment unit might require students to move through more than one type of task.

In a jigsaw or hidden-profile task, each group member could have different information or possess different skills. Groups therefore needed to collaborate to identify then combine each member’s information and skills to solve the problem.

Consensus-building tasks required a group to agree on a decision after considering the views, opinions, and arguments of all group members.

Finally, there were negotiation tasks, in which not all group members shared the same individual goals. Groups needed to negotiate in order to achieve a best-case scenario that satisfied their individual goals and overall group goals.
Sample questions from the assessment unit: XANDAR

In the XANDAR unit, students joined a team with two computer agents to take part in a contest answering questions about the fictional country of Xandar. The full unit required students to complete fourteen questions across four tasks involving decision-making, coordination, and consensus-building collaboration.

**Figure A.1: Xandar; Introduction**

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18 A fuller description of this unit is available in PISA 2015 Results (Volume V): Collaborative Problem Solving.

19 A unit is a group of tasks based around related texts or pictures or graphs or similar (stimuli).
Xandar: Task 1 – Agreeing on a strategy

In the first question, students joined a chat with the computer agents Alice and Zach. The second question required them to reach consensus about how to proceed. Throughout this task, Alice suggests a collaborative plan, while Zach promotes an individual strategy that does not take into account the collaborative aspect of the contest. The questions in the first Xandar task primarily evaluate the establishing and maintaining shared understanding collaborative problem solving competency. In this question, the scored answer (highlighted in blue in the figure below) is the one that moves toward a collaborative team approach.

Figure A.2: Xandar: Task 1
Xandar: Task 2 – Reaching a consensus regarding preferences

Task 2 begins with a disagreement that requires resolution to proceed and evaluates the establishing and maintaining team organisation collaborative problem solving competency. The scored answer is the one that gets the team closer to a decision, using the information provided by Alice and Zach to assign the subject “People” and resolve the disagreement.

Figure A.3: Xandar: Task 2
Xandar: Task 3 – Playing the game effectively

At the beginning of Task 3, the subjects have been assigned and the student’s subject area is “Geography”. Task 3 involves answering questions about Xandar’s geography using the map. The next question assesses establishing and maintaining shared understanding; one of the computer agents immediately answers a question in the Geography category assigned to the student before the student has time to answer. The scored answer is the one that keeps to the previously-agreed rules of engagement; that the student will answer Geography questions and their teammates will each keep to their own assigned topics.

After this is resolved, the student continues answering the questions about Xandar.
Xandar: Task 4 – Assessing progress

The question below assesses the competency taking appropriate action to solve the problem. The scored answer is the one that best answers Alice’s question about progress. Regardless of the response, Zach will tell the team that he is having trouble with the question, providing an opportunity to offer encouragement and assistance.

The unit finishes with a screen informing the students that they were successful in answering all the questions correctly in time to win the contest.
# Appendix 2: Proficiency Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Score range</th>
<th>What students can typically do</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Equal to or higher than 640 score points</td>
<td>At Level 4, students can successfully carry out complicated problem solving tasks with high collaboration complexity. They can solve complex problems with multiple constraints, keeping relevant background information in mind. These students maintain an awareness of group dynamics and take actions to ensure that team members act in accordance with their agreed-upon roles. At the same time, they can monitor progress towards a solution and identify obstacles to overcome or gaps to be bridged. Level 4 students 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.</td>
</tr>
<tr>
<td>3</td>
<td>540 to less than 640 score points</td>
<td>At Level 3, students can complete tasks with either complex problem solving requirements or complex collaboration demands. These students can perform multi-step tasks that require integrating multiple pieces of information, often in complex and dynamic problems. They orchestrate roles within the team and identify information needed by particular team members to solve the problem. Level 3 students 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.</td>
</tr>
<tr>
<td>2</td>
<td>440 to less than 540 score points</td>
<td>At Level 2, students can contribute to a collaborative effort to solve a problem of medium difficulty. They can help solve a problem by communicating with team members about the actions to be performed. They can volunteer information not specifically requested by another team member. Level 2 students 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 students can request additional information required to solve a problem and solicit agreement or confirmation from team members about the approach to be taken. Students near the top of Level 2 can take the initiative to suggest a logical next step, or propose a new approach, to solve a problem.</td>
</tr>
<tr>
<td>1</td>
<td>340 to less than 440 score points</td>
<td>At Level 1, students can complete tasks with low problem complexity and limited collaboration complexity. They can provide requested information and take actions to enact plans when prompted. Level 1 students 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 students can help find a solution to the given problem.</td>
</tr>
</tbody>
</table>
Appendix 3: Technical notes

A note on ethnicity

When New Zealand undertakes this kind of research, students are free to identify with as many of the different ethnic groups as they wish. No priority is given to any one of the student’s choices in the analysis of the findings. This means that when looking at results by ethnicity, an individual student can, and does, ‘count’ in more than one group. For example, a student who identified as Māori and Asian would be included in any analysis for Māori students and any analysis for Asian students.

This approach means that the results for each ethnic grouping cannot be directly compared to each other (e.g. Māori cf. Pasifika, or Asian cf. Pākehā). If we did do this, students’ responses would be counted multiple times and students who chose more than one ethnic grouping would effectively be compared to themselves. However, students who identify as a particular group can be compared to all those who did not. For example, those who identified as only Māori or Māori and another grouping can be compared to those students who did not identify as Māori at all. This way each student would only ‘count’ once. Comparisons on ethnicity are therefore limited to one group compared to everyone not identifying with that ethnicity (e.g. Māori cf. non-Māori, Pākehā cf. Non-Pākehā).

A note on socio-economic status

Socio-economic status is a measure of the social and economic resources of an individual or group of individuals. It is often measured as a combination of education, occupation and income or wealth. The measure can be used to help understand differences between social and economic groups in society.

In the PISA assessment, a student’s socio-economic status is estimated by the PISA Index of Economic, Social and Cultural Status (ESCS). This index is based on information about the level of parents’ education and occupation, the number of home possessions that can be considered as material wealth, and the educational resources available at home. Students are classified as socio-economically advantaged if their values on the ESCS index are among the top 25 percent in their country or economy. They are classified as socio-economically disadvantaged if their values on the ESCS index are among the bottom 25 percent.
Participants in PISA 2015

- Albania
- Algeria
- Argentina
- Australia
- Austria
- Belgium
- Brazil
- B-S-J-G (China)
- Bulgaria
- Canada
- Chile
- Chinese Taipei
- Colombia
- Costa Rica
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Dominican Republic
- Estonia
- Finland
- France
- Germany
- Georgia

- Greece
- Hong Kong (China)
- Hungary
- Iceland
- Indonesia
- Ireland
- Israel
- Italy
- Japan
- Jordan
- Kazakhstan
- Korea
- Kosovo
- Latvia
- Lebanon
- Lithuania
- Luxembourg
- Macao (China)
- FYR Macedonia
- Malaysia
- Malta
- Mexico
- Moldova
- Montenegro

- Netherlands
- New Zealand
- Norway
- Peru
- Poland
- Portugal
- Qatar
- Romania
- Russian Federation
- Singapore
- Slovak Republic
- Slovenia
- Spain
- Sweden
- Switzerland
- Thailand
- Trinidad & Tobago
- Tunisia
- Turkey
- United Arab Emirates
- United Kingdom
- United States
- Uruguay
- Vietnam

* non-OECD countries and economies
B-S-J-G (China) refers to the four participating China provinces: Beijing, Shanghai, Jiangsu, Guangdong.
FYR Macedonia refers to the Former Yugoslav Republic of Macedonia.
We shape an education system that delivers equitable and excellent outcomes