Learning for the Future:
The performance of 15-Year-olds in Ireland on reading literacy, science and mathematics in PISA 2018

Caroline McKeown, Sylvia Denner,
Sarah McAteer and Gerry Shiel,
with Lynsey O'Keeffe

Educational Research Centre

December 2019

Learning for the Future: The performance of 15-Year-olds in Ireland on reading literacy, science and mathematics in PISA 2018

Caroline McKeown, Sylvia Denner,
Sarah McAteer and Gerry Shiel,
with Lynsey O'Keeffe

Educational Research Centre

December 2019

http://www.erc.ie

Cataloguing-in-publication data:

McKeown, Caroline.

Learning for the Future: The Performance of 15-year-olds in Ireland
on Reading Literacy, Science and Mathematics in PISA 2018 /
Caroline McKeown, Sylvia Denner, Sarah McAteer, and Gerry Shiel, with Lynsey O'Keeffe.

Dublin: Educational Research Centre

xx, 189p., 30cm

ISBN: 978-0-900440-82-3 (print)

ISBN: 978-0-900440-81-6 (e-Report)

1. Programme for International Student Assessment (Project)
2. Science (Secondary) – Ireland
3. Reading (Secondary) – Ireland
4. Mathematics (Secondary) – Ireland
5. Academic achievement
6. Educational surveys – Ireland

Issue I (revised for print, February 2020)

I Title. II Denner, Sylvia. III McAteer, Sarah. IV Shiel, Gerry. V O'Keeffe, Lynsey.

371.262

Printed in the Republic of Ireland by Naas Printing Limited, Naas, Co. Kildare.

Contents

List of Tables

Back to Contents

List of Figures

Preface

The Programme for International Student Assessment (PISA) is an assessment of the skills and knowledge of 15-year-olds in reading literacy, science and mathematics. It is a study of the Paris-based Organisation for Economic Cooperation and Development (OECD). PISA has taken place every three years since 2000, with PISA 2018 the seventh cycle. In each cycle, one domain is the major domain of assessment, and the remaining two areas are assessed as minor domains. Reading literacy was the major assessment domain in 2018, with science and mathematics assessed as minor domains.

The 2018 cycle of PISA is the second full-administration of the study on computer. PISA 2015 saw the transition to computer-based assessment for about 50 participating countries, including all OECD countries. In 2018, 79 countries participated and 70 countries administered the assessment on computer. PISA 2018 builds on changes in the design and methodology of earlier cycles, and includes for the first time adaptive testing for reading literacy and machine-supported scoring with automatic coding of exact match student responses in reading literacy, science and mathematics.

PISA 2018 was administered in 79 countries, including 37 OECD countries. Tests and questionnaires were completed by over 600,000 students worldwide. In Ireland, 5,577 students in 157 schools took part. In Ireland, PISA is implemented by the Educational Research Centre, on behalf of the Department of Education and Skills.

An international consortium, led by Educational Testing Service (ETS) in the United States, was responsible for the implementation of PISA. ETS took over from the Australian Council for Educational Research (ACER) in the 2015 cycle.

The OECD has published an assessment framework (2019a), and a technical report is also expected to be released in early 2020 (OECD, 2020, in press). Three volumes on the main outcomes of PISA 2018 will be published in line with the launch of the results: *PISA 2018 Results (Volume 1): What students know and can do* (OECD, 2019d), *PISA 2018 Results (Volume 2): Where all students can succeed* (OECD, 2019e), and *PISA 2018 Results (Volume 3): What school life means for students' lives (OECD, 2019f)*.

This report is divided up into seven chapters. Chapter 1 provides an overview of PISA 2018 and describes its implementation in Ireland. Chapter 2 outlines the research and policy context of PISA 2018 in Ireland. Chapters 3-5, for reading literacy, science and mathematics respectively, summarise student performance in 2018, link performance with key variables (e.g., gender, socio-economic status), and describe trends over recent cycles of PISA. Chapter 6 examines selected key findings from the PISA questionnaires, including student reading engagement and use of reading strategies, use of digital technology for teaching and learning, and aspects of student well-being in PISA 2018. Where relevant, these findings are reported in relation to student performance on reading literacy. The final chapter comprises conclusions based on PISA 2018 and a look ahead to PISA 2021.

This national report will be followed by a series of short thematic reports in 2020 and 2021 on digital technology, reading literacy, student well-being and the performance of students in DEIS schools in PISA.

Acknowledgements

We gratefully acknowledge the contributions and advice of the National Advisory Committee (see Appendix A for a list of members), who provided guidance and feedback throughout the development and implementation of PISA 2018 in Ireland. In particular, we acknowledge the help and support of the members of the Inspectorate chairing the committee – Suzanne Dillon (until August 2019) and Orlaith O'Connor (from September 2019).

We would like to thank all those involved in implementing the PISA 2018 Field Trial in spring 2017, and the Main Study in spring 2018. These include: the principal teachers, school contact persons and administrative staff who facilitated the involvement of their schools in PISA; and the members of the Inspectorate and the retired inspectors, principals and teachers who administered PISA in schools; Ruth Richards of the Inspectorate who helped with the organisation of training sessions for test administrators and with the organisation of PISA in schools; the technical support persons who ensured that the laptops were ready for testing and in good working order at all times; students' parents who completed a Parent Questionnaire for the second time as part of PISA; and last, but not least, the students who completed the assessments, without whom PISA would not be possible. The Main Study in PISA 2018 was a particularly challenging period for schools, teachers, students and their families with the disruption caused by Storm Emma, and we acknowledge their commitment to the PISA study in facilitating rescheduled test dates in their schools.

Thanks are due to current staff at the Educational Research Centre who were pivotal in the administration of the study and worked closely on all aspects, including Gerry Shiel, Sylvia Denner, Sarah McAteer, and Lynsey O'Keeffe. Thanks are also due to Mary Delaney for her work as a regional coordinator in the 2018 Main Study. Also, a special thank you to David Millar for his advice on sampling and to former CEO, Peter Archer, who provided guidance throughout the study. Thanks to the current CEO Jude Cosgrove for her advice and support throughout the reporting of the study, and to a former staff member, Robyn Mulligan, who was involved in the implementation of the PISA 2018 Field Trial.

Thanks are due to Paula Chute, Seán Close, Brenda Donohue, Emer Delaney, Rachel Perkins, Rachel Cunningham and Adrian O'Flaherty for their help with various aspects of the implementation of PISA 2018. Thanks are also due to Anne Comey, Patricia Gaffney, Lynn Jackson and Imelda Pluck for their administrative input and assistance.

Thanks to the international consortium (led by Educational Testing Service) for their coordination and leadership throughout the 2018 cycle in developing the materials, supporting the administration of the study and processing and scaling the data for PISA in all 79 participating countries. Thanks to the Organisation of Economic Cooperation and Development Secretariat for their oversight and management of the study, along with the PISA Governing Board.

Caroline McKeown, December 2019

PISA 2018 national team

Caroline McKeown: National Project Manager
Sylvia Denner: National Data Manager
National Team: Sarah McAteer, Lynsey O'Keeffe, Mary Delaney, and Gerry Shiel.

Acronyms and Abbreviations

ACER	Australian Council for Educational Research
CBA	Computer-based Assessment
CES	Centre for Effective Services
DCYA	Department of Children and Youth Affairs
DEIS	Developing Equality of Opportunity in Schools
DES	Department of Education and Skills
DIF	Differential Item Functioning
DLF	Digital Learning Framework
ECCE	Early Childhood Care and Education (Scheme)
ERC	Educational Research Centre
ESCS	Economic, Social and Cultural Status
ETB	Educational and Training Board
ETS	Educational Testing Service
FT	Field Trial
GPCM	Generalised Partial Credit Model
ICT	Information and Communication Technology
HBSC	Health Behaviour in School-aged Children
IRT	Item Response Theory (Scaling)
JCPA	Junior Cycle Profile of Achievement
MS	Main Study
MSAT	Multi Stage Adaptive Testing
NAEP	National Assessment of Educational Progress (US)
NCCA	National Council for Curriculum and Assessment
OECD	Organisation of Economic Cooperation and Development
PBA	Paper-based Assessment
PDST	Professional Development Service for Teachers
PIAAC	Programme for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
SEC	State Examinations Commission
SSE	School Self-Evaluation
SSP	School Support Programme
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TPL	Teachers' Professional Learning
UNESCO	United Nations Educational, Scientific and Cultural Organisation
2PL	2 Parameter Logistic (Model)

Executive Summary

The Programme for International Student Assessment (PISA) is a project of the Organisation for Economic Cooperation and Development (OECD), of which Ireland is a member. PISA, which has taken place every three years since 2000, assesses the preparedness of 15-year-olds to meet the challenges they may encounter in their future lives, including education (OECD, 2019a). In 2018, over 600,000 15-year-olds in 79[1] countries/economies, including all 37 OECD countries, took part in PISA. In Ireland, 5,577 students in 157 schools took part. Reading literacy was the major assessment domain in 2018, with science and mathematics assessed as minor domains. In Ireland, PISA is implemented by the Educational Research Centre, on behalf of the Department of Education and Skills.

Throughout the Executive Summary, reference is made to targets in the *Action Plan for Education 2016-2019* (DES, 2016). The targets relate to student performance on PISA below Proficiency Level 2 (low-performing students) and at or above Proficiency Level 5 (high-performing students), to be achieved by 2025. As the Action Plan targets were set before the transition to computer-based assessment in PISA 2015, and significant revisions are made to the framework and test content for each domain every third cycle, consideration may need to be given to the relevance of those targets looking forward. It may also be prudent to consider the relative proximity of the performance of students in Ireland to each target, taking measurement error into account.

In the Executive Summary, and in the Main Report, comparisons are made using a selection of participating countries/regions based on their performance on reading literacy. Selected comparator countries are: Singapore, Estonia, Canada, Finland, Korea, Poland, Sweden, New Zealand, United Kingdom, United States, and Northern Ireland. The same set of countries comprises the comparison group for science and mathematics.

Changes to PISA in 2018

PISA 2018 was the second full administration on a computer-based platform. Following on from the mode and design changes in 2015, several changes were incorporated into the design and administration of PISA in 2018, along with the revisions to the reading literacy framework.

The incorporation of a test of reading fluency into PISA 2018, where students were asked to mark as many sentences as possible as 'true' or 'false' within a specified period of time, was designed to provide a better measure of performance among students scoring at or below the lowest levels of proficiency. Adaptive testing was integrated into the assessment of reading literacy, to provide increased accuracy in reporting scores at either end of the score distribution (below Level 1b and at Levels 4, 5 and 6). Machine-scoring of some open-ended responses was incorporated across the three domains, based on the scores awarded in the PISA 2015 Main Study and PISA 2018 Field Trial, to increase efficiency and accuracy in the scoring phase of the study.

1 While 79 countries/regions participated in PISA 2018, reference is made to 78 countries/economies in reporting; full international comparability of results for Vietnam could not be assured at the time this report was published.

Implementation of PISA 2018 in Ireland

In Ireland, the PISA Main Study was carried out in March and April 2018. A representative sample of 157 schools in Ireland was selected to participate in PISA 2018, with all 157 schools participating, giving a school response rate of 100%. Within each school, up to 44 students aged 15 years (those born in 2002) were selected to participate, and were divided into two test sessions of up to 22 students. In total, 5,577 students participated in the assessment, yielding a weighted student response rate of 86.5%, with students spread over five year levels: First/Second Year (1.9%), Third Year (61.6%), Transition Year (27.9%) and Fifth Year (8.5%). Of participating students, 49.8% were female, and 50.2% were male (weighted percentages).

As was the case in PISA 2015, PISA 2018 was administered solely on laptops hired and transported to schools for the assessment by technical support persons, with Department of Education and Skills Inspectors acting as lead test administrators, alongside 24 support test administrators (mainly retired Inspectors and principals).

Students sat a 2-hour test session, followed by a 55-minute questionnaire session on the laptops. Parents of participating students were asked to complete a paper-based questionnaire, while school principals and teachers of Junior Cycle English were also invited to complete questionnaires on computer and on paper, respectively. The data collected during the Main Study were processed and scaled by the OECD's contractors, with the weights applied to students' responses based on the sampling process. Global competence was introduced as the innovative assessment domain in the 2018 cycle; however, Ireland and many other countries chose not to participate in the cognitive assessment component, though students in Ireland responded to questionnaire items on the same topic.

Overall performance on PISA 2018

Ireland's performance on reading literacy, science and mathematics was relatively stable between 2015 and 2018, with small but not statistically significant changes in each domain. On average across OECD countries between 2015 and 2018, mean scores on reading literacy and science dropped by small and non-significant amounts, while the mean score for mathematics increased non-significantly.

On reading literacy, students in Ireland ranked 4th out of 36 OECD countries, and 3rd out of 27 EU countries[2]. Student performance on PISA reading literacy in Ireland is characterised by an above-average percentage of high performers (12.1%), and a small and below-average percentage of low performers (11.8%); there are significantly fewer low performers and significantly more high performers in Ireland than on average across OECD countries. Comparing student performance in reading literacy in Ireland to 2009 (when reading was also the major assessment domain), Ireland's overall mean score was 22.4 points higher in 2018. However, comparisons between 2009 and 2018 should be made cautiously[3].

2 The OECD average for reading literacy in 2018 is based on 36 countries, while for mathematics and science, the average is based on 37 countries. Reporting on PISA 2018 reading literacy data for Spain is deferred until sub-optimal response patterns are investigated. For trend comparisons in reading literacy 2009-2018, the OECD average is based on 35 countries; trends for Austria were not reported in 2009.

3 Low student engagement and the statistical model used to scale the PISA 2009 data may have resulted in an underestimate of Ireland's reading literacy score (see Chapter 2, Section 2.2.1).

On science, students in Ireland ranked 17th among 37 OECD countries, and 11th out of 28 EU countries. Student performance on PISA science in Ireland is characterised by an average percentage of high performers (5.8%), and a significantly lower percentage of low-performing students (17.0%), compared to the corresponding OECD average percentages. Coinciding with the introduction of computer-based testing in 2015, the overall trend in science performance in Ireland over the period 2012 to 2018 shows a significant decline (-25.9 points), but, as noted, the small drop (-6.5) between 2015 and 2018 is not statistically significant.

On mathematics, students in Ireland ranked 16th out of 37 OECD countries, and 11th out of 28 EU countries. Student performance on PISA mathematics in Ireland is characterised by a significantly lower percentage of high achievers (8.2%), and a significantly lower percentage of low-performing students (15.7%) compared with the corresponding OECD average percentages. The overall trend in mathematics performance between 2012 and 2018 is stable, with a non-significant change in mean scores.

The relatively narrow range of achievement (low standard deviations around mean scores) in reading literacy, mathematics and science in Ireland compares favourably with the OECD, EU, and selected comparator countries.

The gender gap in reading literacy in PISA 2018 in Ireland in favour of females (23.2 points) is statistically significant; however, it is among the lowest on average for OECD countries. For mathematics and science in Ireland, mean score differences between female and male students are not statistically significant. This differs from 2015 when male students performed significantly better than females in mathematics and science.

While the percentage of high achievers on reading literacy in Ireland is amongst the highest in the OECD, the percentages of students in Ireland performing at the highest levels in mathematics and science have receded in recent PISA cycles. A change in the proportion of high achievers in science between 2015 and 2018 is not significant. However, in mathematics there were significantly fewer high achievers in 2018 compared with 2012. Ireland has relatively lower proportions of high-performing students compared to countries with similar mean scores in mathematics and science.

Performance on reading literacy in PISA 2018

In preparation for the 2018 assessment, the PISA reading literacy framework underwent considerable revision, to better reflect how reading has evolved in recent years, mainly because of new technologies. As noted above, a new element, fluency, was added to the framework and to the assessment for 2018.

Ireland's mean score of 518.1 on the reading scale is significantly higher than the OECD average of 487.1. Ireland ranked 4th out of 36 OECD countries (or between 1st and 5th if a 95% confidence interval is applied) and 8th out of all 77 participating countries/economies for whom valid data were available (between 5th and 9th if a 95% confidence interval is applied).

The highest-performing countries/economies were B-S-J-Z[4] (China), Singapore and Macao (China). They significantly outperformed all other countries/economies, including Ireland. Six countries/regions (Hong Kong (China), Estonia, Canada, Finland, Korea, and Poland) had mean scores that did not differ significantly from Ireland's, while the remaining 67 countries/economies with valid data, including 30 OECD countries, had significantly lower scores. Among these were the selected comparator countries of the United Kingdom, the United States, New Zealand and Australia. Ireland's mean score is significantly higher than the EU average score of 481.7. Northern Ireland also had a mean score (500.7) that is significantly lower than Ireland's.

In Ireland, the standard deviation for reading literacy was 90.7, indicating a relatively narrow range of achievement. This compares favourably with the corresponding average standard deviations across OECD and EU countries (99.4 and 98.7 respectively). Among comparison countries, only Estonia (93.2) has a standard deviation as small as that of Ireland.

In Ireland, 11.8% of students performed at the lowest levels of proficiency on overall reading literacy (i.e., below Level 2), compared to 22.6% on average across OECD countries, indicating that there are relatively fewer students with very low achievement in reading literacy in Ireland. Ireland has the 2nd lowest percentage of low performers in reading literacy in the OECD, just behind Estonia (11.1%). The percentage of low achievers in Ireland is close to the 2025 target of 10% set out in the *Action Plan for Education 2016-2019*. Only one entity, B-S-J-Z (China), had a percentage of low performers in PISA 2018 below 10%.

Almost one in eight students in Ireland (12.1%) performed at the highest proficiency levels in reading (Levels 5-6 combined), and hence can be considered higher-achieving readers. On average across OECD countries, 8.7% perform at Levels 5-6, indicating that Ireland has more higher-achieving readers. Ireland has the 10th highest percentage of high performers across OECD countries, with Canada as the country with the highest proportion of high-achieving students at 15%. The percentage of students achieving at the highest levels in reading literacy in 2018 is within 1% of the target of 13% set out in the *Action Plan for Education 2016-2019*.

Student performance on reading literacy can be broken down into three superordinate cognitive process subscales, Locating Information, Understanding, and Evaluating and Reflecting, and two source subscales, Single, and Multiple. Not unexpectedly, given Ireland's strong overall performance, students in Ireland performed well on all three reading process subscales. In Ireland, the mean score on Locating Information was 33.5 score points above the OECD average; it was 23.6 score points above the OECD average for Understanding; and it exceeded the OECD average by 30.0 points for Evaluating and Reflecting. Students in Ireland also scored significantly above the OECD average on both Single and Multiple Text subscales, with a difference of 27.5 points for Single Texts and a difference of 26.5 points for Multiple Texts.

Female students in Ireland significantly outperformed male students on PISA 2018 overall reading. The difference, 23.2 score points in favour of females, was among the lowest across comparison countries, at a similar level to Singapore, the United States, Korea and the United Kingdom. On average across OECD countries, the gender difference in favour of female students was 29.7 points, while the average difference in favour of females across EU countries was 32.7 points. On the overall reading proficiency scale, 8.5% of females, and 15.1% of males in Ireland performed below Level 2. Hence, there are more lower-achieving males than females in Ireland, a finding that also emerged on average across OECD countries where 27.7% of males and 17.5% of females performed below Level

4 B-S-J-Z (China) refers to the four PISA-participating provinces/municipalities of: Beijing, Shanghai, Jiangsu and Zhejiang.

2. In Ireland, more females (13.8%) than males (10.3%) performed at Levels 5-6. The corresponding OECD average estimates were 10.4% and 7.1%% respectively.

In Ireland, the percentage of variation in reading attributed to differences between schools was 11.1%. This compares favourably with the OECD average of 29.0%. The estimate for Ireland also compares favourably with most countries in PISA 2018. The combination of relatively high average performance on reading, alongside relatively small differences between schools, is also found in Finland and Canada.

Trends in reading literacy performance

Ireland was amongst a group of countries that experienced a small and non-significant drop in reading performance since 2015 (-2.7 score points), but the decrease was lower than that experienced on average across OECD countries (-3.0 points).

Ireland's performance on reading literacy in 2009 was significantly lower than that of that achieved in previous cycles of PISA. Student performance in reading literacy in Ireland returned to the pre-2009 level in 2012, and has remained relatively stable in 2015 and 2018. Issues with the statistical model used to scale the PISA 2009 data and low engagement among students in Ireland may have resulted in an underestimate of Ireland's reading literacy score, meaning that comparisons between 2009 and 2018 should be made cautiously. These issues did not apply to PISA 2012 or 2015 (see Chapter 2).

Female students in Ireland achieved a mean score in 2009 that was some 39.2 score points higher than male students. In 2015, the difference fell to 12.0 score points, before increasing to 23.2 points in 2018. On average across OECD countries, there was a gender gap of 39.3 score points in 2009 (based on 35 OECD countries[5]). This fell to 27.3 score points in 2015, before increasing slightly to 29.7 points in 2018.

In Ireland, 17.2% of students performed below Level 2 in 2009, and this dropped significantly to 11.8% in 2018. On average across OECD countries between 2009 and 2018, there was a significant increase in the percentage performing below Level 2, from 19.4% to 22.6%. There was a large and significant increase in the percentage of students in Ireland performing at or above Level 5 between 2009 and 2018 (+5.1%). On average across OECD countries, a significantly higher percentage of students also performed at Level 5 or above in 2018 (8.8%) compared with 2009 (7.3%).

In Ireland, fewer male students performed below Proficiency Level 2 in 2018 (15.1%) compared with 2009 (23.1%). The difference (-8.0 score points) is statistically significant. Fewer females in Ireland also performed below Level 2 in 2018 (8.5%) compared with 2009 (11.2%). On average across OECD countries, 25.7% of boys performed below Level 2 in 2009, while 27.7% did so in 2018. The difference, though small, is statistically significant.

In 2018, over twice as many male students in Ireland (10.3%) performed at or above Level 5, compared with 2009 (4.5%). The increase of 5.8% is statistically significant. There was also a statistically significant increase of 4.3% in the proportion of female students who performed at or above Level 5 in 2018 when compared to 2009. On average across OECD countries, 5.0% of boys performed at Levels 5-6 in 2009 and this increased significantly to 7.1% in 2018. In 2009, 9.7% of girls performed at Levels 5-6, and there was also a significant increase to 10.5% in 2018.

5 For trend comparisons in reading literacy 2009-2018, the OECD average is based on 35 countries; trends for Austria were not reported in 2009, while reporting reading literacy data for Spain is deferred for 2018.

Performance on science in PISA 2018

Science was a minor assessment domain in PISA 2018, having been the major domain in 2015, when a revised framework and new interactive items (for example, asking students to simulate experiments by choosing different values on two/three variables) were created to take advantage of computer-based assessment. With this transition from major to minor domain, the actual number of science items decreased, though the interactive science items comprised a greater proportion of the total item set in 2018.

The mean science score of students in Ireland on PISA 2018 was 496.1. This is significantly, if only slightly, above the OECD average of 488.7. Ireland ranked 17th among 37 OECD countries (or between 13th and 21st if a 95% confidence interval is applied), and 22nd among 78 participating countries/economies with valid data (or between 18th and 26th if a 95% confidence interval is applied).

Sixteen countries had significantly higher mean scores than Ireland, including the highest-scoring systems, B-S-J-Z China (590.5) and Singapore (550.9). Eleven countries had mean scores that were not significantly different from Ireland, while 50 countries/economies had significantly lower mean scores, including selected comparator countries Germany, the United States, Sweden, Belgium, France and Denmark. Ireland's mean score was significantly higher than the EU average score of 484.0. Northern Ireland had a mean science score (491.3) that was lower than but not significantly different from Ireland's.

Ireland's standard deviation in science, 88.3 score points, indicated a narrower range of achievement, compared with the averages across OECD countries (93.5) and EU countries (93.8). Among comparison countries, only Estonia (87.8) had a standard deviation as low as Ireland's.

In Ireland, 17.0% of students performed below Proficiency Level 2. In general, there were fewer students below Level 2 in comparison countries with higher mean scores than Ireland's, such as Estonia (8.8%), Singapore (9.0%), Finland (12.9%), and Canada (13.4%). On average across OECD countries, 22.0% performed below Level 2, while in Northern Ireland almost 1 in 5 students (19.5%) did so. Ireland has the 8th lowest percentage of low performers among OECD countries; Estonia has the lowest percentage (8.8%). The percentage of low performers in Ireland in 2018 is in excess of the 2025 target of 10% set out in the *Action Plan for Education 2016-2019*.

In Ireland, 5.8% of students performed at Proficiency Levels 5-6, which is on a par with the average across OECD countries (6.8%), even though Ireland's mean score is significantly higher than the OECD average. Among comparison countries, only Northern Ireland (5.4%) has (marginally) fewer students performing at Levels 5-6 than Ireland. Ireland is 21st among OECD countries for high performers in science; Japan is the country with the highest proportion of students considered as high-achieving at 13.1%. The percentage of students in Ireland achieving at the highest levels in science in 2018 is lower than the target of 13% set out in the *Action Plan for Education 2016-2019*.

Gender differences in science performance across countries tend to be small. In Ireland, male students achieved a mean score of 495.4, while females achieved a mean score of 496.9. The difference, 1.5 score points in favour of females, is not statistically significant. On average across OECD countries, male students had a mean score of 487.5, while females had a mean score of 489.8. The difference in favour of females, 2.3 score points, is statistically significant.

In Ireland, more male students (18.1%) performed below Level 2, compared with females (16.0%), while on average across OECD countries, 23.2% of males and 20.8% of females performed below Level 2. While the gender difference below Level 2 in Ireland is not significant, the OECD average difference is. More male students than female students in Ireland also achieved Levels 5-6 (6.8%

and 4.9% respectively), though the difference is significant. On average across OECD countries, significantly more males (7.3%) than females (6.2%) achieved Levels 5-6.

Trends in science performance

Ireland's overall mean score on PISA science in 2018 (496.1) was some 6.5 score points lower than in 2015 (502.6), the last time science was the major domain of assessment. The change in performance is not statistically significant. Countries with negative changes in achievement that are statistically significant included Canada (-9.7 score points), Denmark (-9.3), Switzerland (-10.2), Japan (-9.3) and Finland (-8.8). In contrast, performance increased in Poland (+9.6) and Turkey (+42.8). On average across OECD countries, there was a small and non-significant decline in performance (-2.0 score points) between 2015 and 2018.

In PISA 2015 there was a significant difference of 10.5 score points in favour of male students in Ireland, whereas in 2018, there was a non-significant difference of 1.5 score points in favour of female students. Hence, while the mean score of males in Ireland dropped by 12.3 score points between 2015 and 2018, the mean score of females was almost the same in both years (497.2 and 496.9 respectively). On average across OECD countries, there was a statistically significant difference in favour of males in 2015 (3.4 score points) and a statistically significant difference (2.3 score points) in favour of females in 2018. On average across OECD countries, the mean score for males also dropped between 2015 and 2018 (from 492.3 to 487.5) while the mean scores of females were almost identical in both cycles (488.9 and 489.8 respectively).

Although the percentages of students in Ireland performing below Level 2 on the PISA science scale increased from 15.3% to 17.0% between 2015 and 2018, the change is not statistically significant. On average across OECD countries, the percentages of students performing below Level 2 remained almost the same, decreasing by 0.1% from 22.1% in 2015 to 22.0% in 2018. In Ireland, more males (18.1%) performed below Proficiency Level 2 in 2018, compared with 2015 (15.7%), though the difference is not statistically significant. More females also performed below Level 2 in 2018 (16.0%) compared with 2015 (14.9%), though again, the difference is not statistically significant. On average across OECD countries, more male students (23.2%) performed below Level 2 in 2018 compared with 2015 (22.6%), though the difference is not statistically significant. The corresponding estimates for females, 21.5% in 2015 and 20.8% in 2018, are significantly different.

There was a non-significant drop in the proportion of students in Ireland performing at Levels 5-6, from 7.1% in 2015 to 5.8% in 2018, while there was a small but significant decline, from 7.4% in 2015 to 6.8% in 2018, on average across OECD countries. In 2018, significantly fewer male students in Ireland (6.8%) performed at Levels 5-6, compared with 2015 (9.0%). Similar proportions of female students performed at Levels 5-6 in both 2015 and 2018 (5.0% and 4.9% respectively). In 2018, on average across OECD countries, fewer male students performed at Levels 5-6 (7.3%) compared with 2015 (8.5%). The difference, 1.2%, is statistically significant. Similar percentages of females performed at Levels 5-6 in 2015 (6.3%) and 2018 (6.2%).

Performance on mathematics in PISA 2018

Mathematics was a minor assessment domain in PISA 2018. Unlike reading literacy and science, no items specifically designed for computer-based assessment were included, though this is due to change in 2021, when PISA mathematics will be the major assessment domain. All PISA mathematics items administered in 2018 were drawn from the paper-based assessment in 2012.

The overall mean mathematics score of students in Ireland in 2018 was 499.6. This was significantly, if slightly, higher than OECD average score of 489.3. Ireland's mean score ranked 16th of 37 OECD countries (or between 12th and 21st, if a 95% confidence interval is applied), and 21st among all 78 participating countries with valid data (or between 17th and 26th if a 95% confidence interval is applied).

Sixteen countries had significantly higher mean scores than Ireland, including high-performing B-S-J-Z China (591.4 score points) and Singapore (569.0). Ireland's mean score does not differ significantly from ten countries/economies, including Sweden, the United Kingdom and Germany, while 51 countries perform significantly less well than Ireland. The mean score for Northern Ireland (492.0), although some 7.6 points lower than Ireland's score, is not significantly different.

Ireland's standard deviation for mathematics (77.8) is smaller the OECD average (90.6) and is among the smallest across all countries in PISA 2018. This indicates a narrower spread of mathematics achievement in Ireland than on average across OECD countries.

In Ireland, 15.7% of students performed below Level 2 on mathematics, indicating that they lacked the mathematical knowledge and skills required for future education and work (OECD, 2019a). This was significantly below the OECD average of 24.0%. Just 7.1% of students in Singapore performed below Level 2. While Ireland had more lower-achieving students than countries with significantly higher average scores in mathematics, it had similar proportions to countries with mean scores that are not significantly different. Ireland has the 7th lowest percentage of low performers among OECD countries for mathematics. Estonia has the lowest percentage (10.2%) across the OECD. The percentage of low-performing students in mathematics in Ireland in 2018 is in excess of the 2025 target of 10% set out in the *Action Plan for Education 2016-2019*.

In Ireland, 8.2% of students performed at Levels 5-6 in PISA mathematics. This is significantly lower than the OECD average of 10.9%. A number of countries with overall mean scores not significantly different from Ireland's had proportionately more students at Levels 5-6, including Sweden (12.6%) and the UK (12.9%). In Northern Ireland, 8.3% of students performed at Levels 5-6. Ireland ranks 30th on the percentage of high-performers amongst OECD countries for mathematics. Across the OECD, Korea has the highest percentage of students performing at the highest levels in mathematics at 21.4%. The percentage of students in Ireland achieving at the highest levels in mathematics in 2018 is 2.7% lower than the target of the OECD average set out in the *Action Plan for Education 2016-2019*, which was 10.9% in 2018.

Gender differences in mathematics performance across countries tend to be small and non-significant. In Ireland, male students achieved a mean score of 502.6. Although higher than the mean score of females (496.7), the difference (5.9 score points) is not statistically significant. On average across OECD countries, the difference in favour of male students was marginally smaller than in Ireland (5.2 points), but reached statistical significance.

In Ireland, similar proportions of male and female students (15.7% in both cases) performed below Proficiency Level 2, while the corresponding OECD average percentages were higher, at 23.9% for males and 24.0% for females. Significantly more male students in Ireland (9.9%) compared with females (6.6%) performed at Levels 5-6, and the corresponding OECD averages, also significantly different from one another, were 12.3% and 9.5% respectively.

Trends in mathematics performance

In Ireland, overall mean scores in mathematics across cycles indicate quite a stable trend since 2012, with Ireland's 2018 mathematics mean score 4.1 points lower than in 2015, and 1.9 points lower than in 2012. Neither difference is statistically significant. The OECD average showed a small (-1.1 point) decline between 2012 and 2018, and an increase of 2.1 points between 2015 and 2018; neither difference is statistically significant.

There is a narrowing of the gender gap in mathematics performance in Ireland, with a non-significant difference in favour of males in 2018 (5.9 score points) compared with significant differences in favour of males in earlier cycles (15.3 score points in 2012, 16.1 in 2015). However, fluctuations in samples from cycle to cycle need to be taken into account in considering this change.

The percentage of students in Ireland performing below Proficiency Level 2 increased slightly between 2015 and 2018 (from 15.0% to 15.7%), but was lower in both cycles than in 2012 (16.9%). The percentage of students achieving at or above Level 5 dropped significantly from 10.7% in 2012 to 8.2% in 2018. On average across OECD countries, similar percentages of students (24.4% in 2012, 24.6% in 2015, and 24.0% in 2018) performed below Level 2. On average across OECD countries, the percentage performing at or above Level 5 dropped from 12.1% in 2012 to 10.3% in 2015, before increasing slightly to 10.9% in 2018. As in Ireland, the percentage of students performing at or above Level 5 on average across OECD countries was significantly lower in 2018 than in 2012.

Between 2012 and 2018 the percentage of males performing below Level 2 in Ireland increased marginally (+0.5%), while the percentage of females decreased (-3.0%); neither difference is statistically significant. On average across OECD countries, the percentage of males who performed below Level 2 increased non-significantly from 23.5% in 2012 to 23.9% in 2018, while the percentage of females performing below Level 2 decreased significantly, from 25.3% in 2012 to 24.0% in 2018.

The percentage of males in Ireland achieving at or above Level 5 dropped significantly between 2012 and 2018 (-2.8%), while the percentage of females performing at these levels dropped non-significantly (-2.0%). The proportions of students at or above Level 5 across OECD countries also fell significantly for both genders, with 14.0% of males scoring at or above Level 5 in 2012, and 12.3% doing so in 2018. Similarly, in 2012, 10.1% of females on average across OECD countries achieved at or above Level 5, compared with 9.5% of females in 2018.

Equity and socio-economic differences in PISA 2018 reading literacy

The variation in reading performance accounted for by between-school differences, as a proportion of the OECD average total variation, was 11.1% in Ireland, compared to 29.0% on average across OECD countries. This indicates that the Irish education system is comparatively equitable across schools in relation to reading performance.

The correlation (relationship) between performance on PISA reading and the PISA index of Economic, Social and Cultural Status (ESCS) at the student level in Ireland is moderate (.33). Students in the highest ESCS quartile in Ireland achieved a significantly higher reading literacy score (by 74.8 score points), compared with those in the lowest quartile. The corresponding difference was larger on average across OECD countries (88.8 score points), meaning that Ireland is relatively equitable on this measure.

Nonetheless, students in DEIS schools in Ireland had an average reading literacy score that is 51.2 points below that of students in non-DEIS schools, while a difference of 53.4 score points was

observed between fee-paying and non-fee paying schools in Ireland. An examination of mean scores in reading literacy by school sector and gender composition revealed significantly higher scores for students in girls' secondary and mixed secondary schools, compared to ETB vocational schools, with the differences between ETB vocational and boys' secondary and between ETB vocational and (mixed) community/comprehensive schools non-significant.

Reading habits and strategies of students in PISA 2018

The percentage of students who never read for enjoyment increased from 33.4% in 2000, to 41.9% in 2009, to 47.7% in 2018. In 2018, students who did not read for enjoyment had a reading score that was lower, by 86.9 points, than the mean score of students who read for enjoyment for more than 1 hour per day. In 2018, significantly more males (56.1%) than females (39.4%) in Ireland reported that they did not read for enjoyment. Reading for enjoyment was significantly less frequent among students in DEIS schools (relative to students in non-DEIS schools) as well as among non-immigrant (native) students (relative to immigrant students).

A key development in the reading literacy framework for 2018 is the recognition of digital texts, which bring traditional texts and new forms of reading together. Students who read books more often in paper format, more often in digital format, and students who read books equally often in both formats had significantly higher mean scores on reading literacy (561.4, 511.3 and 541.8 respectively), than students who rarely or never read books (478.7).

In 2018, students in Ireland were slightly but significantly more likely to employ effective reading strategies for understanding and remembering (0.05) on an OECD-developed index, than on average across OECD countries (-0.01). Students in Ireland were also significantly more likely to employ effective summarising strategies than on average across OECD countries (0.10 and 0.00 respectively).

Students in Ireland achieved a mean score (0.21) on a composite index drawing on their use of strategies to assess the credibility of sources in digital texts, which was significantly above the average across OECD countries (0.00). Students in the United Kingdom and Finland also scored relatively high on the index, while students in Korea scored below the OECD average. The performance of students in Ireland is positive given that they can expect to encounter large amounts of digital information of variable quality and credibility in the future.

Use of digital technologies by students in PISA 2018

In 2018, under half of participating students had taken a test on computer prior to PISA, which was up slightly from 2015 (46.5% in 2018 and 42.8% in 2015). Comparable data are not available for other countries.

For subject-related digital technology use in class, students in Ireland had a mean score (-0.37), which was significantly and substantially below the average across OECD countries (0.00). The corresponding figure for subject-related digital technology use outside of class for Ireland was -0.30, also significantly below the OECD average. These indicate an underuse of digital technology for school subjects by students in Ireland (inside and outside of class) compared to the corresponding averages across OECD countries.

Exploring how digital devices are used in teaching and learning, students in Ireland reported that

across selected subjects (English[6], Science, and Mathematics), it was mainly the teacher who used digital devices in the classroom. The rate of use by teachers only in English classes in Ireland (52.5% of students) was over twice that reported by students on average across OECD countries for classes in the test language (24.6%). On the other hand, use of digital devices by both teachers *and* students during English lessons was higher on average across OECD countries (37.4%) than in Ireland (23.0%). In Ireland, teacher-only usage of digital devices was associated with higher performance in reading, mathematics and science among students, compared with student-only usage and teacher and student usage, perhaps reflecting uneven usage of digital technologies among students of different abilities in Ireland.

Principals' views on the capacity of their schools to enhance teaching and learning through digital technology are less favourable in Ireland than on average across the OECD. In particular, principals in Ireland highlighted access to technical support or assistance, the availability of effective professional resources for teachers to learn how to use digital technology, and the skill levels of teachers (and time for planning) as challenges to successful integration of digital technology in teaching and learning. This information from principals was collected in March and April 2018, and highlights the continued importance of the *Digital Strategy for Schools 2015-2020* (DES, 2015a) and the roll-out of the *Digital Learning Framework* (DLF, DES, 2017a), and indicates a need for ongoing monitoring and enhancement of resources, supports and the provision of time for CPD and preparation for instruction. The final evaluation of the DLF pilot (Cosgrove et al., 2018b) identified a number of key challenges frequently highlighted by DLF leaders, teachers and the PDST advisors that are consistent with findings from PISA 2018.

Patterns of time spent using digital devices by students in Ireland indicate that moderate or lower levels of use are related to higher student performance on PISA reading literacy. For example, students who don't play computer games or play them for less than an hour a day achieved significantly higher scores on reading literacy than students with higher levels of usage: 539.5 and 535.0 score points respectively, compared to 517.3 for 1 to 3 hours of use, 498.6 for 3 to 5 hours of use, and 461.5 for more than 5 hours of use on a normal school day. Students who spent more than three hours watching TV (including online) had significantly lower reading performance that students who watched less television, or none at all. For interacting with friends on social media, students with more moderate levels of activity (up to 3 hours of use) had significantly higher performance on reading, compared to no use or to the highest levels of social media activity.

Aspects of student well-being in PISA 2018

Worry about failing an exam or feeling nervous and stressed about exams is prevalent in Ireland, with 51.6% of students reporting that they often or always worry about what would happen if they fail an exam or test. Students in Ireland who reported that they often or always put themselves under pressure to do well on exams and tests scored significantly higher on reading literacy (531.0 and 548.5 respectively), compared with students who reported that they never put pressure on themselves to do well (494.0). Students who reported never feeling under pressure from their teachers to do well also scored significantly lower in reading literacy compared to students who reported sometimes feeling pressure (517.3), often feeling pressure (535.2) or always feeling pressure (530.1). Students who reported that they often or always felt physically unwell thinking about exams performed less

6 Some students sat the PISA assessment in Irish; students were asked to respond to questions about the test language, which was English for the majority of students.

well on average on reading literacy (498.9 and 509.1 respectively), compared to students who never felt physically sick thinking about exams (546.9). The different relationships between student performance on PISA and students' reports of exam stress, pressure and feeling physically unwell thinking about tests, highlight the complex inter-relationships between well-being, exam stress, and test performance. It may be the case that certain levels of exam stress or anxiety represent a 'healthy' desire to do well. However, the situation of students who report feeling physically unwell thinking about exams merits further analysis, not just in relation to their performance, but for their overall well-being.

Three-fifths (61.4%) of students in Ireland reported that they were satisfied with their lives, which is significantly lower than the overall average across OECD countries (66.9%). On average, significantly fewer female students in Ireland reported that they were satisfied with their life (55.5%) compared to male students (67.3%). Students in Ireland who reported that they were 'very satisfied' with their lives had a mean reading score of 505.2, which was significantly lower than the mean score of students who reported that they were not satisfied with life (522.8).

Almost half of students in Ireland (45.3%) reported feeling happy all of the time in normal circumstances, compared to 41.0% of students on average across OECD countries, while fewer students in Ireland felt cheerful, joyful or proud than students on average across OECD countries. Students in Ireland who are low Internet users were more likely to report positive feelings in general (e.g., happy or lively) and less likely to report negative feelings (e.g., sad or afraid) than heavy Internet users.

The findings related to aspects of student well-being in PISA 2018 are in line with recent research, including *My World 2* (Dooley et al., 2019). That study highlighted increased levels of depression and anxiety between two waves of the national study (2012 and 2019). According to Dooley et al., the top 3 stressors that adolescents endorsed were all school-related (school, exams and homework), and male students were more likely to be satisfied with life than their female peers. The findings underline the importance of underpinning and promoting the well-being of young people in Ireland that have been prioritised in recent years via inter-departmental policies and strategies, including *Better Outcomes, Brighter Futures: The National Policy Framework for Children and Young People, 2014-2020* (DCYA, 2014), *Guidelines for Wellbeing in Junior Cycle* (DES & NCCA, 2017), and the *Wellbeing Policy Statement and Framework for Practice* (DES, 2019b).

Further reporting

The OECD published three volumes on the outcomes of PISA 2018 in December 2019, with further thematic reporting planned for 2020-2021. Further national-level analyses using data from PISA 2018 on key themes such as reading literacy, digital technologies, student well-being and a more detailed look at student performance on PISA in DEIS schools, are also planned for 2020-2021.

Chapter 1
Overview and Implementation of PISA 2018

Key Points - Chapter 1

- PISA 2018 was the seventh cycle of the study which began in 2000, and was the second cycle fully administered on computer in most participating countries.
- In 2018, reading literacy was the main assessment domain, while mathematics and science were minor domains. Ireland did not participate in the optional cognitive assessment of Global Competence, but did administer the questionnaire items to students on this topic.
- Two key changes were introduced in 2018, multi-stage adaptive testing (MSAT) in reading literacy and machine-supported scoring across all three core domains.
- The administration of PISA 2018 in Ireland met all required technical standards.

1.1 Introduction

The Programme for International Student Assessment (PISA) is a project of the Organisation for Economic Co-operation and Development (OECD) that aims to assess how well students, at age 15[7], are prepared to meet the challenges they may encounter in future life, including education (OECD, 2019a). At age 15, students in most OECD countries are approaching the end of compulsory education. The approach taken by PISA is forward-looking, considering students' skills and knowledge rather than focusing on student mastery of curricula. Therefore, the focus is how students' can apply what they learn at school to real-life (and potentially unfamiliar) situations.

PISA takes place every three years and assesses students in the three domains of reading literacy, mathematical literacy and scientific literacy[8]. The way in which PISA assesses these domains is guided by an assessment framework (OECD, 2019a). The reading literacy framework was updated for PISA 2018 to reflect findings from international research, policy and curriculum communities' understandings and priorities, as well as developments in digital technologies that have implications for reading literacy. The assessment framework for each domain is provided at the beginning of the relevant results' chapter. Previous cycles of PISA were primarily paper-based, though, from 2006 onwards, innovative assessments of digital reading, computer-based mathematics, science, and

7 The PISA population in a country is defined as all students who are enrolled in educational programmes aged between 15 years and 3 months, and 16 years and 2 months (OECD, 2019a). For PISA 2018 in Ireland, this meant that students born in 2002 were eligible to take part.

8 Throughout this report, the terms mathematical literacy and science literacy are abbreviated to mathematics and science.

problem solving were included on an optional basis. The 2015 cycle of PISA was the first cycle to fully administer the three core domains on computer. The vast majority of countries, including Ireland, implemented PISA on computer, with a few countries opting to remain with a paper-based administration. The 2018 cycle of PISA was the second full administration of PISA on computer and this has facilitated some technical innovations in the assessment (see Chapter 2).

Each cycle of PISA focuses on one 'major domain', to which a majority of testing time is devoted. The 'minor domains' provide a less detailed profile of achievement. Reading literacy was the major domain for the third time in PISA 2018 (see Table 1.1). Therefore, it provides the first opportunity for a detailed examination of changes in reading literacy outcomes since 2009.

Table 1.1: Assessment domains across PISA cycles (2000-2018)

Year	Major domain	Minor / Optional domains
2000	Reading	Mathematics, Science
2003	Mathematics	Reading, Science ***Problem-Solving***
2006	Science	Mathematics, Reading
2009	Reading	Mathematics, Science
2012	Mathematics	Reading, Science ***Problem-Solving,*** *Financial Literacy*
2015	Science	Mathematics, Reading *Computer-based Collaborative Problem-Solving, Financial Literacy*
2018	Reading	Mathematics, Science ***Global Competence*,*** *Financial Literacy*

Additional domains are italicised, and options Ireland participated in are marked in **bold**.
*Ireland participated in the questionnaire but not the cognitive component of global competence.

Ireland did not take part in two optional assessments that were available in PISA 2018 – global competence and financial literacy. However, Ireland did administer international questionnaire items related to global competence, and the findings will be reported by the OECD in the second half of 2020.

Over 600,000 students in all 37 OECD countries and an additional 42 partner countries/economies[9] (listed in Table 1.2) participated in PISA 2018, i.e. the tests of reading literacy, science and mathematics. Of these, students in 70 countries/economies completed the tests on computer, while 9 (all non-OECD-member countries) completed the paper-based versions.

Since PISA 2015 results were published in December 2016, two countries were invited to become full OECD members, Lithuania and Columbia. Lithuania acceded in 2018, while Columbia's accession is pending. In this report, the OECD averages comprise 37 countries and therefore differ from previously published OECD averages for 2015, based on 35 countries. B-S-J-Z China in 2018 differs from B-S-J-G China in 2015, as Guangdong province has been replaced by Zhejiang.

9 Not all participating entities are countries (e.g., the Chinese cities of Beijing, Shanghai, Jiangsu and Guangdong).

Table 1.2: Countries/economies participating in PISA 2018

OECD Countries		Partner Countries/Economies		
Australia	Korea, Republic of	Albania	Kazakhstan	Ukraine (PBA)
Austria	Latvia	Argentina (PBA)	Kosovo	United Arab Emirates
Belgium	Lithuania	Baku (Azerbaijan)	Lebanon (PBA)	Uruguay
Canada	Luxembourg	Belarus	Macao-China	Vietnam*** (PBA)
Chile	Mexico	Bosnia and Herzegovina	Malaysia	
Columbia*	Netherlands	Brazil	Malta	
Czech Republic	New Zealand	Brunei Darussalam	Moldova (PBA)	
Denmark	Norway	Bulgaria	Montenegro	
Estonia	Poland	China (B-S-J-Z)**	Morocco	
Finland	Portugal	Chinese Taipei	Panama	
France	Slovak Republic	Costa Rica	Peru	
Germany	Slovenia	Croatia	Philippines	
Greece	Spain****	Cyprus	Qatar	
Hungary	Sweden	Dominican Republic	Romania (PBA)	
Iceland	Switzerland	Nth Macedonia (PBA)	Russian Federation	
Ireland	Turkey	Georgia	Saudi Arabia (PBA)	
Israel	United Kingdom	Hong Kong-China	Serbia	
Italy	United States	Indonesia	Singapore	
Japan		Jordan (PBA)	Thailand	

PBA: Paper-based assessment. All other countries including Ireland administered PISA on computer (CBA).
EU countries are highlighted in blue.

*Columbia was invited to become a full OECD member on 25th May 2019; **Beijing-Shanghai-Jiangsu-Zhejiang; ***Vietnam was removed from the international comparisons for reading, mathematics and science due to issues around data quality. Hence, data for 78 countries/economies are available for comparing achievement for mathematics and science across participating countries in 2018; ****Reporting on data for Spain's results on reading literacy has been deferred by the OECD due to anomalies in student response behaviour (based on timing information) in the assessment of reading fluency. Therefore, data for 77 countries/economies are available for comparing achievement across countries for reading literacy in 2018.

In assessing the broad educational achievements of 15-year-olds in English reading, mathematics, science and their preparedness for adult life, findings from PISA make a significant contribution to policy development in Ireland and across OECD and partner countries/economies. PISA is steered by member governments through the OECD on the basis of shared, policy-driven interests. Since 2015, PISA has been implemented by a consortium of five institutions under the direction of the Educational Testing Service (ETS) in the United States. In Ireland, PISA is implemented by the Educational Research Centre (ERC) on behalf of the Department of Education and Skills (DES). It is supported in this work by a National Advisory Committee, which includes representatives from the DES, the National Council for Curriculum and Assessment (NCCA), the State Examinations Commission (SEC), and subject matter experts in English Reading, mathematics, science and ICT in education (see Appendix A for membership of the advisory committee).

The remainder of this chapter is organised in three sections. The first introduces the 2018 assessment, outlining the key updates and changes since the 2015 cycle; the second describes the assessments of reading literacy, mathematics, and science, and the content of the questionnaires administered to participating students, teachers, principals and parents; and the final section describes the implementation of PISA 2018 in Ireland.

1.2 The PISA 2018 Assessment

This section describes the PISA tests and questionnaires administered in 2018, and outlines the key updates and changes made to the assessment in this cycle.

1.2.1 The PISA Tests and Questionnaires

As in previous cycles of PISA, computer-based tests of reading literacy, science, and mathematics take two hours, and the computer-based questionnaires that immediately follow last about 55 minutes. The theoretical basis of each domain is articulated in a set of assessment frameworks, which also served to guide test development (OECD, 2019a). Though the framework for each test domain differs from the others, all are similarly structured in that each one describes the type of *content or knowledge* the test encompasses, the *processes* required of students, and the *situations/contexts* in which assessment items are situated.

In order to interpret performance, student scores and assessment items are placed on a single scale. This scale can be divided into levels of proficiency, allowing for the skills and competencies of students to be described (See Box 1.1 at the end of this chapter for more information). Level 2 is considered as baseline proficiency in each domain by UNESCO (OECD, 2019d). All students who have attained a particular level are expected to demonstrate the skills and competencies represented at all lower levels, in addition to those associated with the proficiency level that has been reached.

The PISA tests comprise units consisting of stimulus material (text and other information such as tables, charts, pictures, graphs and diagrams) followed by one or more items that are based on the stimulus material. The assessment features both selected-response (multiple-choice) and open-response type item formats, with approximately one-third of the items in an open-response format. Multiple-choice items are either simple multiple-choice, requiring students to select one answer from a list, or complex multiple-choice, in which students are asked to choose between two possible responses (e.g., yes or no) to a series of statements. Open-response items are designed to elicit a written response from students, which may be long or short depending on the context.

In the 2018 cycle, as reading literacy was the main domain of assessment, the cognitive framework was updated in line with changes in the nature of reading literacy. This resulted in the development of new test content to support the changes in the framework, taking into account the functionality of the computer-based test platform. Stimulus materials in reading included new dynamic text formats with additional functionalities, for example, hyperlinks, navigation and dropdown menus. Further detail on the changes to the assessment of reading literacy in PISA 2018 is provided in Chapter 3.

The assessment of scientific literacy in 2018 comprised of a subset of test items from the 2015 assessment of science. Trend items from earlier cycles were presented alongside new science stimulus materials developed for PISA 2015 science. The new item types included interactive items, where students were asked to simulate experiments by controlling for a number of variables at the same time and evaluating outcomes with reference to the question being asked (see Chapter 4).

Mathematical literacy in PISA 2018 comprised test items based on the 2012 mathematics framework. A subset of test items was carried forward and administered in 2015, to coincide with the transition to computer-based assessment, and the same test content was administered to students in 2018. Hence, unlike reading and science, the mathematics test still comprises older paper-based items only, albeit on a computer platform. An overview of the mathematics framework and sample items is included in Chapter 5.

In Ireland, the questionnaire session includes the international core Student Questionnaire, along with the international optional short questionnaires on ICT, Educational Careers and Well-being. Further information on the PISA 2018 Questionnaire Framework (OECD, 2019a) and on the core School Questionnaire for school principals or their nominee(s), the Parent Questionnaire and the nationally-developed Questionnaire for Teachers of Junior Cycle English is set out in Chapter 6.

Global competence was the innovative domain in the 2018 cycle; however, Ireland and many other countries chose not to participate in the cognitive assessment. Ireland did, however, administer global competence questionnaire items to students as part of the Student Questionnaire. Findings from this questionnaire are under embargo by the OECD and due to be published in 2020.

1.2.2 Key Updates and Changes in the 2018 Cycle

While the transition to computer-based assessment has been fundamental in the evolution of PISA in recent cycles, some key changes were carried over from 2015 and some were introduced for the first time in the 2018 cycle. This section outlines the changes made in 2015 and developments initiated in the 2018 cycle.

The changes to the design and scaling of PISA introduced in 2015 (Shiel et al., 2016) remain in the 2018 cycle. As noted earlier, the assessment mode is computer-based, with 70 of 79 participating countries administering the assessment using a computer-based platform in 2018, up from 57 of 72 participating countries in 2015. Improvements were introduced in PISA 2015 that allow for more test questions in the minor domains, leading to increased construct coverage. Consequently, the measurement of trends over time is more robust, and this also results in a slight increase in the measurement error (as a smaller number of students take each test item), but the benefit of more stability in the reporting of trends across cycles is seen as offsetting this limitation (OECD, 2017b).

As in 2015, the calibration sample used for scaling incorporates multiple cycles of PISA data, and not just the most recent assessment. PISA uses an approach called item response theory[10] (IRT) to estimate achievement/proficiency scores. This modelling approach estimates both the difficulty of the items and proficiency of the students. Two adjustments were made in 2018, as in 2015, to improve the robustness of the achievement estimates. First, to account for test items that behave differently across countries[11], some unique item parameters are applied within countries. In total, for the Irish data, 52 unique item parameters were used: 33 for reading literacy, 16 for science and 3 for mathematics. Second, to reduce bias in the estimates, questions not reached by students were treated as not administered, while prior to 2015, these items were categorised and treated as incorrect. Together, these two changes are likely to result in truer (unbiased) estimates of students' proficiencies. See the PISA 2018 Technical Report (OECD, 2020, in press) for further details.

A key change was introduced in 2018 relating to reading literacy's position as the main assessment domain. Alongside the development of new test content and item formats, PISA 2018 introduced adaptive testing for computer-based countries in order to improve the accuracy and fairness of the reading test. Using Multi-Stage Adaptive Testing (MSAT), the test is adaptive to each student's ability level: students start on a common set of items, and then, at intervals, progress onto items of a lower or higher difficulty, based on their previous performance. There were three stages during testing.

10 In 2018, the PISA tests were again scaled using two-parameter logistic (2PL) item-response theory model for dichotomous data and a generalised partial credit model (GPCM) for polytomous data.

11 Such differences are ascertained by implementing differential item functioning (DIF) analysis.

First, students were randomly assigned to one of eight 'core' non-adaptive stages, consisting of about 10 items. Based on their core score, students were assigned to a block in 'stage 1'. About 14 items were administered to each student during 'stage 1'. When 'stage 1' was complete, a student's score on the 'core' and 'stage 1' blocks was considered to assign a low or high pathway at 'stage 2'. 'Stage 2' included 13 items on average for each student. Note that a small percentage of students were randomly assigned to a high or low pathway at 'stage 1' and 'stage 2', akin to non-adaptive testing in previous cycles and in mathematics and science domains, to ensure broad coverage of the domain at all proficiency levels (OECD, 2020, in press). In all, 132 paths were possible during the assessment of reading literacy in the 2018 Main Study (*ibid*). Increased accuracy of reporting scores at the bottom and top of the reading scale (below Level 1b and at Levels 4, 5 and 6) was highlighted as a goal by the PISA contractors and the OECD in the 2018 Main Study (*ibid*).

Machine-supported scoring was also introduced in PISA 2018 across the three core domains. Approximately one-third of items in PISA are open-ended and require human scoring. With the introduction of computer-based assessment in 2015, there was an opportunity to improve data processing and efficiency of scoring students' open-ended responses via a technology-based scoring programme. While most open-ended student responses were human-scored, the PISA contractors introduced a technique[12] that automatically scored frequent exact-match responses within a country, based on the scores awarded in the PISA 2015 Main Study and PISA 2018 Field Trial. Across the participating CBA countries, there was increased efficiency with almost one-third of mathematics responses machine-scored, and over one-quarter in reading (new and trend) and science (*ibid*).

1.3 Implementation of PISA 2018 in Ireland

All countries or entities taking part in PISA must conduct a Field Trial in the year before the Main Study. Both the Field Trial and the Main Study designs are guided by protocols and technical standards concerning sample size, response rates, and uniformity in assessment conditions. In each country, PISA is overseen by a National Project Manager (NPM) who, alongside a team, co-ordinates the study through a National Centre (the Educational Research Centre in the case of Ireland), preparing all test materials and liaising with schools, test-administrators and other support staff to ensure the smooth-running of the study and adherence to the procedures and standards. This section describes the implementation of PISA 2018 in Ireland, including the Field Trial held in March-April 2017, and the Main Study held in March-April 2018.

1.3.1 The PISA 2018 Field Trial

Forty schools in Ireland were selected to take part in the Field Trial in spring 2017 and all agreed to participate. The sample of schools was a convenience sample from a range of counties in the East, South and midlands, and representing a mix across school sector (secondary, EBT/vocational, community/comprehensive) and DEIS[13] status. The Field Trial had several objectives: to examine the quality of the new reading items, to evaluate (and if necessary, refine) the operations and data management of the study, and to confirm the feasibility of introducing adaptive testing in reading literacy in the Main Study.

12 A pool of responses was developed for each country and language combination, with two rules applied: first, the response must appear at least five times; and second, empty responses are filtered out.

13 Delivering Equality of Opportunity in Schools.

In each of the 40 schools, 60 students were selected to participate, and were assigned randomly to one of three groups as follows:

- 20 students were assigned to fixed-unit order (FUO) trend items in reading literacy, science and mathematics
- 20 students were assigned to variable-unit order (VUO) trend reading literacy, science and mathematics items, along with new reading literacy units
- 20 students were assigned to fixed-unit order (FUO) new reading items.

In all schools, testing was facilitated on one day. Nine members of the Department of Education and Skills' Inspectorate functioned as lead test administrators, while 17 support test administrators and staff of the Educational Research Centre fulfilled the role of support test administrators. All test sessions were administered on laptops hired by the ERC for the administration of the study, with technical support personnel hired to transport and set-up equipment, and troubleshoot any issues with the hardware during the sessions. All sessions were administered on computer, using a specific PISA computer-platform that did not require Internet access.

Of the 2,399 PISA-eligible students (one school had 59 eligible students) selected to take part in the field trial, 1,870 took part, giving a response rate of 77.9%. Parents of the selected students were provided with a questionnaire in paper format and invited to complete it. Nine in ten of the parents of students who participated in the Field Trial (90.1%) completed the questionnaire. The outcomes of the Field Trial provided a basis for selecting test and questionnaire items for the PISA 2018 Main Study across all participating countries.

1.3.2 The PISA 2018 Main Study

The sampling design is a two-stage stratified cluster design, with schools selected first, followed by students. Schools were selected with probability proportional to size (PPS).

First, a representative sample[14] of 157 schools in Ireland was selected to participate in PISA 2018 by Westat, one of the organisations in the international PISA consortium. In order to obtain nationally-representative samples in PISA, each country advises Westat on the characteristics of the post-primary education system that are structurally, demographically and academically relevant. Naturally, these vary from country to country. In Ireland, schools were grouped on the sampling frame (list of all schools containing PISA-eligible students) by enrolment size (large, medium or small[15], depending on the number of 15-year olds enrolled) and sector (secondary, ETB/vocational[16], community/ comprehensive). Within each of the resulting nine groups or explicit strata, schools were ordered by the percentage of 15-year old female students in the school, and socioeconomic quartile, based on percent of students in a school with a Junior Certificate examination fee waiver (the implicit stratifying variables).

14 In addition to PISA, the Trends in International Mathematics and Science Study (TIMSS) Field Trial involving students in Second year was implemented in Ireland in spring 2018. The PISA 2018 Main Study sample was selected before the TIMSS 2019 Field Trial sample and so no overlap control was needed during PISA sampling. Minimal overlap control was put in place during TIMSS sampling, to prevent an overlap of schools with the PISA Main Study sample.

15 Small schools had up to 45 PISA-eligible students enrolled, medium schools had between 46 and 85, and large schools had over 85.

16 Vocational schools, managed by the ETBs (Education and Training Boards).

In the second stage of sampling, up to 44 students aged 15 years (those born in 2002) were selected to participate and were divided into two test sessions of up to 22 students.[17] The students were spread over five year levels: First, Second and Third year, Transition year and Fifth year.

In Ireland, the PISA Main Study was carried out in March and April 2018.[18] The start of the testing was delayed by three days due to Storm Emma school closures, with 22 school test dates rescheduled across alternative dates in March and April, significantly impacting on the overall administration of the study. The commitment of schools participating in PISA and the dedication shown by test administrators and technical support personnel ensured the successful administration of the study during the test window.

Twenty-seven Inspectors acted as lead test administrators, alongside 24 support test administrators (mainly retired Inspectors and principals). Several of the support test administrators acted as lead test administrators in schools with a change to a test date or in a follow-up test session. The lead and support test administrators were assigned to one of four 'PISA regions' for administrative purposes. One member of the PISA team in the ERC acted as a co-ordinator for each PISA region.

As was the case in PISA 2015, PISA 2018 was administered solely on laptops hired and transported to schools for the assessment. A laptop hire company provided 650 laptops, onto which two versions of the assessment were loaded, an English-only language version and an English-Irish language option[19]. The test and questionnaire sessions were run from each laptop's hard drive[20], and this worked well throughout testing. In addition to the test administration personnel, technical support personnel were hired to support the computer-based administration. Their role was to support the test sessions and the lead and support test administrators, by transporting and setting up laptops, resolving any technical difficulties students had during the assessment, and, after the assessment, uploading the student results to a secure server.

All test administrators and technical support persons attended a training day led by the ERC's PISA national team, and also received support materials (manuals, script, training videos) outlining the procedures for testing, the completion of paperwork (including student tracking and session report forms), and the uploading of data to the secure server.

PISA School Contact persons (usually teachers) were identified in all participating schools by principals, and acted as the contact point for planning and preparation for testing. They carried out key tasks and liaised with the ERC regional coordinator and the lead test administrator, prior to testing. The school contact was also available to the PISA team on the test date to deal with any school-level issues that arose.

In all 157 participating schools, testing took place on a single day, with two test sessions running in parallel. In a number of schools, notably on the first few days of testing and where a school requested additional assistance, an ERC staff member (usually the regional co-ordinator) attended the school on the test date. Follow-up testing was conducted in a number of schools where the number of assessed students was low on the initial test date.

17 Seven schools had fewer than 44 15-year olds enrolled and all such students were selected.

18 Most Northern Hemisphere countries carried PISA out in spring 2018. A few, including the UK and the US, carried it out in autumn 2018 (when Southern Hemisphere countries also conduct their PISA testing).

19 Students in schools with a language option were asked to select either English or Irish for the PISA tests. They were given a language option for the questionnaires also. Students in Irish-medium schools, including those with Irish-medium units, were informed of this option before the test date.

20 Some countries administered the assessment on school computers (usually via USB sticks).

PISA Quality Monitors (in Ireland, these were retired Senior Inspectors, employed by the PISA consortium) visited about 10 per cent of schools participating in the 2018 Main Study. Quality Monitoring is a key part of ensuring that PISA is administered in a standardised manner across countries. The schools were selected by the international PISA consortium, and the Quality Monitors submitted a report to the consortium on the extent to which test administrators adhered to testing procedures, as stipulated in the training materials and administration manuals.

Table 1.3: Numbers of participating, non-participating/absent, ineligible and excluded students in the PISA 2018 sample in Ireland, by gender

	Students - Sampled	Students - Participated		Didn't Participate/ Absent		Ineligible		Exempted	
		n	% *	n	%	n	%	n	%
All	6,761	5,577	82.5	868	12.8	59	0.9	257	3.8
Gender									
Male	3,413	2,800	41.4	434	6.4	36	0.5	143	2.1
Female	3,348	2,777	41.1	434	6.4	23	0.4	114	1.7

Source: PISA 2018 Weighting Summary Report for Ireland, issued by Westat in July 2019. The data in the table are unweighted and all percentages in the table are relative to the number of all sampled students i.e., 6,761, or all male (3,413) or all female (3,348) sampled students.

All 157 schools selected for the Main Study agreed to participate, with principals and school contact persons given the opportunity to select a test date that suited them best, to minimise disruption and the burden to schools, students and teachers. Across these schools, 6,761 students were selected to participate (Table 1.3). In total, 5,577 students (82.5% unweighted) participated in the assessment in 2018. Of the 6,761 students selected to participate, 59 were deemed ineligible, because, for example, their dates of birth were outside the testing window or they no longer attended the selected school (Table 1.3). A further 868 were did not participate in testing or were absent on the day on which the test was administered. Of these, 75 were withdrawn from the assessment by their parents.

In all, 257 students (or 3.8% of all sampled students) were exempted from testing (Tables 1.3 and 1.4). Table 1.4 presents the breakdown of the unweighted number and percentage of students exempted. Students exempted because of limited language proficiency included exchange students from other EU countries who were enrolled in post-primary schools in Ireland for part of the 2017-18 school year and were deemed by their school principal or the school contact to have insufficient language skills to attempt the PISA tests. Students in Irish medium schools and schools providing an Irish stream were given the option to sit the assessment in Irish[21]; 76 students opted to take the cognitive assessment in Irish, while 29 students elected to complete the questionnaires in Irish.

21 Reading literacy is assessed in English, while science and mathematics are assessed in Irish.

Table 1.4: Unweighted numbers and percentages of within-school exemptions in Ireland, by category

Category	Functional disability	Intellectual disability/ behavioural or emotional disorder	Limited language proficiency	Specific learning disability (e.g., severe dyslexic difficulties)	Total
Number – unweighted	39	90	45	83	257
Exemptions as a % of all sampled students	0.6%	1.3%	0.7%	1.2%	3.8%

Source: OECD (2019b), Annex 2.

The weighted and unweighted school-level response rates in Ireland were 100% (Table A1.1), i.e. all sampled schools agreed to take part. This was broadly in line with PISA 2012 and 2015 and exceeded the OECD requirement of 85% participation at school level. The weighted and unweighted student response rates in Ireland (after excluding ineligible and exempted students) were both 86.5%. Hence, the required weighted student-level response rate of 80.0% was exceeded. PISA requires that 50% of students selected in a school to take the PISA assessment (excluding ineligible and exempted students) to attempt both test and questionnaire. If this falls below 50%, the school is considered not to have participated. All schools achieved a student participation rate of at least 50%. Table 1.5 shows the distribution of participating PISA 2018 students in Ireland across year levels. Three-fifths of participants (61.6%) were in Third Year, 27.9% in Transition Year, 8.5% in Fifth Year and a very small minority (1.8%) in First/Second Year.

Table 1.5: Unweighted numbers of students and weighted percentages in Ireland completing the PISA 2018 assessment

Grade Level	Ireland equivalent	Unweighted number of students	Weighted percent
Grade 7 / 8	First / Second Year	116	1.8
Grade 9	Third Year	3,533	61.6
Grade 10	Transition Year	1,479	27.9
Grade 11	Fifth Year	449	8.5

Source: PISA 2018 Weighting Summary Report for Ireland, issued by Westat in July 2019. The numbers of students in First and Second Year are collapsed due to the small numbers of students.

Comparing the participation rates in Ireland in 2015 and 2018, the school response rates were equally high in both cycles (88.6% and 86.5% respectively). The school sample size for PISA is a minimum of 150 post-primary schools, with seven schools added in 2018 in Ireland after small school analysis, which oversamples small schools in the population to ensure representativeness in the sample. Two changes implemented during the 2018 cycle are relevant here. First, the national team decided to increase the size of PISA sessions from 42 (two groups of 21) to 44 (two groups of 22) students per school. Second, the cut-off points for school size (an explicit stratifier) were adjusted from 2015[22], to balance out the number of schools across 9 strata (school size by school sector).

22 The cut-off points for school size were increased from 'up to 40' in 2015 to 'up to 45' PISA-eligible students in the smallest school size category. The cut-off between medium and large schools was also increased from 80 to 85 PISA-eligible students.

The within-school exclusion (exemption) rate increased from 3.0% in 2015 to 3.8% in 2018; however, this is an improvement from the 2012 exclusion rate of 4.5% (E-Appendix Table A1.2, Perkins et al, 2013). In 2015 and 2018, there was strong liaison between the ERC, test administrators and schools in relation to who should be excluded from testing. There was a more balanced proportion of male students in 2018, at 49.7%, from 51.3% 2015, although adjustments to student weights were designed to address this in the scaling and analysis of the data in both cycles.

There was relative consistency in student response rates in 2015 and 2018, with weighted response rates of 88.6% and 86.5% respectively, well in excess of the 80% stipulated in the PISA 2018 Technical Standards. A particular challenge in organising PISA in Ireland in recent years has been access to Transition Year students. These students are often engaged in out-of-school activities such as work placements or school trips during the PISA testing window. This reduced the number of days on which PISA could be administered during the relatively short testing window (the month of March and part of April), and with early Easter holidays. With the challenges associated with testing in the springtime, a feasibility study for autumn testing took place in late 2018. The findings of this study will be published in 2020.

The percentages of the students participating in PISA across the three most recent cycles is relatively stable by school sector and gender composition (Table 1.6). The weighted percentage of students participating in PISA 2018 from DEIS post-primary schools is higher than the overall percentage of students attending DEIS schools in Ireland (Table 1.6); however, the percentage of assessed students in DEIS schools in PISA 2018 is representative of the total population of PISA-eligible students (15-year-olds) in Ireland, i.e. there is no statistical difference between the two groups. The PISA 2018 sample is also not significantly different to that of the PISA 2015 sample, in respect of the representativeness of students attending DEIS schools (Table A1.4).

Table 1.6: Weighted percentages of students by school sector and gender composition, and by school DEIS status participating in PISA 2015 and 2018, and overall percentage of 15-year-old students in Ireland attending DEIS schools in 2016/2017

Sector	% 2018	% 2015	% 2012
Girls Secondary	21.3	21.1	21.6
Boys Secondary	15.0	16.7	16.2
Community/Comprehension	17.0	17.6	16.8
Mixed Secondary	17.6	18.6	20.3
Vocational (ETB)	29.1	26.0	25.1
DEIS Status	**% 2018**	**% 2015**	**% 15-year-old students attending DEIS schools 2016-17[23]**
Non-DEIS	75.9	84.1	78.5
DEIS	24.1	15.9	21.5

All PISA technical standards were met by Ireland in relation to the administration of PISA 2018. The data for the United States, Hong Kong (China), the Netherlands and Portugal did not meet the PISA technical standards but were accepted as largely comparable (OECD, 2020, in press). In addition, the

23 Unweighted data from the Department of Education and Skills; these are based on the total number of 15-year-old students in the 2016-17 academic year attending DEIS schools in Ireland.

OECD decided to defer the publication of PISA 2018 reading literacy results for Spain and these are not included in the reports published on the 3rd of December, 2019. Anomalies in one section of the reading literacy assessment, identified via timing data on student responses, were being investigated at the time of writing. Therefore, the final section in this chapter - Interpreting Analyses in this Report - includes reference to the use of different OECD averages. This is relevant in relation to the reporting of 2018 results for reading literacy and on the reporting of reading literacy trend comparisons 2009-2018 involving OECD average scores. The use of OECD averages based on a different group of countries is noted in the relevant chapters and sections, where appropriate.

1.4 Structure of This Report

The report is divided up into seven chapters, including this overview of the implementation of PISA 2018 in Ireland. The research and policy context of PISA 2018 is outlined in Chapter 2, including the achievement outcomes of PISA from previous cycles and from other studies, factors associated with achievement and recent policies and developments in education in Ireland. The results for PISA 2018 reading literacy and associated trend information are provided in Chapter 3, with the results for science and mathematics outlined in Chapter 4 and 5, respectively. Each of the three achievement chapters outlines the relevant assessment framework and sample items, before the overall results are presented, with overall mean scores, proficiency levels, breakdown by several student- and school-level variables and the reporting of trends over multiple cycles. Chapter 6 sets out the selected key findings from the student and school questionnaires on reading engagement and strategies, use of digital technology in school, and student well-being. Chapter 7 includes a summary of the key findings and a discussion of the results in the context of relevant research and policies. At the end of the current chapter, descriptions of statistical terminology are provided to aid with the interpretation of analyses presented in the report.

1.5 Interpreting the Analyses in This Report

Throughout the remaining chapters in this report, a number of statistical terms are used. These are defined in Box 1.1. below.

Box 1.1. How to Interpret the Analyses in this Report

OECD average

Throughout the report reference is made to the OECD average. This is the arithmetic mean of all OECD countries that have valid data on the indicator in question (e.g., reading literacy performance). The terms 'OECD average' and 'OECD mean' are used interchangeably throughout.

Columbia is set to become the 37th OECD country, and all OECD countries participated in PISA 2018. Throughout the report, the number of countries in the reported OECD average varies as it relates to the number of OECD countries in 2018 that had data available. In Chapters 3-5, which report on PISA 2018 outcomes, OECD average scores are generally based on either 36 (reading) or 37 (mathematics and science) participating OECD member countries.

Where performance is compared across PISA cycles (for example, reading in 2009 to 2018 in Chapter 3), the OECD average represents the number of OECD countries in 2018 that had valid data for the earlier cycle. If a country is omitted from the calculation of the OECD average because of difficulties with the data, this is noted under the relevant tables. This is the case in Chapter 3 on

reading literacy where the OECD average for 2018 results is based on 36 countries, due to the deferral of reporting on Spain's reading literacy data. In relation to the reporting of trends in reading literacy for the years 2009 and 2018, the OECD average is based on 35 countries, as Austria was excluded from trend comparisons in PISA 2009 and Spain's data were deferred in PISA 2018. In Chapter 2, where performance on previous cycles of PISA is reviewed, the OECD average is the published average for the year in which PISA was administered. For example, in PISA 2015, there were data for 35 OECD countries, and in PISA 2000, there were data for 23 OECD countries.

Data sources

For international comparisons, results were generally taken from the OECD reports on PISA 2018 (OECD, 2019d; OECD, 2019e) and were verified using a preliminary PISA 2018 international database. National analyses, especially those reported in Chapter 6, were conducted by the ERC. A number of national questions or demographic variables are included in the analyses in Chapters 3-5 and in Chapter 6. These variables were taken from the DES schools database.

Comparing mean scores

Because PISA assesses samples of students, and students only attempt a subset of PISA items, achievement estimates are prone to uncertainty arising from sampling and measurement error. The precision of these estimates is measured using the standard error, which is an estimate of the degree to which a statistic, such as a country mean, may be expected to vary about the true (but unknown) population mean. Assuming a normal distribution, a 95% confidence interval can be created around a mean using the following formula: *Statistic ± 1.96 standard errors.* The confidence interval is the range in which one would expect the population estimate to fall 95% of the time, if many repeated samples were used.

The standard errors associated with mean achievement scores in PISA were computed in a way that takes account of the two-stage, stratified sampling technique used in PISA, with adjustments made to the alpha level for multiple comparisons. The approach used for calculating sampling variances for PISA estimates is known as Fay's Balanced Repeated Replication (BRR), or balanced half-samples, which takes into account the clustered nature of the sample. Using this method, half of the sample is weighted by a K factor, which must be between 0 and 1 (set at 0.5 for PISA analyses), while the other half is weighted by 2-K.

Statistical significance

Statistical significance indicates that a difference between estimates has not occurred by chance and would likely occur again if the survey was repeated (i.e., for significance at the 5% level, the observed difference would most likely be observed again 95 times out of 100). In this report, mean scores are sometimes compared for countries or groups of students. When it is noted that such scores differ significantly from one another, the reader can infer that the difference is *statistically* significant. Within tables, statistically significant differences are generally indicated in bold.

Standard deviation

The standard deviation is a measure of the spread of scores for a particular group. The smaller the standard deviation, the less dispersed the scores are. The standard deviation provides a useful way of interpreting the difference in mean scores between groups, since it corresponds to percentages of a normally distributed population (i.e., 68% of students in a population have an achievement score that is within one standard deviation of the mean and 95% have a score that is within two standard deviations of the mean).

Proficiency levels

In PISA, student performance and the level of difficulty of assessment items are placed on a single scale for each domain assessed. This means that each scale can be divided into proficiency levels and the skills and competencies of students within each proficiency level can be described.

In 2018, six proficiency levels are described for mathematics, seven for science, and eight for reading literacy. In each domain, Level 2 is considered the minimum level of proficiency students should acquire by the end of schooling in the context of the United Nations Sustainable Development Goals (SDG global indicator 4.1.1c). However, according to the OECD, no one level of proficiency can be highlighted as the key level needed to participate effectively and productively in society and in future learning (OECD, 2019d).

Within a level, all students are expected to answer at least half of the items at that level correctly (and fewer than half of the items at a higher level). A student scoring at the bottom of a proficiency level has a .62 probability of answering the easiest items at that level correctly, and a .42 probability of answering the most difficult items correctly. A student scoring at the top of a level has a .62 probability of getting the most difficult items right, and a .78 probability of getting the easiest items right (OECD, 2016a, Figure 15.2).

Correlations

Correlation coefficients describe the strength of a relationship between two variables (e.g., the relationship between socioeconomic status and reading achievement). However, a correlation does not imply a causal relationship. The value of a correlation can range from -1 to +1.

A negative correlation (e.g., -.26) means that as one variable increases, the other decreases; a positive correlation (e.g., .26) means that both either increase or decrease together.

In this report, correlations are considered *strong if* $r > \pm .56$, *moderate-to-strong* if in the range $r \pm .41$ to $r \pm .55$, *moderate* if from $r \pm .26$ to $r \pm .40$, *weak-to-moderate* if $r = \pm .11$ to $r \pm .25$, and *weak* if $< r \pm .10$.

Bivariate Versus Multivariate, Multilevel Analyses

Results in Chapters 3 to 6 are largely based on bivariate analyses, in that they examine the relationship between two variables, such as mean achievement scores by gender, or reading engagement and mean achievement in reading literacy. These analyses are useful for identifying patterns but do not account for mediating variables. Multi-variate and multi-level analyses can provide a more nuanced understanding of individual differences in achievement, since an observed relationship between one variable and achievement may be partly or wholly accounted for by the other. Multi-variate analyses of PISA 2018 are planned for subsequent national thematic reporting in 2020 and 2021.

OECD Indices

Indices are initially scaled to a mean of 0 and a standard deviation of 1. Where indices are reported, percentages are generated for component items (which may be reported in an appendix table), and mean scores and standard errors, based on the indices, are presented in the body of the report.

The OECD used a two-parameter IRT model (a generalised partial credit model) to scale clusters of questionnaire items with more than two response options. These include indices such as Reading for Enjoyment or Time Spent Using Digital Devices during Class. Where the indices are based on trend (that is, the same items were administered in two or more cycles), scaling involved a concurrent calibration of the data for the years in question.

Chapter 2
Research and Policy Context of PISA 2018 in Ireland

This chapter describes the research and policy context of PISA 2018 in Ireland. The chapter is presented in three sections: the first looks at recent developments and policies in post-primary education in Ireland; the second considers the results of previous cycles of PISA and of other international assessments in education; and the final section reviews the variables associated with achievement in 2009, when reading literacy was also a major assessment domain in PISA.

2.1 Recent Developments in Education in Ireland

This section outlines the recent developments relevant to PISA in Ireland. It describes recently implemented policies including the *Statement of Strategy 2019-2021* for education in Ireland, and the *Digital Strategy for Schools, 2015-2020.* Developments related to Junior and Senior Cycle reform are then described, followed by an overview of curricular changes related to the three core PISA domains of reading (English), mathematics and science.

2.1.1 Strategies and policies relevant to PISA

The *Statement of Strategy 2019-2021* for the Department of Education and Skills sets out a three-year vision to facilitate learning experiences that challenge each person to realise their potential via the highest international standards, through a system that anticipates and responds to the changing needs of learners, society and the economy (DES, 2019a). One of the strategic actions is that current and future needs of learners, in a world being transformed by technology, are met within our education system. An expanded use of digital technologies in teaching, learning and assessment is highlighted, along with the need to equip education providers with the skills and support to provide a quality learning experience. PISA is referenced, along with other national and international surveys, as a source of information on the performance of Irish students, and as a means to measure progress against the goals outlined in the strategy and in a yearly action plan, though no specific performance targets are mentioned.

The *Action Plan for Education 2016-2019*, published before the PISA 2015 results were available, references the performance of Irish students in PISA 2012, noting that while they performed well on print and digital reading, mathematics and science, 'improvements are required in maths and science to match the best performers internationally' (DES, 2016: 14). There are three targets included in the 2016-2019 Action Plan, related to the proportion of high performers (PISA Proficiency Levels 5 and 6), the proportion of low performers (PISA Proficiency Level 2 and below), and the overall position of Ireland in relation to OECD countries (DES, 2016). At the time of the Action Plan, Ireland was in the top-ten OECD countries for reading literacy and science, but not for mathematics (based on PISA 2012). In PISA 2015, Ireland retained a top-ten position in reading literacy, but sat outside the targets for science and mathematics (the performance of Irish students in PISA 2015 is examined in more detail in Section 2.2).

The target for low performers in PISA in the *Action Plan for Education, 2016-2019* (DES, 2016) aims to reduce the percentage of students performing below Level 2 to less than 10% by 2025, across the three core domains (Table 2.1). In relation to the high performers in reading and science, the target is to increase the percentage performing at Levels 5-6 to 13% by 2025, a percentage that was above the OECD average in 2012. In relation to mathematics, the target is to increase, by 2025, the percentage of students at Levels 5-6 to that above the average across OECD countries (which was 13% in PISA 2012).

Table 2.1: Targets in the Action Plan for Education 2016-19 and Revised Literacy Numeracy Strategy targets (2017-2020)

	PISA Proficiency Levels	Action Plan 2016-2019 (by 2025)	Revised Literacy Numeracy Strategy 2017-2020	Position as of PISA 2015
Reading literacy	Below Level 2*	Less than 10%	Below 8.5%	10%
	At or above level 5	13%	12%	11%
	At or above level 4	-	40%	37%
Mathematics	Below level 2	Less than 10%	10.5%	15%
	At or above level 5	Above OECD avg (2015 – 10.7%)	13%	10%
	At or above level 4	-	36%	31%
Science	Below level 2	Less than 10%	-	15.3%
	At or above level 5	13%	-	7.1%
	At or above level 4	-	-	27.2%

Source: DES, 2016; DES, 2017c.
*For 'Below Level 2', a lower percentage of students is preferable, while for Levels 5-6, a higher one is preferable.

The National Literacy and Numeracy Strategy - *Literacy and Numeracy for Learning and Life, 2011-2020* (DES, 2011) – set out to raise standards in literacy and numeracy in educational contexts, in response to concerns about national standards. Concern was due, in part, to the profile of the PISA 2009 results that presented a large and significant drop in student performance on mathematics and reading literacy in Ireland. An interim review of the strategy took place in 2016, with new priorities and targets set for the period 2017-2020 (DES, 2017c), as the results from PISA 2015 indicated that all PISA-related targets[24] had been met or surpassed by 2015.

Since 2009, the performance of students in Ireland on mathematics and reading has been close to pre-2009 levels, showing relative consistency over time (for further discussion of trend results for reading and mathematics, see Section 2.2.1 and 2.2.3). Therefore, the revised targets may be considered a more meaningful benchmark against which to measure progress on the performance of Irish students. As is evident from the targets in the *Interim Review of the Literacy and Numeracy*

24 The strategy also includes targets for the National Assessments of English Reading and Mathematics and for the take up of Higher Level Mathematics at Junior Cycle and Leaving Certificate.

Strategy, there is a specific focus on supporting the highest-achieving students to reach their potential (DES, 2017c).

Considering both the targets in the *Action Plan for Education 2016-19* and the *Interim Review of the Literacy and Numeracy Strategy*, there are several relevant issues to note. First, PISA has employed computer-based assessment in most participating countries since 2015, and the tests in reading literacy and science now include new item formats and an assessment mode that students in Ireland may not be familiar with. Second, the number of OECD member countries continues to increase (it is now 37 with the approved accession of Columbia). This means that the OECD average periodically changes with the addition of new countries (there were 35 countries at the time of reporting for PISA 2015). Third (and somewhat related to the second), the OECD average has been steadily decreasing across the three domains in the most recent cycles of PISA.

A further point is related to the *Action Plan for Education* targets of fewer than 10% of students performing below Proficiency Level 2 by 2025 in the three core domains. To contextualise the target using PISA 2015 results, only one economy achieved this benchmark in reading literacy, Hong Kong China (9.3%), and Ireland was the next country with 10.2% of students performing below Level 2 (and the OECD country with the lowest percentage of low performing students). In mathematics, three countries achieved this benchmark, Macao China (6.6%), Singapore (7.6%), and Hong Kong China (9%), while 15% of students in Ireland performed below Level 2, the sixth lowest percentage among OECD countries. In science, six countries and economies achieved this target (Vietnam, Macao China, Estonia, Hong Kong China, Singapore, Japan, Canada), with Ireland at 15.5%, having the seventh lowest percentage of all OECD countries. However, when focusing on the targets set for the higher performers (at Levels 5 and 6) it is evident that there is greater scope for improvement, with a large gap between the performance of students in Ireland compared to the targets in both the Action Plan and the Revised Literacy Numeracy Strategy. For example, 7.1% of students in Ireland were classed as top performers (Proficiency Levels 5 and 6) in science in PISA 2015, while the corresponding Action Plan target is set at 13%. These themes and their implications for the interpretation of PISA 2018 results are discussed in Chapter 7.

The *STEM Education Policy Statement 2017-2026* and corresponding Implementation Plan (DES, 2017b) set out the context for a national focus on STEM education. The policy statement seeks to transform the STEM education experience of learners from early years through to post-primary, via three principles to underpin STEM initiatives: ignite learners' curiosity so they participate in solving real world problems and make informed career choices; enable learners to build and apply knowledge, deepen their understanding and develop creative and critical thinking skills; and STEM education should embody creativity, art and design. Four pillars guide the action plan, and under Pillar 3, 'Support STEM Education Practice', international studies such as PISA and TIMSS are highlighted as providing benchmarks for student achievement to support the evaluation of STEM education at post-primary level.

2.1.2 Digital strategy and Digital learning framework

Recent years have seen an increased number of strategies and reports on the integration and embedding of digital technology in the Irish education system. In Ireland and internationally, the integration of digital technology in teaching, learning and assessment in post-primary schools highlights the opportunities to enrich learning in a variety of ways.

The *Digital Strategy for Schools 2015-2020* (DES, 2015a) set out a five-year roadmap for the embedding of digital technology and digital learning tools in Irish primary and post-primary schools. It

built on an earlier policies and strategies focussed on investment in ICT in schools (e.g., DES, 2008), and utilises the baseline data collected in the ICT Census (Cosgrove et al., 2014a) as a starting point. The current strategy aims to facilitate the use of digital technology at all levels and in all spheres of teaching, learning and assessment, and references the impact on initial training and continuing professional development for teachers.

Four key themes are identified in the Strategy: teaching, learning and assessment using ICT; teacher professional learning; leadership, research, and policy; and ICT infrastructure. These key themes align with the Digital Learning Framework, part of the strategy for schools 2015-2020. A key objective of the Digital Learning Framework (DLF) was the adaptation of the UNESCO ICT Competency Framework for the Irish context, whilst also incorporating the learning from other international frameworks (DES, 2017a). The Digital Learning Framework Trial Evaluation Baseline Report (Cosgrove, et al., 2018a) highlighted the improvements in the infrastructure, engagement with and use of technology within the trial schools. The report also emphasised the interdependencies between dimensions and domains of the DLF, including teaching and learning, and leadership and management. In particular, it emphasised translation and transformation of the framework into actions at national and school levels.

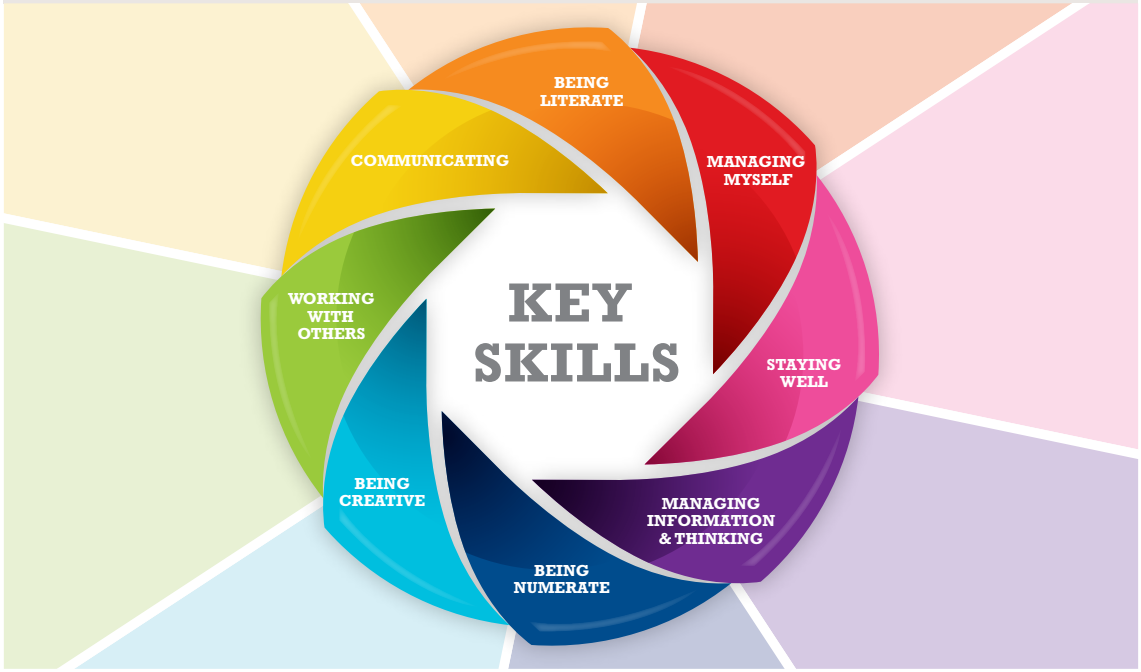
The final report from the trial evaluation on the DLF pilot in schools (Cosgrove et al., 2018b) noted two key challenges that were most frequently identified by DLF leaders, teachers and Professional Development Service for Teachers (PDST) advisors. These related to the time required to develop and implement changes, and to variability in digital technology infrastructure (hardware and connectivity). Other common challenges were the variations in teachers' digital competence and attitudes towards technology, and a perceived lack of support and leadership from school management. These challenges are particularly relevant for the contextualisation of results from PISA and in looking to support and allow students in Ireland to reach their potential in future education, training, and work environments.

While the embedding of digital technology into teaching and learning is underway, state examinations are mainly paper-based, although there has been some integration of multi-modal approaches in Classroom-Based Assessments. As noted in the PISA 2015 national report (Shiel et al., 2016), it is unlikely that greater use of computers by students in post-primary schools will by itself lead to the development of skills and strategies that students need to do well on the types of virtual experiments and interactive items they are now asked to respond to on PISA science and elsewhere. The development of interactive items for PISA mathematics in 2021 may present students with additional challenges (see Chapter 7).

2.1.3 Junior and Senior Cycle reform and curricular developments

The Junior Cycle programme has been under phased reform over the past five years, under the *Framework for the Junior Cycle* (DES, 2015b). Containing 24 statements of learning, underpinned by the eight key skills (Figure 2.1), the framework allows for schools to plan for, design and evaluate their Junior Cycle programmes. The framework includes strong links to the school self-evaluation (SSE) process, and emphasises development of literacy and numeracy across subject areas, in line with the *National Literacy and Numeracy Strategy 2011-2020*. Of particular relevance to PISA is the phased transition to new curriculum specifications (Table 2.2) and the emphasis on the area of well-being.

Figure 2.1: The Key Skills of the Junior Cycle



Source: NCCA website, (https://www.ncca.ie/en/junior-cycle/framework-for-junior-cycle).

The Key Skills underpinning the Junior Cycle have a strong overlap with other frameworks, such as the *Key Competencies Framework* (European Commission, 2012), and the *21st Century Skills Project* (Griffin, McGaw & Care, 2012). The emphasis on numeracy and literacy is consistent with earlier national strategies, but is now combined with newer emphases on being creative, staying well, managing oneself, and managing information and thinking. The role and individual-level interaction with digital technology is pertinent to several of these areas, in being responsible, safe and ethical (staying well), accessing, using and managing content (managing information), and stimulating creativity using digital technology (being creative).

Students entering First Year in the 2019-2020 school year are studying new specifications in all subjects, under a five-phase approach to Junior Cycle reform. Students participating in PISA 2018, who were drawn from a range of grade levels between First and Fifth Years (with a majority in Third Year), had studied or were studying a mix of subjects based on Junior Certificate Syllabi published prior to 2012, and new Junior Cycle specifications since phase one changes began in 2014.

The new English specification was introduced in 2014, and thus all participating students in PISA 2018 studied under the new specification (Table 2.2). The new science specification was introduced in 2016, with the first round of students sitting that subject as part of the Junior Cycle Profile of Achievement (JCPA) in 2019. Therefore, fewer than 2% of students participating in PISA 2018 (those in First and Second years) studied under the new specification for science. The new mathematics specification was introduced in September 2018; only a small number of First Year students participating in PISA 2018 had studied under the new specification at the time of the assessment in March-April 2018.

Table 2.2: The new Junior Cycle introduction dates relevant to PISA, for First Year students, and for the first JCPA.

Subject	First introduced to First Year students	First Year of JCPA Reporting
English	September 2014	Autumn 2017
Science	September 2016	Autumn 2019
Wellbeing	2017	n/a
Mathematics	September 2018	Autumn 2021

Source: NCCA website, https://www.ncca.ie/en/junior-cycle/assessment-and-reporting/junior-certificate.

English

The new Junior Cycle specification for English comprises three strands: oral language, reading and writing, with three elements underpinning the three strands: communicating as a listener, speaker, reader, and writer; exploring and using language; and understanding the content and structure of language (NCCA, 2018a). The structure of the Junior Cycle specification for English mirrors the structure of the primary language curriculum, with continuity prioritised over the transition from primary to post-primary schooling. The new specification differs from the old syllabus in that it includes a clearer presentation of learning outcomes, and clearer links across elements and strands, as well as a clearer focus on the use of multi-media texts. Assessment arrangements also differ, with the introduction of new classroom-based assessments including one based on oral language, the requirement for students to complete an assessment task that is externally marked, and the amalgamation of the old Ordinary and Foundation levels.

Also relevant to PISA is that the format of the Junior Cycle English examination is subject to change year-on-year, unlike previous examinations, and requires good exam technique and time management (SEC, 2017). Unlike PISA[25], the Chief Examiner's Report for English noted that the standard of expression, syntax, spelling and punctuation influenced the outcome for each candidate (*ibid*).

Science

Prior to September 2016, the suggested content of the Junior Certificate Science Course was outlined in the Junior Certificate Science Syllabus (NCCA, 2003). The syllabus was described using three major domains, biology, chemistry and physics, each of which was associated with a number of additional sub-domains. The Junior Certificate Science course was assessed at two levels, Higher and Ordinary level. According to the syllabus, the relative difficulty of questions and grading criteria were intended to differ between higher and ordinary levels, although all students were to be assessed using an identical assessment structure.

The new Science Junior Certificate specification (NCCA, 2015) introduced in the 2016-2017 academic year relates Junior Cycle science to the PISA 2015 Science Framework (OECD, 2016a) and to the PISA definition of scientific literacy (see Chapter 4). A key change to the new specification is the inclusion of the nature of science strand, along with the introduction of Earth and Space as a discrete content area, bringing the total number of strands to five. The nature of science is a core unifying strand; it cuts across the four other strands, facilitating scientific enquiry and making 'the

25 Scoring in PISA does not penalise students for spelling, grammar or punctuation errors.

science classroom a dynamic and interactive space, in which students are active participants in their development' (NCCA, 2015: p. 11). The core elements of this strand are relevant to PISA: understanding about science; investigating in science; communicating in science; and science in society. Reflecting on the interactive items that are included since PISA 2015 (see section 4.2), element 4 in the nature of science strand is of particular note in that, 'students should be able to produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions' (NCCA, 2015: p. 16). As with other subjects, JCPA assessment for science involves Classroom-Based Assessments, an Assessment Task, and a final common level paper assessment at the end of Third Year.

PISA science (and mathematics) are also referenced in *the STEM Education Policy Statement 2017-2026*, where it is noted that, while there are encouraging trends, there is room for improvement in these areas (DES, 2017b).

Mathematics

In Ireland, PISA has influenced the development of curricula for Junior Cycle mathematics, including the curriculum referred to as Project Maths, implemented on a phased basis between 2008 and 2015 (e.g., Conway & Sloane, 2005; Jeffes et al., 2012, 2013; Kirwan, 2015; Merriman et al., 2014; Shiel & Kelleher, 2017), and its successor (NCCA, 2017), which reflects the focus on being numerate in the Junior Cycle Framework (DES, 2015b), as well as on new approaches to assessment. However, as Kirwan (2015) has noted, while PISA mathematics has focused for the most part on students' ability to solve mathematical problems presented in real-life contexts, recent assessment of mathematics at Junior Cycle has featured a dual approach, focusing on abstract, symbolic mathematics as well as the application of mathematical knowledge in solving realistic problems.

The new specification for mathematics was introduced to First Year students in 2018; therefore, all but a small number of PISA 2018-eligible students in First Year studied under the previous specification, often referred to as Project Maths. Students participating in PISA 2018 are the last PISA cohort who will have studied under the 'Project Maths' syllabi at Junior Cycle level. An evaluation of the impact of Project Maths on the performance of students in Junior Cycle mathematics was undertaken by Shiel and Kelleher (2017), on behalf of the NCCA. Based on available data, the report concluded that the Project Maths curriculum had a small positive impact on student performance in mathematics, as measured by PISA 2015 and TIMSS 2015. The report identified relative weaknesses that need to be addressed, referring to student performance on Space and Shape in PISA and on Algebra and Geometry in TIMSS. Looking ahead to the transition to computer-based assessment in international studies like PISA and eTIMSS, the report suggested that the role of digital technology in developing and assessing students' mathematical knowledge in interactive ways may need to be examined. This is discussed later in this report (in Chapter 7) in relation to PISA 2021 and the introduction of new interactive items in PISA mathematics.

The overall aim of the new mathematics specification is to foster mathematical proficiency among Junior Cycle students, and in this way, it is consistent with its predecessor. Mathematical proficiency is a multi-dimensional concept, composed of five interrelated components, including conceptual understanding and adaptive reasoning. The specification illustrates how Junior Cycle mathematics is embedded in, and interwoven with, the *Framework for Junior Cycle*. The use of technology within mathematics is also referenced, and new approaches to assessment are introduced. Structurally, the new specification differs from the previous syllabus in a number of ways. For example, the content strands of Algebra and Functions are combined into a single strand, resulting in four content strands. These strands are underpinned by a fifth unifying strand, which consists of six 'Elements'.

These elements include 'Building blocks' (understanding key concepts and carrying out procedures) as well as other key mathematical skills/processes such as representing, problem solving and communicating. The elements are seen as inextricably linked to each other, as well as to the content and learning activities of the other four strands. This contrasts with earlier syllabi where content areas and processes were described separately. As a result, it is envisaged that over the three-year cycle, students will engage with the various aspects of the specification in an integrated manner.

Senior Cycle Review

About one-third of PISA-eligible students in Ireland are in Transition Year and Fifth Year; hence, developments at Senior Cycle may also be relevant to PISA. The Senior Cycle programme is currently under review by the National Council for Curriculum and Assessment (NCCA) and was sent out for public consultation (phase three) in autumn 2019. The NCCA published an interim report in July 2019 outlining several challenges identified within the current approach taken at Senior Cycle, including high stress levels for students, a narrow assessment timeline for the Leaving Certificate Established, and reporting on a narrow range of skills (NCCA, 2019).

Questions were also raised about the range of teaching and learning methods and assessment approaches and whether diversified (short, longer, or accelerated) programmes should be offered to Senior Cycle students. Key strengths highlighted include the wide range of subjects offered, and the fairness of an external certification process. An advisory report, which will issue to the Minister for Education and Skills for consideration, will be the product of the review and consultation process. The aim of the new Junior Cycle, providing a much broader snapshot of student achievement and skills, and drawing attention away from a single high-stakes examination at the end of Third Year, contextualises the discussion of teaching, learning and assessment at Senior Cycle. As highlighted by Banks, McCoy and Smyth (2018), teachers and students feel under pressure to 'cover the course', and this results in a focus on rote learning, to the neglect of higher order thinking and broader skill development.

Well-being

A Junior Cycle curriculum specification for well-being was introduced in 2017-18 academic year (NCCA, 2017b). The Junior Cycle Framework stresses that well-being in Junior Cycle is about young people feeling confident, happy, healthy and connected (DES, 2015b). The *Wellbeing Policy Statement and Framework for Practice* (DES, 2019b) sets out the vision on how to underpin and promote the wellbeing of young people in Ireland. The relationship between student performance and well-being is underlined: 'children and young people learn more effectively and have better academic outcomes if they are happy in their work, believe in themselves and feel acknowledged and supported in their schools' (*ibid:* 8). The national policy environment for well-being is consistent with the international context, 'in other words, what happens in school is crucial for well-being' (OECD, 2017a, p. 19).

The promotion of student well-being, now a core issue, has been integrated into the delivery of the Junior Cycle, to enable children and young people to achieve their full potential. Wellbeing is an interagency issue, and cuts across the work of several departments, with data from PISA also included in the *National Policy Framework for Children and Young People 2014-2020 – Better Outcomes Brighter Futures* (BOBF) indicator list, for well-being indicators, parent-child interaction, and internet use, alongside achievement scores in reading literacy, mathematics and science.

2.2 Achievement Outcomes from Previous PISA Cycles and Other National and International Studies

This section presents the achievement outcomes from previous cycles of PISA, up to and including PISA 2015, and briefly outlines achievement outcomes from other international assessments such as the Programme for International Assessment of Adult Competencies (PIAAC), Trends in International Mathematics and Science (TIMSS) and Progress in International Reading Literacy Study (PIRLS). Outcomes of recent national assessments at primary level are also examined.

In each cycle of PISA, the performance of students is linked back to the performance of their counterparts in previous cycles in order to allow for the reporting of trends. Between PISA 2000 and 2012, the core assessments were paper-based, and since 2015 the domains of reading literacy, science and mathematics have been administered on computer in most participating countries including Ireland. Since 2015, all previous cycles of PISA have been used to form the link for reporting trends, whereas up to 2012 the linking of trend data was only based on the current and previous cycles.

The data presented in this section have been extracted from the appendix tables referenced in Volumes I and II of the international reports on PISA 2018 (OECD 2019d, OECD 2019e). These data may differ from the data in previous national reports based on the maximum number of OECD countries with data available in a given cycle. The data source is referenced under each table.

2.2.1 PISA reading literacy, 2000-2015

PISA reading literacy was taken on paper in all participating countries in each cycle between 2000 and 2012, though optional computer-based versions were also taken in some countries, including Ireland, in both 2009 and 2012. In PISA 2015, the transition to computer-based assessment, which occurred in most participating countries including Ireland, involved the transfer of paper-based items to computer and items presented on computer in 2009 and 2012 were not used. As noted in Chapter 1, it was in advance of PISA 2018 that the framework for reading literacy was substantially revised, and additional item types were developed, including items based on multiple texts. Multi-stage adaptive testing was also introduced for PISA 2018.

Average performance on reading literacy in Ireland has been significantly above the OECD average in each PISA cycle to date, with the exception of PISA 2009, when Ireland's mean score was not significantly different from the OECD average (Figure 2.2). On average across OECD countries, performance has also been relatively stable. The average score across 35 OECD countries dropped from 491.2 in 2009 to 490.2 in 2015, a difference that is not statistically significant. The highest performing country on reading literacy in 2012, and the only country with a mean score that was significantly higher than Ireland's in that year, was Singapore (535.1). In that year, Ireland ranked 3rd among 35 OECD countries (or 2nd to 6th, if a 95% confidence interval is applied), and 5th of 70 participating counties (or 4th to 8th, if a 95% confidence interval is applied).

The drop in performance of students in Ireland on PISA reading in 2009 is an outlier compared to all other cycles. Subsequent analyses of the Irish PISA 2009 data indicate that at least some of the decrease is attributable to issues with the reading literacy test design, changes in missing response patterns on test items, and the international scaling procedure used in 2009 (Cosgrove & Cartwright, 2014). More recent research suggests that if a scaling model that accounts for changes in missing data patterns is applied to the Irish PISA 2009 data to estimate trends, the large decline in reading scores is reduced (Sachse, Mahler & Pohl, 2019). Therefore, while the trend comparison

for Ireland shows significant increases from 2012 onwards, care needs to exercised in claiming that performance has actually improved since 2009.

In Ireland, 17.2% of students performed below proficiency Level 2 in reading in 2009. This dropped significantly to 9.6% in 2012, when Ireland's mean score increased by 27.9 score points, and increased slightly to 10.2% in 2015 (OECD, 2019d, Table 1.B1.7). On average across 35 OECD countries, 19.4% performed below Level 2 in 2009, and this increased marginally to 20.9% in 2015. Hence, in 2012 and 2015, considerably fewer students in Ireland performed below Level 2, compared with the corresponding OECD averages. Moreover, in both years, only a small number of countries (for example Estonia at 9.1% in 2012) had as few students below Level 2 as Ireland.

Figure 2.2: Performance on PISA reading literacy 2000-2015, for the OECD and Ireland

Note. Data for OECD average in 2000 is based on 23 countries, for 2003 on 29 countries, and for 2006 on 35 countries (excluding Austria and the United States); data for 2009-2015 is the OECD average of 35 countries (excluding Austria and Spain). Source: OECD (2019b, Table I.B1.10).

In Ireland, 7.0% of students performed at Levels 5-6 in 2009. This increased significantly to 11.4% in 2012, in line with the overall increase in mean performance, and fell back a little to 10.7% in 2015. On average across 35 OECD countries, 7.3% performed at Levels 5-6 in 2009 (about the same as in Ireland in that year). In both 2012 and 2015, 8.1% performed at Levels 5-6 – significantly fewer than in Ireland in both years.

Across PISA cycles, there have been relatively large gender differences in reading literacy in favour of female students. In PISA 2009, female students in Ireland achieved a mean score of 515.5 on paper-based reading literacy, while the mean score of male students was 476.3. The difference, 39.2 score points, is statistically significant. In 2012, females had a mean score of 537.7, while males had a mean score of 509.2. The difference, 28.5 score points in favour of females, is again statistically significant. In 2015, when PISA paper-based items for reading moved to a computer-based platform, female students in Ireland achieved a mean score of 527.9, while males achieved a mean score of 515.0. The differences, a significant 12.0 score points in favour of females, was among the lowest across OECD countries. In 2009, female students across 35 OECD countries (excluding Austria and Spain), achieved a mean achieved score of 511.0, while males achieved a mean score of 471.7. The difference, 39.2 score points in favour of females (the same as the difference in Ireland in that year), is statistically significant. In 2015, the scores of female and male students across 35 OECD countries

were 504.0 and 477.7 respectively; again, the difference, 27.3 score points in favour of females, is statistically significant.

2.2.2 PISA science, 2006-2015

The PISA science framework was updated in the 2015 cycle, during the transition to computer-based platform. The test development process incorporated the technological features of the computer-based platform by integrating interactive simulation items that now form part of the assessment.

The mean score of students in Ireland on PISA science in 2006 was 508.3. Ireland's mean score in 2009 was about the same (508.0), but increased significantly to 522.0 in 2012, before falling significantly to 502.6 in 2015 (Figure 2.3), coinciding with the implementation of computer-based testing in most participating countries, including Ireland. It is noteworthy that performance on PISA science in Ireland was stable in 2009, when the mean scores of students dropped significantly in both reading literacy and maths, suggesting that, perhaps, the improvement observed in 2012 had already been built into the 2009 mean score but was hidden by other factors. The OECD average score for science dropped from 494.8 in 2006 to 490.6 in 2015 for 37 OECD countries that participated in both years, though the 4.2 score point difference is not statistically significant. On the other hand, the 7.7 score points difference in OECD average scores between 2012 and 2015 is statistically significant. This drop in performance, while smaller than the drop of 19.4 score points in Ireland, also coincided with the implementation of computer-based testing in most countries participating in PISA.

Figure 2.3: Performance on PISA science 2006-2015, for the OECD and Ireland

Note. Data for 2006, 2012, 2015 is the OECD average of 37 countries, and for 2009 the average of 36 countries (excluding Austria). Source: OECD, 2019b, I.B1.12

The proportions of students in Ireland performing below proficiency Level 2 in science have been broadly similar across most PISA cycles, ranging from 15.5% in 2006 to 15.3% in 2015. However, in 2012, when Ireland's mean score in science increased significantly compared with 2009, just 11.1% performed below Level 2. On average across OECD countries, 21.0% performed below Level 2 in 2006, while 22.1% did so in 2015. There was a small drop in 2012, when 18.6% performed below Level 2.

The proportions of students in Ireland performing at proficiency Levels 5-6 in science fell from 9.4% in 2006 to 7.1% in 2015, a difference that is statistically significant. In 2012, when Ireland's mean score in science improved compared with earlier cycles, 10.7% of students performed at Levels 5-6. On average across OECD countries, 8.4% performed at Levels 5-6 in 2006, while 7.4% did so in 2015. It is noteworthy that, with the exception of 2012, the percentages of students in Ireland achieving Levels 5-6 are not significantly different from the corresponding OECD average percentages, even though the overall mean score for Ireland has been significantly above the OECD average in each PISA cycle to date.

In an analysis of percent correct scores between 2012 and 2015, Shiel et al. (2016) noted that Irish students underperformed on the new interactive science items relative to their performance on trend science items in comparison to selected comparator countries and the OECD average.

In PISA 2006, there was no difference in science performance between male and female students in Ireland, where their respective mean scores were 508.1 and 508.5. In PISA 2012, the mean score of males (523.9) was not significantly different from that of females (520.0). In PISA 2015, when PISA science was a major assessment domain, and it moved to computer-based testing, the mean score of males (507.7) was significantly higher than that of females (497.2), by 10.5 score points. On average across 37 OECD countries in 2006, males (495.8) had a marginally but significantly higher mean score than females (493.8), with a difference of 1.9 score points. In 2015, the OECD average score for males was 492.3, while for females it was 488.9. The difference, 3.4 score points in favour of male students, is also statistically significant.

2.2.3 PISA mathematics, 2003-2015

The PISA mathematics framework was updated for the 2012 cycle, the last time mathematics was a main domain. Prior to 2012, the framework had been updated in 2003. The mode of administration was paper-based in 2012, with an optional assessment of digital mathematics on offer to countries in that cycle. With the change of mode to computer in most participating countries including Ireland in 2015, a subset of paper-based items from 2012 was transferred to the computer-based platform with minimal changes, ensuring the format and presentation of items was as close as possible to the presentation of the units on paper in 2012. No new items for mathematics have been developed since 2012, nor have the optional computer-based items from 2012 been used. Hence, there are no items that seek to take advantage of the capabilities of testing on a computer-based platform to assess mathematics (e.g., interactive items, new response formats etc.). The mathematics framework and corresponding test items are currently being updated for the next cycle in 2021.

The overall trend in student performance in Ireland on PISA mathematics since 2003 has been relatively stable, except for a significant decline experienced in 2009 (Figure 2.4). Ireland's performance on mathematics was not significantly different from the OECD average in 2003, significantly above the OECD average in 2006, not significantly different from the OECD average in 2009[26], and significantly above the OECD average in both 2012 and 2015 (Perkins et al., 2012; Perkins et al., 2013; Shiel et al., 2016). The OECD categorises the performance trajectory as U-shaped (OECD, 2019d); however, when 2009 is removed, mean performance in mathematics in all other years is close to that observed in the first cycle in which mathematics was the main domain, 2003, with the OECD average falling since then.

26 Initial reports on PISA 2009 (e.g., Perkins et al., 2010) showed that the mean score for Ireland was significantly below the OECD average of 495.7, based on 34 OECD countries.

In 2012, when mathematics was last a major domain, students in Ireland achieved an overall mean score of 501.5, compared to the OECD average of 490.4. Ireland ranked 13th out of 37 OECD countries and 20th overall, with a true rank (at a 95% confidence interval) ranging from 11th to 17th across the OECD countries and 18th to 24th across all participating countries. In 2012, Ireland's performance on mathematics was not significantly different to that of the United Kingdom, Austria, France, Denmark and New Zealand (among other countries). Ireland outperformed several countries including Norway, the United States and Sweden. The top seven performing countries and economies were Asian, with Shanghai-China standing out as the top performing region with a mean score of 612.7, followed by Singapore at 573.5. Korea was the highest performing OECD country with a mean score of 536.4 (OECD, 2019d, Table 1.B1.11).

Figure 2.4: Performance on PISA mathematics 2003-2015, for the OECD and Ireland

Note. The OECD average for 2003 is based on 30 countries, for 2006 on 37 countries, for 2009 on 36 countries (excluding Austria), and for 2012-2015 on 37 countries again. Source: OECD, 2019b, Table I.B1.11.

In 2015, when the transition to computer-based assessment took place, student performance in mathematics in Ireland (503.7 score points) was slightly but not significantly higher than in 2012, while the OECD average dropped significantly to 487.2. Ireland ranked 13th out of 37 OECD countries, and 18th out of all 70 participating countries and economies. Ireland's true rank, which takes account of measurement and sampling error, was between 10th and 14th across the OECD, and 15th and 19th across all countries. Ireland's performance on PISA mathematics in 2015 was not significantly different to that of Austria (496.7), Belgium (507.0), Germany (506.0) and Norway (501.7), while it was significantly above the performance of students in United Kingdom (492.5) and the United States (469.6). Students in Singapore recorded the highest overall mean score of 564.2, while Japan was the highest-performing OECD country, with a mean score of 532.4.

Lower percentages of students in Ireland performed below proficiency Level 2 in 2012 (16.8%) and in 2015 (15.0%), compared to 24.4% on average across OECD countries in 2012, and 24.6% in 2015. Ireland has a smaller percentage of students performing below Level 2 (15.0%) compared with Germany (17.7%), the United Kingdom (21.8%), and the United States (25.5%). Shanghai-China was the region with the lowest percentage of students performing below Level 2 (3.8%), followed by Korea (9.1%) and Finland (12.3%).

In 2012, 10.7% of students in Ireland performed at the highest levels in mathematics (Levels 5 and 6), compared to 12.1% across the OECD, even though Ireland's mean score was significantly above the OECD average. In 2015, 9.8% of students performed at Levels 5-6, compared to 10.9% on average across OECD countries. In 2015, several comparator countries had a higher percentage of students performing at Levels 5-6 than Ireland, including the United Kingdom (10.6%), Germany (12.9%), and Canada (15.1%). Singapore had the highest percentage of students performing at Levels 5-6 (34.8%).

In 2012, male students in Ireland had a mean score in mathematics that was significantly higher than that of females, by 15.3 score points. On average across OECD countries, the corresponding difference was 10.6 score points, which was also statistically significant. In 2015, male students in Ireland achieved a mean score that was again significantly higher than that of females, by 16.1 score points. On average across OECD countries, the difference in favour of males was a significant 7.8 score points. Hence, in 2015, in both mathematics and science, the size of the gender difference was greater in Ireland than on average across OECD countries.

2.2.4 PIAAC

In late 2011 and early 2012, the first round of PIAAC (the OECD's Programme for the International Assessment of Adult Competencies) was administered to adults aged 16-64 in 24 countries. In Ireland, this was overseen by the Central Statistics Office (CSO), on behalf of the Department of Education and Skills. The mean score[27] of Irish adults for literacy was 267, which was not significantly different from the study average of 268 (OECD, 2016b). The mean score of Irish adults on numeracy, 256 score points, was significantly below the study average of 263. On a third measure, computer-based problem solving, where mean scores are not reported, 25% of adults in Ireland performed at Level 2 or 3 (the highest proficiency levels), significantly below the OECD average of 31%. The performance of countries in PIAAC that are often included as comparator countries for Ireland when reporting on PISA results is useful to consider, especially in relation to problem-solving in technology rich environments; 44% of adults in New Zealand performed at Proficiency Levels 2 or 3, along with 42% of adults in Finland, 42% in the Netherlands, 29% in Northern Ireland, 35% in England and 31% in the United States.

As noted in the PISA 2015 national report (Shiel et al., 2016), when the performance of Irish adults in PIAAC is compared with the performance of adults who could have been in the PISA cohorts of 2000, 2003, 2006, 2009 and 2012[28], Irish adults scored less well in PIAAC, suggesting a deterioration in skills since lower post-primary schooling. However, as there is no direct link between the studies in the form of common items, or a targeted analysis of the performance of PIAAC participants who took part in earlier PISA cycles, firm conclusions about skills levels throughout the lifecycle cannot be drawn. The second cycle of PIAAC will take place 2021-2022, with publication of results expected in late 2023.

27 As a study of the OECD, the results are reported in a similar vein to that of PISA, though with a mean score of 500 across all participating countries and five proficiency levels for literacy and numeracy, and four proficiency levels for problem-solving.

28 17-19 years, 20-22 years, 23-25 years, and 26-28 years of age respectively.

2.2.5 TIMSS

Students in Ireland have participated in three rounds of TIMSS at post-primary level (1995, 2015 and 2019), with the 2019 results not yet published. TIMSS is a study of the International Association for the Evaluation of Education (IEA); it is a grade-based study that assesses the mathematics and science achievement of Second Year students on a four-year cycle, while PISA takes place every three years and draws on an age-based sample. There are a number of other differences between PISA and TIMSS. For example, TIMSS places equal weight on both mathematics and science in each cycle, whilst PISA has a main domain and two minor domains in each cycle. TIMSS is curriculum-based, drawing on the content covered in school curricula across the participating countries, while PISA emphasises real-world skills. Both studies provide evidence-based information for policy-making, drawing on different emphases within the education system.

The results of TIMSS 2015 presented Ireland as amongst the highest achievers in mathematics at Grade 8 (Second year) with an overall mean score of 523 (Clerkin, Perkins & Cunningham, 2016). Only six countries/economies (Singapore, Republic of Korea, Chinese Taipei, Hong Kong SAR, Japan, and Russian Federation) performed significantly above Ireland. Students from five countries (Kazakhstan, Canada, United States, England and Hungary) achieved mean scores that are not significantly different to that of students in Ireland. In science, students in Ireland achieved a mean score of 530, not significantly different to England, Kazakhstan, United States, Hungary, Canada, and Sweden. Seven countries and economies significantly outperformed Ireland, including the same six countries as for mathematics, along with Slovenia, which also recorded strong performance in science at Grade 4 in 2015. While students in Grade 8 in Ireland improved by 5 score points in mathematics since 1995 (the last year prior to 2015 in which Ireland participated in TIMSS at Grade 8), the change is not statistically significant. In science, students in Ireland achieved a mean score that is significantly higher than in 1995, by 12 score points. Students in Grades 4 and 8 participated in TIMSS 2019 in the spring of 2019. The results of the study are due to be released in late 2020.

2.2.6 PIRLS and other primary-level assessments

PIRLS is a primary level study, examining the reading literacy of students in 4th class. Like TIMSS, PIRLS is a grade-based and is under the auspices of the IEA. The results of PIRLS 2016 highlighted the strong performance of Irish pupils with an overall mean score of 567 on print reading, which is not significantly different from four countries and economies (Hong Kong SAR, Finland, Poland and Northern Ireland) (Eivers et al., 2017). Only two countries/economies significantly outperformed Ireland (the Russian Federation and Singapore). Ireland's performance on e-PIRLS[29], a digital assessment administered to students in Ireland and in a subset of PIRLS 2016 countries, was equally strong, with a mean score of 567. This was significantly above the international average and significantly above most other participating countries. Only Singapore had a significantly higher score than Ireland on e-PIRLS (588), with Norway the only country with a mean score did not differ significantly from that of Ireland. Pupils in Ireland recorded a significant improvement of 15 score points on print PIRLS between PIRLS 2011 and PIRLS 2016.

It is also important to note the performance of Irish pupils in national assessments at primary level, as changes at that level might be expected to impact on PISA in the future. The National Assessments in 2014 (Shiel et al., 2014) revealed that the overall performance of pupils on reading

29 ePIRLS was a digital reading assessment administered in schools at the same time of the paper-based assessment.

in Second class was significantly higher in 2014 than in 2009, by 14 score points, or just over one-quarter of a standard deviation. The overall performance on English reading in Sixth class was also significantly higher in 2014 than in 2009, by an equivalent amount. The mean scores of pupils in Second and Sixth class in mathematics were also significantly higher in 2014 compared to 2009, by 14 and 12 score points respectively. The 2014 National Assessments are especially noteworthy, because they represent the first time since 1980 when performance increased significantly, and some of that improvement can be attributed to the implementation of the National Strategy to Improve Literacy and Numeracy 2011-2020 (DES, 2011), which included such measures as increased allocation of time to reading literacy and mathematics, greater use of standardised test results for school self-evaluation and planning, and a focus on literacy and numeracy across all curriculum areas. Furthermore, the targets for improved performance in the National Assessments by 2020, set in the National Literacy and Numeracy Strategy in 2011 (DES, 2011), were largely achieved by 2014, and have now been replaced by new targets (DES, 2017c).

2.3 Factors Associated with Reading Literacy in Earlier PISA Assessments

This section examines factors associated with performance on earlier cycles of PISA, with a particular emphasis on PISA 2009 when, as in 2018, reading literacy was the major assessment domain. The section looks at school-level and student-level characteristics associated with performance, and then looks at outcomes of a multi-level model of performance based on PISA 2009 reading literacy, drawing on data from Perkins et al. (2012).

PISA collects rich background and contextual information on student, school and home characteristics, through the student, school and parent questionnaires. The parent questionnaire is a new option in PISA and has been administered in Ireland since 2015 (see Chapter 6 for details on the content of these questionnaires).

2.3.1 School characteristics

In each PISA cycle, student-level data on economic, social and cultural status (ESCS) are gathered (see Chapter 3 for details) and are then averaged to school level, providing a measure of the ESCS of each participating school. In Ireland in PISA 2009, a half a standard deviation increase on the index of ESCS at the school level was associated with an increase of 27 points on the print reading scale. While this finding supports the existence of a social context effect, it is somewhat weaker in Ireland than on average across OECD countries (32 points). In Ireland, students in girls' secondary schools significantly outperformed students in all other school types in print and digital reading. Students in (ETB) vocational schools had the lowest mean scores in both domains. However, these achievement differences are also related to differences in ESCS (see the following section). For example, students in vocational schools had a significantly lower mean ESCS score than students in other school types.

Again in 2009, large and significant achievement differences were observed between students in the School Support Programme (SSP) under DEIS (DES, 2005) and students in non-SSP schools on both digital reading (40 score points) and print reading (70 points). Students in SSP schools had a mean ESCS score that was three-fifths of a standard deviation below that of students in non-SSP schools.

Students enrolled in secondary schools that charged fees (about 9% of the sample) had a significantly higher mean score on reading literacy in 2009, than students in non-fee-paying schools.

The mean ESCS score of students in fee-paying schools was also higher, by about four-fifths of a standard deviation.

Five measures related to school climate were positively associated with both achievement and ESCS in PISA 2009, though the strength of these associations was weak: indices of teacher behaviour/expectations, student behaviour, teacher-student relations, disciplinary climate in reading classes in the language of instruction, and students' sense of belonging in school.

The achievement and ESCS scores of students attending schools in differing locations (in terms of population density) generally did not vary significantly. The number of schools available locally was also unrelated to school average achievement or ESCS. Two indicators of school selectivity (ability grouping and academic selectivity on intake) did not show associations with achievement or with ESCS either.

2.3.2 Student background characteristics

In 2009, the mean ESCS score of Irish students (at the individual student level) did not differ from the OECD average. In Ireland, a one-standard-deviation increase in ESCS was associated with a 39-point increase in achievement on the print reading scale, which is about the same as the OECD average. The association between ESCS and achievement in digital reading was slightly weaker (a 34-point increase), but was also about the same as the corresponding OECD average.

In Ireland, immigrant students who spoke English or Irish in the home (4.5%) had mean achievement scores in print and digital literacy that did not differ from native Irish students, and a mean ESCS score that was slightly but significantly lower. Immigrant students who spoke a language other than English or Irish (3.5%) had mean achievement scores on both literacy assessments that were significantly lower than the mean scores of non-immigrant students, even though their mean ESCS scores were significantly higher.

Since PISA employs an age-based sample, students in Ireland in 2009 were in Second, Third, Fourth (Transition), and Fifth Years at the time of the assessment, though the majority (about 60%) were in Third Year. Students in Second Year had significantly lower mean scores in both print and digital literacy. Students in Transition Year significantly outperformed students in Third Year and in Fifth year on both literacy assessments.

One-in-seven students in Ireland in PISA 2009 (17%) reported that they had not attended preschool, which is well above the OECD average (8%). Students in Ireland who had attended preschool had a significantly higher score on the ESCS scale than students who had not. Their achievement scores on print and digital reading were significantly higher than non-preschool attenders, even after accounting for ESCS differences.

In Ireland, students were asked if they intended to complete the Leaving Certificate. About 9% indicated that they were not sure or that they definitely wanted to leave prior to school completion. There were large achievement differences between students who wanted to leave school early and those who did not – over 60 score points in both literacy assessments. There were also marked differences in the socioeconomic characteristics of the two groups: potential early school leavers had a mean ESCS score that was half a standard deviation below potential completers.

Students in Ireland who had not been absent from school in the two weeks prior to the PISA 2009 assessment had significantly higher mean scores on print and digital literacy than students who had been absent for either one or two days, or three or more days, with the lowest mean score achieved by those absent for three or more days.

2.3.3 Student attitudes, engagement and use of reading strategies

Given the status of reading literacy as a major domain in PISA 2009, the assessment, and the student questionnaire in particular, included a strong focus on students' attitudes to and engagement with reading, and on their use of reading and learning strategies. It is recognised that attitudes, engagement and use of strategies are related to one another and to performance, sometimes in reciprocal ways. For example, a positive attitude towards reading may be linked to higher levels of engagement in reading (such as reading for enjoyment), and this, in turn, may be linked to higher performance and vice versa.

In 2009, 42% of students in Ireland reported that they spent no time reading for enjoyment. This is significantly higher than the OECD average of 37%. Not reading for enjoyment was more common among boys (48%) than girls (36%) in Ireland. Average print reading achievement scores were almost 100 points lower for students who did not read compared with students who did read. However, there was only a small increase in achievement associated with spending over one hour a day reading, compared with 31-60 minutes per day.

On an index of enjoyment of reading, based on students' levels of agreement with statements such as 'I read only if I have to' (reverse coded) and 'I like to express opinions about the books I have read', students in Ireland had a mean score of -0.8, indicating lower enjoyment of reading, than on average across OECD countries (mean = 0.0). In Ireland, there was a correlation of .74 between frequency of reading and enjoyment of reading, confirming that those who read more enjoy reading more, and vice versa.

On an index of diversity of online reading materials read, based on the frequency with which students read materials such as emails and online news, searched for information online, and took part in group discussions, students in Ireland had a mean score of -0.50, indicating a low level of diversity compared with the OECD average of 0.00. The difference in the mean scores of male and female students in Ireland on diversity of reading is not statistically significant.

Students in Ireland achieved mean scores that were significantly above the corresponding OECD average scores on two measure of reading strategy usage, based on their views on the usefulness of various strategies. On a scale based on perceived usefulness of understanding and remembering strategies such as 'When I study, I try to relate new information to what I already know in other subjects', students in Ireland had a mean score 0.16, which was significantly above the OECD average of 0.00. On a scale based on perceived usefulness of summarisation strategies such as 'I carefully check that the most important facts in the text are represented in the summary', students in Ireland achieved a mean score of 0.14, which was again significantly higher than the corresponding OECD average of 0.00. Both scales correlated significantly with print reading. Female students in Ireland had significantly higher mean scores than males on both strategy usage scales.

2.3.4 Multi-level model

In Ireland, multilevel models were used to examine the extent to which a range of school and student characteristics, when considered jointly, contributed to the explanation of variance in print and digital reading achievement in PISA 2009.

School-level variables examined for inclusion in the models were: sector/gender composition, fee-paying status, SSP-DEIS status, average socioeconomic intake (ESCS), percent of students speaking a language other than the language of instruction, urban/rural location, availability of other schools in the local community, use of ability grouping, academic selectivity, school leadership,

disciplinary climate, student-teacher relations and outlier-school status (schools with very low performance on PISA 2009 print reading that had performed better in earlier PISA cycles). Variables at the student level that were considered included: gender, immigrant/language status, family structure, number of siblings, parental occupation, parental education, number of books in the home, home educational resources, material possessions, cultural possessions, part-time work, grade (year) level, preschool attendance, summarising strategies, understanding and remembering strategies, reading for enjoyment, attitude to reading, diversity of reading, library usage, frequency of online reading, early school leaving intent, and level of absenteeism.

Only two school-level characteristics were statistically significant in the final model of print reading: SSP-DEIS status and outlier school status. At the student level, several variables were significant: gender, immigrant/language status, number of siblings, parental occupation, parental education, number of books in the home, part-time work, grade (year) level, summarising strategies, understanding and remembering strategies, reading for enjoyment, attitude to reading, library usage, online reading, early school leaving intent, and level of absenteeism. School- and student-level characteristics together explained 59% of the total variance in print reading achievement, or 81% of between-school variance and 51% of variance within schools. The model also showed that:

- Students in SSP-DEIS schools had an expected print reading score that was 38 points lower than that of students in non-SSP schools.
- Students in outlier schools had an expected print reading score that is 23 points lower than that of students in non-outlier schools.
- Immigrant students who spoke the language of instruction had an expected reading score only slightly lower (by 8 points) than students born in Ireland, while immigrant students who spoke another language had an expected reading score that was 23 points lower.
- Parental occupation, though significant, was less important than parental education in explaining differences in print reading achievement.
- Part-time work by students, particularly when it is for more than eight hours a week, was negatively associated with print reading. Similarly, early school leaving intent and more frequent absenteeism were associated with lower reading achievement.
- Significant achievement differences in print reading across grade level remained after adjusting for the other characteristics in the model. Relative to Third Year, students in Transition Year and Fifth Year had expected print reading scores that were about 20 points higher, while students in Second Year had an expected print reading score that was 35 points lower.
- Students' awareness of reading strategies was important in explaining achievement differences in print reading scores. Over and above school and student socioeconomic and demographic characteristics, they explained 10% of the total variance. Similarly, student engagement in reading explained 12% of the total variance in achievement over and above the other characteristics in the model. However, engagement with education (e.g., absenteeism rates) explained little additional variance (2%), indicating its relationship to socioeconomic and demographic characteristics.

The model for digital reading had somewhat weaker explanatory power than the model for print reading. It explained 48% of total variance in achievement, or 57% of variance between schools, and 46% within schools. Unlike the model for print reading, no school characteristics remained in the final model. This is consistent with the observation that schools differed less from one another with respect to average achievement in digital reading than in print reading.

The final model for digital reading included gender, immigrant/language status, number of siblings, parental occupation, parental education, books in the home, part-time work, grade (year) level, preschool attendance, summarising strategies, understanding and remembering strategies, reading for enjoyment, attitude to reading, library usage, online reading, and early school leaving intent.

The size of the gender difference in both print and digital reading achievement varied across mixed schools. Follow-up analyses suggested that the difference tended to be smaller in schools with higher overall achievement. Furthermore, gender differences in students' awareness of reading strategies and engagement in reading accounted for about two-thirds of the achievement difference between boys and girls in both the print and digital reading assessments.

2.4 Summary

PISA 2018 took place at a time of considerable educational change in Ireland. Key policy documents and initiatives included the *Action Plan for Education 2016-19*, the *Interim Review of the National Strategy for Literacy and Numeracy,* the *Digital Strategy for Schools* and the *Digital Learning Framework*, reforms in curriculum and assessment at Junior and Senior Cycle levels, and the *Wellbeing Policy Statement and Framework for Practice*.

Both the *Action Plan for Education* and the *Interim Review of the National Strategy for Literacy and Numeracy* are important because they include specific targets related to student performance in Ireland on PISA reading literacy, mathematics and science, including targets for the proportions of students performing at the highest proficiency levels in mathematics and science (by 2025 and 2020 respectively). A challenge in meeting these targets relates to the introduction of computer-based testing in PISA in 2015, including the introduction of new item types that seek to capitalise on the affordances of computer-based assessment. Implementation of the *Digital Learning Framework* is important in that increased integration of digital technologies into teaching, learning and assessment has the potential to provide students with digital skills that can be applied across a range of contexts. Reforms in curriculum and assessment at Junior Cycle, in subjects such as English, mathematics and science, can be expected to enhance students' competencies in areas that are relevant to PISA, including literacy, numeracy and digital skills, though it might be noted that not all students taking PISA had studied under new specifications in these subjects when PISA was administered in March-April 2018. The current focus on wellbeing in post-primary schools is consistent with a focus on well-being in PISA 2018, in which students in Ireland completed an optional short questionnaire.

Ireland has participated in all PISA assessments since 2000. Performance on reading literacy, which was a major assessment domain for the first time in 2000, has been consistently above the OECD average, except in 2009, when it was not significantly different. Performance on science, which was a major domain for the first time in 2006, improved between 2009 and 2012, but fell back to pre-2012 levels in 2015, coinciding with the introduction of computer-based assessment in PISA. Nonetheless, students in Ireland have performed significantly above the OECD average in each cycle to date. Mathematics was assessed as a major domain in 2003, when performance in Ireland was not significantly different from the OECD average. It was not significantly different from the OECD average in 2009 either (despite the large drop in performance), but was above the OECD average in 2012 and 2015. In general, relatively few students in Ireland have performed below Level 2 on the PISA proficiency scales, especially in reading literacy. However, the proportions of higher-achieving students in mathematics and science in Ireland are similar to the corresponding OECD averages, even though average performance has been significantly above the OECD average in recent cycles, pointing to underperformance among higher-achieving students in Ireland.

Gender differences in Ireland have varied by assessment domain. In reading literacy, female students have significantly outperformed males in all PISA cycles to date, with differences ranging from 39.2 score points in 2009 to 12.0 in 2015, one of the lowest among all participating countries. There was no gender difference in Ireland in science in earlier PISA cycles (2006, 2009, and 2012). However, in PISA 2015, male students in Ireland achieved a mean score that was significantly higher than females, by 10.5 score points. Male students in Ireland also had significantly higher mean scores in mathematics than females in the two most recent PISA cycles, with an advantage of 15.3 score points in 2012, and 16.1 score points in 2015.

Irish adults participating in the PIAAC assessment in 2012 achieved a mean score on reading literacy that was not significantly different from the average of countries in the study, while Ireland's mean score on numeracy was significantly below the study average. It is unclear if performance on PIAAC represents a deterioration in skills since lower post-primary schooling as there are no direct links between PISA (taken by students at age 15) and PIAAC (taken by adults aged 16-64). In PIAAC 2012, fewer adults in Ireland than on average across participating countries achieved the highest proficiency levels on an assessment of problem solving in technology-rich environments. Ireland is participating in the next round of PIAAC in 2021-2022, with results expected in 2023.

Only six participating countries exceeded the mean score of students in Ireland who participated in TIMSS in Grade 8 (Second Year) in 2015, while seven countries achieved significantly higher mean scores in science. Students in Grade 8 in Ireland improved by 5 score points in mathematics since 1995 (the last year prior to 2015 in which Ireland participated in TIMSS at Grade 8), but the change is not statistically significant. In science, students in Ireland achieved a mean score that is significantly higher than in 1995, by 12 score points. The results of TIMSS 2019 are due to be released in late 2020.

There is recent evidence of strong improvement in reading literacy skills among primary pupils in Ireland. In PIRLS 2016, just two countries significantly outperformed Ireland on print reading (the Russian Federation and Singapore), while Singapore was the only county to outperform Ireland on digital reading. Pupils in Ireland recorded a significant improvement of 15 score points (about one-sixth of a national standard deviation) between PIRLS 2011 and PIRLS 2016. In the 2014 National Assessments of English Reading and Mathematics, students in Second and Sixth classes achieved significantly higher mean scores in both reading and mathematics, with increases in the order of one-quarter of a standard deviation. Ireland is participating in the next round of PIRLS in 2021, with results due in late 2022, while the next round of National Assessments is in 2020.

Among the school-level factors associated with performance in PISA 2009 (when reading literacy was also a major assessment domain) were school-level economic, social and cultural status (the PISA measure of socioeconomic status), school gender composition, school DEIS status, and school fee-paying status. A one-half of a standard deviation increase on the index of ESCS at school level was associated with an increase of 27 score points on the print reading scale – marginally lower than the corresponding OECD average increase. Students in girls' secondary schools significantly outperformed students in other school gender composition categories. Students in non-DEIS schools, and students in fee-paying schools outperformed their counterparts in DEIS and non-fee-paying schools.

General student characteristics associated with reading proficiency (both paper and digital) in PISA 2009 included economic, social and cultural status, immigrant status, year level, attendance at pre-school, intention to complete the Leaving Certificate examination, and frequency of absence from school. Reading-specific factors associated with performance included frequency of reading for enjoyment, enjoyment of reading, diversity of online reading, and awareness of reading strategies (for

understanding and remembering, and for summarising). A multi-level model of performance on print reading underscored the importance of socio-economic status at school level, alongside student variables such as immigrant/language status, parental occupation, grade level, and awareness of reading strategies in explaining variation in performance. For example, immigrant students in Ireland who did not speak the language of instruction at home had an expected print reading score that was 23 points lower than native students, after controlling for other factors.

Chapter 3
Student Performance on Reading Literacy

Key Points from Chapter 3

- Ireland's mean score of 518.1 on the reading scale is significantly higher than the OECD average of 487.1.
- Ireland ranked 4th out of 36 OECD countries with valid data (or between 1st and 5th if a 95% confidence interval is applied) and 8th out of all 77 participating countries/economies (between 5th and 9th if a 95% confidence interval is applied), and 3rd out of 27 EU countries.
- Ireland's standard deviation for reading was 90.7. This is smaller than the OECD average of 99.4, indicating a narrower spread of reading achievement in Ireland than on average across OECD countries.
- Female students in Ireland significantly outperform male students on PISA 2018 overall reading. The difference, 23.2 score points, is among the lowest across selected comparison countries, and lower than on average across OECD countries (29.7 points).
- Student performance on PISA reading literacy in Ireland is characterised by an above-average percentage of high performers (12.1%), and a small and below-average percentage of low performers (11.8%); there are significantly fewer low performers and significantly more high performers in Ireland than on average across OECD countries.
- Ireland's mean score on reading literacy in 2018 (518.1) was significantly higher than in 2009 (495.6), and not significantly different from 2012 (523.2) or 2015 (520.8).

Reading literacy was assessed as the major domain in PISA 2018 – the third cycle in which it was a major domain and the second in which the framework has undergone revision. The concept of reading literacy encompasses a basic decoding of words, an understanding of grammar and the textual structures needed for comprehension, as well as interaction between the text and the reader's knowledge of the world (OECD, 2019a).

The changes that have been implemented in the 2018 assessment of reading literacy reflect the nature and context of how reading forms part of our rapidly developing world, referencing the role that technology has in influencing how individuals read and exchange information at home, at work and in educational environments. The traditional reading processes remain in the framework, and are complemented by the additional text processing components of detecting and handling conflict between texts, assessing the quality and credibility of sources, and an overall mastery of digital navigation across multiple sources.

This chapter provides an overview of the PISA 2018 reading literacy framework, examines overall student performance on the assessment of reading literacy, and provides a trend comparison of

student performance in other participating countries, economies and regions between 2009 and 2018.

The chapter is presented in eight sections:

- Description of the PISA 2018 reading literacy framework
- Selection of reading literacy items administered in PISA 2018, illustrating the range of skills and competencies that were included in the assessment
- Performance on the overall PISA 2018 reading scale
- Percentages of students achieving benchmark reading proficiency levels
- Performance on two sets of reading subscales – cognitive processes (*Locating Information, Understanding, and Evaluating and Reflecting*), and text source, i.e., the number of text sources required to respond to the question (*single source or multiple source*)
- Differences in reading achievement related to key variables (gender, student economic, social and cultural status (ESCS), school gender composition, school fee-paying status, school DEIS status, and between-school variance)
- Trends in student performance on reading literacy from 2009 to 2018
- A summary of results related to reading literacy.

Box 3.1 provides an explanation of the selection of countries for comparison with Ireland in this chapter (as well as Chapters 4 and 5). Additional data tables related to this chapter can be accessed in the PISA 2018 E-Appendix at www.erc.ie/pisa.

Box 3.1: Notes on interpreting results

In this chapter, and in Chapters 4 and 5, overall mean scores for each domain are presented for all participating countries and economies with valid data, and are ordered from highest to lowest. All other comparisons are made using a selection of participating countries, and one region (Northern Ireland).

For reading, selected countries comprise one of the highest performing countries (Singapore), the highest performing EU country on reading literacy (Estonia), the five highest performing OECD countries (Canada, Finland, Korea, Poland, Sweden), and other countries of general interest or relevance (New Zealand, United Kingdom, and United States), and Northern Ireland.

The same set of countries comprises the comparison group for science and mathematics.

3.1 PISA 2018 Reading Literacy Framework

This section considers the reading literacy framework for PISA 2018, including the definition of reading literacy, the processes and scenarios underpinning the tasks that comprise the assessment, and changes in reading literacy over the past two decades. The PISA 2018 reading literacy framework is the third iteration, building on the original reading literacy framework from 2000 and the first revision in 2009. The 2009 framework included greater emphasis on engagement and metacognition, along with an expanded role for digital texts (an optional test of digital reading was available in PISA 2009). The 2018 framework incorporates developments in reading since 2009, whilst also taking

into account the anticipated changes to reading literacy over the next period, before reading literacy returns as a major domain. Reading literacy, as assessed in PISA 2018, is defined as:

> ... understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society (OECD, 2019a, p.28).

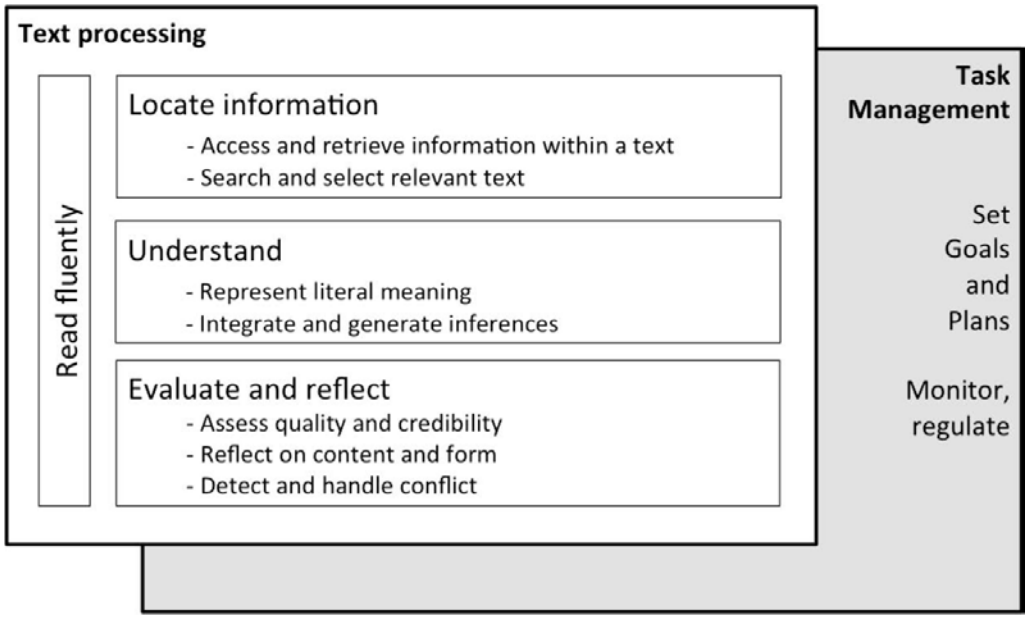
When reading literacy was the major assessment domain in 2009, a reference to 'written texts' was included, and the 2018 definition removes the word 'written'. The key components of reading are highlighted - *understanding, using, evaluating, reflecting on and engaging*, and form the basis of the three cognitive processes that are reported on as reading literacy subscales. These aspects are presented along with the goals and purposes of reading, capturing the varied situations and contexts in which reading literacy is required – *achieving one's goals, developing one's knowledge* and *participating in society.*

The updated reading literacy framework and item pool address three issues: first, the need to reflect the contemporaneous classroom and wider society, with a greater emphasis on diversity of reading while transitioning from traditional paper texts to modern digital formats; second, the need for the framework to reflect current thinking and theory in reading; and third, the need to ensure framework elements can be operationalised in the test content in a large-scale international assessment.

One of the developments reflected in the 2018 framework is the reframing of reading processes under two broad categories, text processing and task management (Figure 3.1). Text processing is the focus of the 2018 reading literacy cognitive assessment, incorporating the reported cognitive processes (and their subcategories), including a new component of reading fluency, outlined below (Figure 3.1). Task management processes (setting goals and plans, monitoring progress and self-regulating strategies) form part of the assessment through student interaction with the test, but are not reported on separately.

While the student questionnaire includes content on metacognition and strategies, the elements of task management that students implement during the cognitive assessment are not processed and scaled within PISA. Future assessments may have scope to report on task management processes within PISA, including computer-generated process indicators of how long students spend reading individual tabs or texts.

Figure 3.1: PISA 2018 Reading framework processes



Source: OECD, 2019a: p.33.

Eight cognitive processes are collapsed into three subscales (Locating Information, Understanding, and Evaluating and Reflecting), while the text sources are separated into two subscales (Single and Multiple).

Reading fluency (the ease and efficiency with which students can read simple texts for understanding) forms part of the assessment of reading, but is not reported on separately. It acts, rather, as an indicator to describe differences between students at the lower end of reading proficiency. A short reading fluency task was administered to all students as part of reading literacy in PISA 2018, requiring them to respond to a series of sentences and judge the plausibility of each one, within 3 minutes. A similar task was used in PIAAC (OECD's Programme for the International Assessment of Adult Competencies) and in the PISA 2000 assessment in Austria (OECD, 2019a).

Table 3.1 sets out the distribution of items in the reading assessment as they relate to the process and text sources for the 2015 and 2018 reading frameworks.

Table 3.1: Approximate distribution of tasks by targeted process and text source, 2015 and 2018

2015 Framework	2018 Cognitive processes	2018 Framework	
		SINGLE text	MULTIPLE text
Accessing and retrieving 25%	Locating information 25%	Scanning and locating 15%	Searching for and selecting relevant text 10%
Integrating and interpreting 50%	Understanding 45%	Literal comprehension 15%	Multiple-text inferential comprehension 15%
		Inferential comprehension 15%	
Reflecting and evaluating 25%	Evaluating and reflecting 30%	Assessing quality and credibility Reflecting on content and form 20%	Corroborating/handling conflict 10%

Source: adapted from OECD, 2019a: p. 42.

In order to compare trends in student performance over time, the reading literacy item pool includes a subset of items (72) that were administered on paper in PISA 2009, when reading literacy was last a major assessment domain. In 2015, these items were administered on computer for the first time, but the content and structure of the items and the stimulus text was preserved, where possible. A pool of new items was developed at the start of the 2018 cycle, underpinned by the updated 2018 framework, and taking into consideration the new item formats and interactive features that were possible using the computer-based assessment platform. A total of 173 new items across 54 units were administered in the 2018 Main Study, with a combined total of 245 test items, across new and trend item pools.

The reading literacy cognitive processes are influenced by several factors, including the text, the task and the reader. In essence, the PISA test of reading literacy manipulates the text and task factors, while the PISA questionnaires examine reader factors, such as strategies, motivation and task perseverance. The reading literacy assessment aims to measure students' mastery of reading processes, via the use of texts and scenarios. The texts are the reading material that constitute the test, while the scenarios provide the new reading items with context and purpose for reading a collection of thematically-related texts. The tasks encompass a range of difficulty levels, achieved by varying the features and goals. These characteristics are operationalised through the test development process, and ensure broad coverage of what students read and for what purposes. The selection of items in the final item pool represent a natural range of difficulty in texts and tasks.

A scenario-based approach to reading assessment provides context and an overarching purpose to reading single or multiple texts. Scenarios simulate a wide range of potential reading situations, defining the context of the test. Situations are grouped into five categories: educational, multiple, occupational, personal and public. A personal situation may reference leisure or recreational activities and include informational texts, biographies, personal emails and online blogs. A public situation relates to wider societal concerns, including official documents, information leaflets about public events and online message boards. Educational situations refer to texts specifically designed for the purpose of instruction, e.g., software for learning, printed textbooks, and the materials are often assigned by the instructor rather than chosen by the student. Occupational reading situations involve an element of immediacy, e.g., give directions to a store, or find a job advertisement. In order to reflect that many texts can be cross-classified, a multiple categorisation under situations is also incorporated, maximising the diversity of content included in the PISA reading assessment.

A range of text types are presented in PISA reading, and the classification used is adapted from the work of Werlich (1976). Seven text types are identified for PISA 2018:

- Argumentation – presents the relationship among concepts or propositions, and includes persuasive and opinionative texts.
- Description – refers to properties of objects in space, e.g., a description of a place in a travel diary.
- Exposition – presents information as composite concepts or mental constructs, e.g., essays from a subjective point of view or online encyclopedias.
- Instruction – provides directions on what to do, e.g., rules, first aid procedures, or recipes.
- Narration – refers to properties of objects in time, and may be factual or fictional e.g., a biographical novel, a short story, or a comic strip.
- Transaction – aims to achieve a specific purpose e.g., make arrangements for a social event, or a business meeting.
- Multiple – refers to any texts that include more than one type of text.

Response formats vary across the reading assessment and are dependent on the type of information presented and the question posed to the student. The mode of assessment also has a key role, with new response formats possible on a computer platform, such as highlighting text and drag and drop. Many of the response formats from paper-based assessment in PISA remain including simple multiple choice, complex multiple choice (e.g., a series of yes/no items prompts within a single question), and constructed response, where students type an answer (previously they wrote a response). Several studies suggest that response format has a significant effect on the performance of different groups and that this effect may vary depending on country, proficiency level, level of intrinsic motivation to read, and gender (OECD, 2019a). Therefore, in order to measure trends over time, the proportional representation of response formats is a key factor in each PISA cycle.

Table 3.2 presents the distribution of reading items by process, text format, situation and text type in PISA 2018. For single and multiple text processes, the percentages of items are compared with the percentages originally proposed in the reading literacy framework for PISA 2018.

Table 3.2: The distribution of PISA 2018 reading items by process, text format, situations and text type, compared with distribution recommended in PISA 2018 reading literacy framework

Component	Number	% items	% framework	Component	Number	% items
Single text processes				***Situations***		
Scan and locate	31	13%	15%	Educational	54	22%
Represent literal meaning	53	22%	15%	Multiple	7	3%
Integrate and generate inferences	63	26%	15%	Occupational	26	11%
Assess quality and credibility	46	18%	20%	Personal	60	24%
Reflect on content and form				Public	98	40%
Total	193	79%	65%	Total	245	100%
Multiple text processes				***Text type***		
Search and select relevant text	19	8%	10%	Argumentative	39	16%
Integrate and generate inferences (MS)	15	6%	15%	Description	30	12%
Corroborate and handle conflict	18	7%	10%	Exposition	73	30%
Total	52	21%	35%	Instruction	12	5%
				Multiple	21	9%
Text format				Narrative	45	18%
Continuous	158	64%	-	Transactional	25	10%
Non-continuous	30	12%	-	Total	245	100%
Mixed	57	23%	-			
Total	245	100%				

Source: adapted from OECD, 2019a: p.42, and OECD, 2019b: p.7.
Note. The PISA 2018 reading framework did not include a recommended distribution for situations, text formats and text types.

While PISA reading includes 82 open-ended responses (33% of all items in PISA 2018), that require students to type their answer, PISA does not assess the spelling or quality of writing in scoring responses.

A key development for PISA 2018 was the introduction of adaptive testing for reading literacy (see Section 1.2.2). The overall aim was to improve the accuracy and fairness of the reading test, with a better match of the test items to a student's proficiency. The multi-stage approach adopted

maintains a degree of random assignment to ensure broad coverage of the domain at all proficiency levels, with the overall goal of improved measurement of high achievement (Levels 4, 5 and 6) and low achievement (below Level 1).

3.2 Sample Reading Literacy Items

Two reading literacy units (Chicken Forum and Cow's Milk) were released after the PISA 2018 Field Trial administration. Sample test items from both units administered in the Field Trial are included in this section. The units were not included in the Main Study administration due to objections from countries related to the content; most of the items within the units had good measurement properties (OECD, 2019c: 5). Seven items from the Easter Island unit (also known as Rapa Nui) and sample practice fluency items were released after the 2018 Main Study (see www.oecd.org/PISA/test).

The format of both units is similar with an introductory scenario screen that sets out the context for the unit to students. Students are asked to read the scenario screen text before progressing onto the first item of the unit overleaf, by clicking on the 'next' arrow. Item descriptors are included under each item, outlining the question type, how it was scored, the assigned cognitive process, and the estimated item difficulty on average across OECD countries. The item difficulty must be interpreted with caution as it is based on data from the Field Trial sample (which is smaller than the Main Study sample, and not necessarily nationally representative, see Chapter 1).

3.2.1 Chicken Forum

The Chicken Forum unit presented to students in the Field Trial included an introduction page, followed by seven questions at various levels of difficulty. The introduction page set out a scenario about a series of posts on a web forum related to how to raise chickens. A student in the scenario presented asked relatives who moved recently to a farm, 'how do you raise chickens?' The unit is classed a multiple text unit, the situation is classed as 'personal', and the text type is classified as 'transactional' (see Section 3.1. and Table 3.2).

The two items illustrate two different cognitive processes. Question 1 falls under illustrate literal meaning and Question 6 is categorised as assessing quality and credibility, which is identified in the framework as a key process related to digital reading within multiple texts.

Question 1

The first item in the unit is a simple computer-scored multiple-choice item (Figure 3.2). It has an item difficulty level of Proficiency Level 1b, indicating that it is a relatively easy item (Table 3.3). The guidance with this released item states, 'this is not simply an 'access and retrieve information within a text' because there is not a direct, verbatim match between the item options and the stimulus' (OECD, 2019c: 23). Option 'A' is the correct response, Ivana_88 wants to know if she can give aspirin to an injured hen.

Figure 3.2: Chicken Forum, Question 1

Table 3.3: Chicken Forum, Question 1: Mapping to framework and item difficulty

Framework Element and Difficulty	Description
Question Type	Simple Multiple Choice
Scoring	Computer-scored
Cognitive process	Represent literal meaning
Source	Multiple text
Situation	Personal
Text type	Transactional
Text format	Continuous
Item difficulty	328 - Level 1b

Question 6 asks students to assess the responses given on the web forum, and to consider the reliability of each post (Figure 3.3). The item has an estimated difficulty level of 2, and combines two response formats, multiple choice and open-ended (Table 3.4). The Field Trial coding guide stipulated that three of the four options could receive credit, as long as the reason students provide in the open-ended text box corresponded to the option selected. For example, if a student selected 'Monie', and typed 'Monie has a hen that recovered when she gave her aspirin', the student received full credit. If a student selected Avian_Deals, no credit was given.

Figure 3.3: Chicken Forum, Question 6

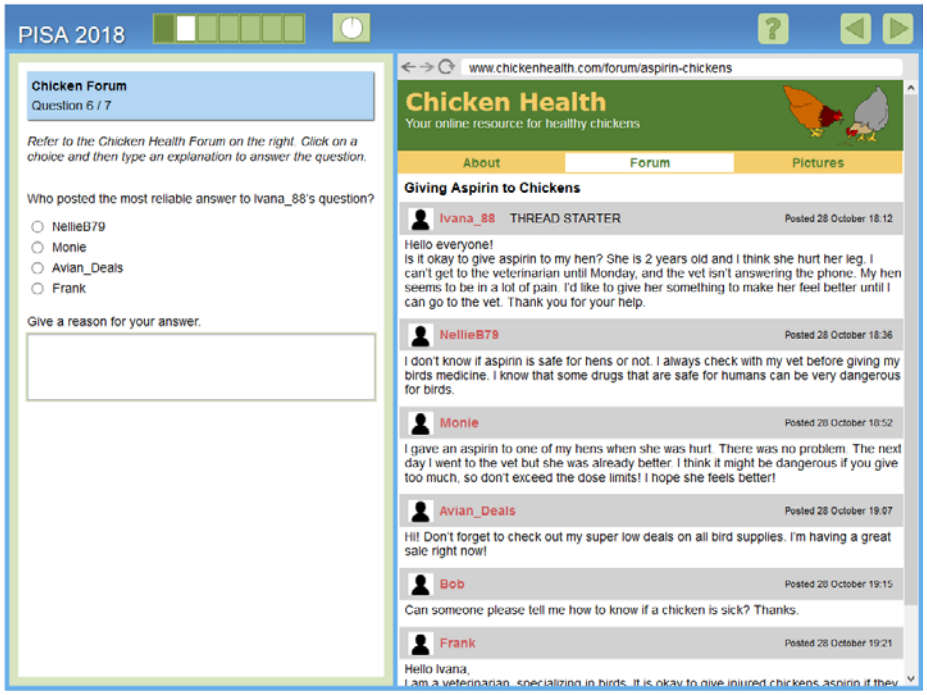


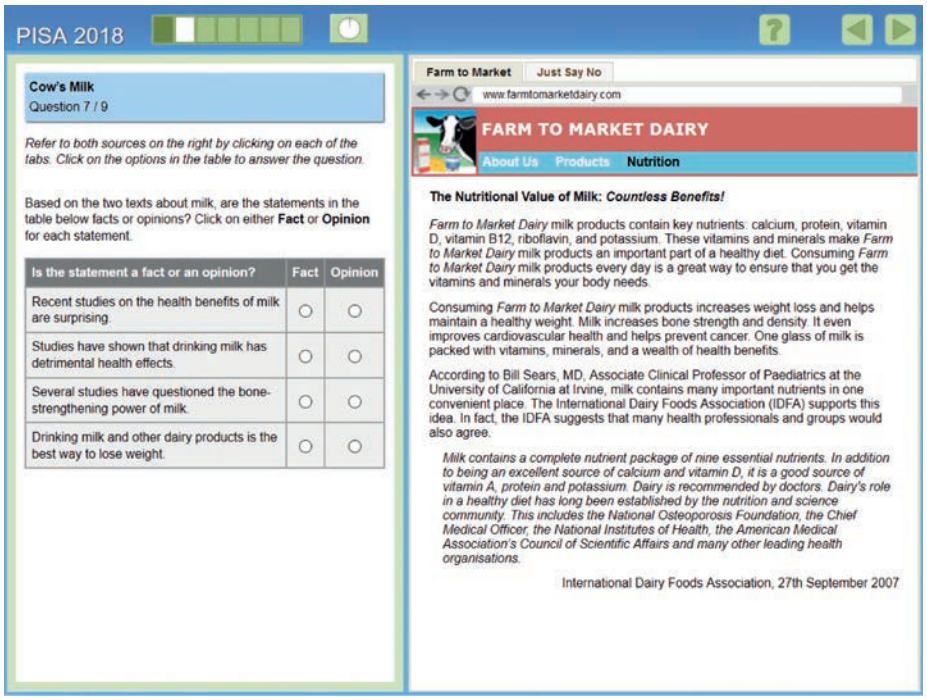
Table 3.4: Chicken Forum, Question 6: Mapping to framework and item difficulty

Framework Element and Difficulty	Description
Question Type	Simple multiple choice & open response
Scoring	Human coded
Cognitive process	Assess quality and credibility
Source	Multiple text
Situation	Personal
Text type	Transactional
Text format	Continuous
Item difficulty	409 - Level 2

3.2.2 Cow's Milk

The Cow's Milk unit presented to students in the Field Trial included an introduction page, followed by nine questions at various levels of difficulty. The introductory scenario focuses on three students' web searches after finding out a local coffee shop will stop serving cow's milk and will instead serve a soya substitute. The nine questions were based on two different webpages, the first about a business that sells dairy products, and the second from a health website entitled 'Just Say No to Cow's Milk'. Question 7 is presented as a sample item on the integration and generation of inferences across multiple sources (Figure 3.4).

Figure 3.4: Cow's Milk, Question 7



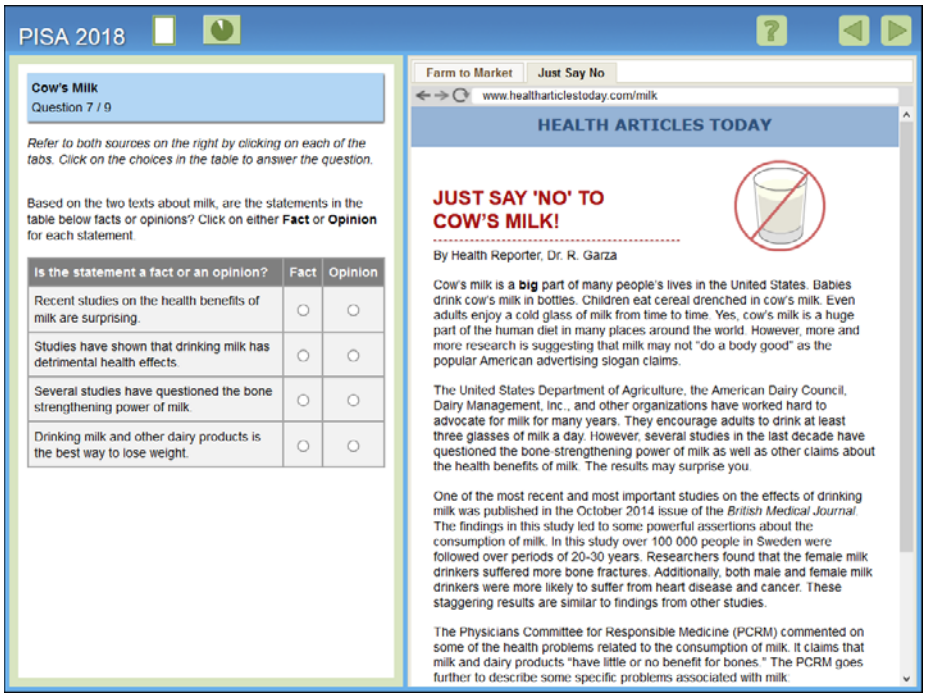


Table 3.5 sets out a mapping of Question 7 to the reading framework. Question 7 is categorised as a multiple-source text, static, continuous and argumentative and has an item difficulty of Level 5, meaning that the item is quite difficult. Students were asked to make an inference on four statements presented from the two separate sources. There is an expectation that units of this type and format require a higher and more sustained level of cognitive engagement from students than units based on single texts, given the cognitive process, item format and the greater amount of reading involved.

Table 3.5: Cow's Milk, Question 7: Mapping to framework and item difficulty	
Framework Element and Difficulty	**Description**
Question Type	Complex multiple choice
Scoring	Computer scored
Cognitive process	Integrate and generate inferences across multiple sources
Source	Multiple text
Situation	Personal
Text type	Argumentative
Text format	Continuous
Item difficulty	662 - Level 5

3.3 Overall Performance on Reading Literacy

Ireland's mean score of 518.1 on the reading scale is significantly higher than the OECD average of 487.1 (Table 5.6). Ireland is ranked 4th out of 36 OECD countries and 8th out of 77 participating countries/economies for whom data were available. Applying a 95% confidence interval, which takes account of measurement and sampling error, Ireland's true rank in reading among the OECD countries is between 1st and 5th, and is between 5th and 9th among all participating countries/economies (OECD, 2019d, Table I.4.4).

B-S-J-Z (China), Singapore, and Macao (China) significantly outperform every other participating country/economy in reading, with mean scores of 555.2, 549.5, and 525.1 respectively. These are the only countries/economies that significantly outperform Ireland in reading literacy. Ireland's mean score does not differ from that of six countries/economies (Hong Kong (China), Estonia, Canada, Finland, Korea, and Poland). The remaining 67 countries/economies, including 30 OECD countries, perform significantly less well than Ireland. The mean reading score for Northern Ireland is 500.7 (SE = 4.0; SD = 97.5). This is significantly below the mean score for Ireland, and is significantly greater than the OECD average (OECD, 2019d, Table I.B2.9).

Table 3.6 also shows the standard deviation for all countries/economies. Ireland's standard deviation for reading is 90.7. This is smaller than the OECD average of 99.4, indicating a narrower spread of reading achievement in Ireland than on average across OECD countries.

Table 3.6: Mean scores, standard deviations and standard errors for all participating countries/economies on the PISA 2018 reading literacy scale and positions relative to the OECD average and Ireland's mean score, for all participating countries/economies

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
B-S-J-Z (China)	555.2	(2.7)	87.2	(1.7)	▲	Greece	457.4	(3.6)	97.4	(1.6)	▼
Singapore	549.5	(1.6)	108.9	(1.0)	▲	Chile	452.3	(2.6)	92.0	(1.2)	▼
Macao (China)	525.1	(1.2)	92.1	(1.1)	▲	*Malta*	448.2	(1.7)	112.8	(1.2)	▼
Hong Kong (China)	524.3	(2.7)	99.5	(1.5)	O	*Serbia*	439.5	(3.3)	96.4	(1.4)	▼
Estonia	523.0	(1.8)	93.2	(1.2)	O	*United Arab Emirates*	431.8	(2.3)	113.3	(0.9)	▼
Canada	520.1	(1.8)	100.3	(0.8)	O	Romania	427.7	(5.1)	98.4	(2.2)	▼
Finland	520.1	(2.3)	99.6	(1.3)	O	*Uruguay*	427.1	(2.8)	95.9	(1.6)	▼
Ireland	**518.1**	**(2.2)**	**90.7**	**(1.0)**		*Costa Rica*	426.5	(3.4)	81.3	(1.7)	▼
Korea	514.1	(2.9)	102.0	(1.7)	O	*Cyprus*	424.4	(1.4)	98.0	(0.9)	▼
Poland	511.9	(2.7)	97.3	(1.4)	O	*Moldova*	424.0	(2.4)	93.3	(1.6)	▼
Sweden	505.8	(3.0)	107.5	(1.5)	▼	*Montenegro*	421.1	(1.1)	86.0	(0.8)	▼
New Zealand	505.7	(2.0)	106.3	(1.3)	▼	Mexico	420.5	(2.7)	83.5	(1.6)	▼
United States	505.4	(3.6)	107.9	(1.6)	▼	Bulgaria	419.8	(3.9)	101.4	(1.8)	▼
United Kingdom	503.9	(2.6)	100.2	(1.3)	▼	*Jordan*	419.1	(2.9)	87.3	(1.7)	▼
Japan	503.9	(2.7)	97.1	(1.7)	▼	*Malaysia*	415.0	(2.9)	84.8	(1.6)	▼
Australia	502.6	(1.6)	108.7	(0.9)	▼	Brazil	412.9	(2.1)	99.6	(1.3)	▼
Chinese Taipei	502.6	(2.8)	101.7	(1.5)	▼	Columbia	412.3	(3.3)	88.7	(1.5)	▼
Denmark	501.1	(1.8)	92.1	(1.2)	▼	*Brunei Darussalam*	408.1	(0.9)	97.4	(0.8)	▼
Norway	499.5	(2.2)	105.7	(1.3)	▼	*Qatar*	407.1	(0.8)	109.6	(0.6)	▼
Germany	498.3	(3.0)	105.7	(1.5)	▼	*Albania*	405.4	(1.9)	80.3	(1.2)	▼
Slovenia	495.3	(1.2)	93.6	(1.2)	▼	*Bosnia and Herzegovina*	403.0	(2.9)	79.3	(1.2)	▼
Belgium	492.9	(2.3)	102.6	(1.3)	▼	*Argentina*	401.5	(3.0)	97.8	(1.5)	▼
France	492.6	(2.3)	101.2	(1.5)	▼	*Peru*	400.5	(3.0)	91.8	(1.5)	▼
Portugal	491.8	(2.4)	96.1	(1.2)	▼	*Saudi Arabia*	399.2	(3.0)	84.4	(1.6)	▼
Czech Republic	490.2	(2.5)	97.3	(1.6)	▼	*Thailand*	392.9	(3.2)	78.9	(1.6)	▼
Netherlands	484.8	(2.7)	104.8	(1.7)	▼	*Republic of North Macedonia*	392.7	(1.1)	94.3	(1.0)	▼
Austria	484.4	(2.7)	99.4	(1.2)	▼	*Baku (Azerbaijan)*	389.4	(2.5)	74.1	(1.7)	▼
Switzerland	483.9	(3.1)	102.7	(1.5)	▼	*Kazakhstan*	386.9	(1.5)	77.3	(1.2)	▼
Croatia	479.0	(2.7)	89.2	(1.7)	▼	*Georgia*	379.8	(2.2)	84.3	(1.2)	▼
Latvia	478.7	(1.6)	90.0	(1.1)	▼	*Panama*	377.0	(3.0)	87.8	(1.9)	▼
Russian Federation	478.5	(3.1)	92.9	(1.8)	▼	*Indonesia*	371.0	(2.6)	75.1	(1.7)	▼
Italy	476.3	(2.4)	96.9	(1.7)	▼	*Morocco*	359.4	(3.1)	74.6	(1.1)	▼
Hungary	476.0	(2.3)	97.6	(1.3)	▼	*Lebanon*	353.4	(4.3)	113.3	(1.6)	▼
Lithuania	475.9	(1.5)	94.3	(1.0)	▼	*Kosovo*	353.1	(1.1)	68.3	(0.7)	▼
Iceland	474.0	(1.7)	104.7	(1.3)	▼	*Dominican Republic*	341.6	(2.9)	81.8	(1.8)	▼
Belarus	473.8	(2.4)	89.4	(1.3)	▼	*Philippines*	339.7	(3.3)	79.9	(2.3)	▼
Israel	470.4	(3.7)	124.5	(1.9)	▼						
Luxembourg	470.0	(1.1)	108.4	(1.0)	▼						
Ukraine	466.0	(3.5)	93.3	(1.7)	▼						
Turkey	465.6	(2.2)	87.7	(1.6)	▼	OECD AVG-R	487.1	(0.4)	99.4	(0.2)	▼
Slovak Republic	458.0	(2.2)	100.3	(1.4)	▼	EU Average	481.7	(0.5)	98.7	(0.3)	▼

	Significantly above OECD average
	At OECD average
	Significantly below OECD average

▲	Significantly higher than Ireland
O	Not significantly different from Ireland
▼	Significantly lower than Ireland

OECD countries are in regular font, partner countries/economies are in *italics*.
OECD AVG-R is used for Reading data: arithmetic mean for 36 of 37 OECD countries (excluding Spain).
Reporting on reading literacy data for Spain is deferred until sub-optimal response patterns are investigated.
Data for Vietnam are excluded as they have not been fully validated for international comparability.

3.4 Performance on Reading Proficiency Levels

To help interpret what students' scores mean in substantive terms, the OECD has divided the reading scale into eight levels of proficiency, with each level indicating the types of tasks that students would be expected to complete successfully. In PISA 2009, 2012 and 2015, seven levels were included from Level 6 to Level 1b. With the expansion of PISA to include more developing countries, the OECD drew on the experience of PISA for Development[30] to incorporate items with a lower difficulty level to facilitate the inclusion of a descriptor of proficiency below Level 1b. In PISA 2018, then, Level 1c is designated as the lowest level of proficiency for reading, with a cut-point score of 189, while the highest proficiency level, Level 6, has a cut-point score of 698 (see Table 3.7).

The expansion of the assessment to include lower levels of proficiency allows for a better description of the proficiency of students at the lower end of the spectrum. PISA proficiency Level 2 in reading literacy is often considered a baseline level for reading skills and the United Nations, in its Sustainable Development Goals, has identified Level 2 reading literacy proficiency as the 'minimum level of proficiency' that should be attained by students before the end of compulsory schooling (OECD, 2019d). Level 2 reading literacy proficiency indicates that students are able to acquire knowledge, solve practical problems, and identify the main idea in a text. Typical tasks at Level 2 involve comparisons or contrasts based on a single element in the text, or comparing the text to outside knowledge, often by drawing on personal experience. Since all students who have attained a particular level are also expected to demonstrate the skills associated with lower levels, students achieving Level 2 are also likely to demonstrate skills associated with Levels 1a, 1b and 1c.

In PISA 2018, reading literacy Proficiency Levels 3-6 explicitly refer to students' ability to assess the quality and credibility of information and to manage conflict across texts. Across Levels 3-6, readers can represent literal meaning, draw inferences and, to varying degrees, evaluate the relationship between texts of differing lengths, performing reasoning based on explicit and implicit instructions. At Level 6, readers can reflect deeply on content, compare and contrast information resolving inter-textual discrepancies, and draw on cues as to the validity of information provided in the text(s).

In general, across the proficiency levels, there is emphasis placed on multiple source and non-linear texts, in line with the 'shift' in the framework. Non-continuous text formats that take advantage of the digital mode of assessment include texts that cannot be viewed simultaneously, requiring students to click on tabs and pop-up boxes to access information.

Table 3.7 summarises the eight levels of reading literacy proficiency, setting out what the students at each level are capable of, and identifies the elements of the tasks that define each level. It is important to note that these proficiency level descriptors are only applicable to the computer-based assessment of reading literacy administered in 70 countries participating in PISA 2018 (see Chapter 1 for list of PBA countries). The paper-based test of reading literacy available in 2018 comprised items from 2009, the last time reading was the main domain using paper-based assessment, and therefore the 2009 descriptors of proficiency levels apply when discussing the results for paper-based countries, though the cut-off points for both sets of descriptors are the same.

30 PISA for Development is an OECD initiative aimed at facilitating participation in PISA by low- and middle-income countries (http://www.oecd.org/pisa/pisa-for-development/).

Table 3.7: Summary description of the eight levels of proficiency on the PISA 2018 reading literacy scale and percentages of students achieving each level, in Ireland and on average across OECD and EU countries

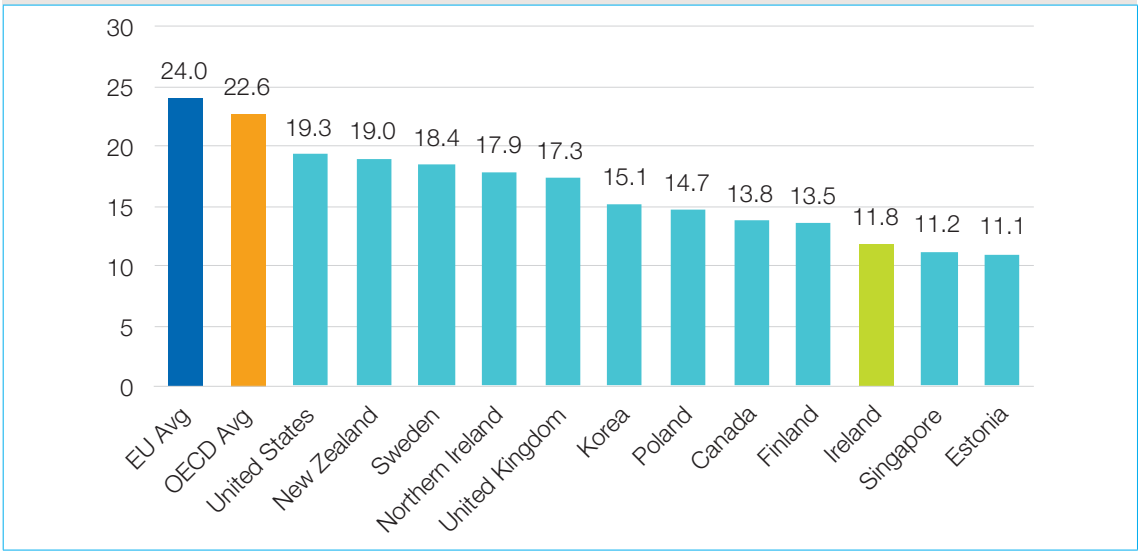
Level (Cut-point)	Students at this level are capable of. . .	Ireland		OECD		EU	
		%	SE	%	SE	%	SE
6 (698 and above)	Reflecting deeply on the text's source in relation to its content, using criteria external to the text. They can compare and contrast information across texts, identifying and resolving inter-textual discrepancies and conflicts through inferences about the sources of information, their explicit or vested interests, and other cues as to the validity of the information.	1.8	(0.3)	1.3	(0.0)	1.1	(0.1)
5 (626 to less than 698)	Comprehending lengthy texts and inferring which information in the text is relevant even though the information of interest may be easily overlooked. They can perform causal or other forms of reasoning based on a deep understanding of extended pieces of text. They can also answer indirect questions by inferring the relationship between the question and one or several pieces of information distributed within or across multiple texts and sources.	10.3	(0.6)	7.4	(0.1)	6.6	(0.1)
4 (553 to less than 626)	Comprehending extended passages in single or multiple-text settings and comparing perspectives and drawing inferences based on multiple sources. Readers can also generate inferences and can evaluate the relationship between specific statements and a person's overall stance or conclusion about a topic; they can also compare and contrast claims explicitly made in several texts and assess the reliability of a source based on salient criteria.	24.1	(0.8)	18.9	(0.1)	18.1	(0.1)
3 (480 to less than 553)	Representing the literal meaning of single or multiple texts in the absence of explicit content or organisational clues. Readers can integrate content and generate both basic and more advanced inferences. They can search for information based on indirect prompts, and in some cases, readers at this level recognise the relationship between several pieces of information based on multiple criteria. Level 3 readers can reflect on a piece of text or a small set of texts, and compare and contrast several authors' viewpoints based on explicit information.	30.3	(0.9)	26.0	(0.1)	26.0	(0.2)
2 (407 to less than 480)	Identifying the main idea in a piece of text of moderate length. They can understand relationships or construe meaning within a limited part of the text. Level 2 readers can select and access a page in a set based on explicit though sometimes complex prompts, and locate one or more pieces of information based on multiple, partly implicit criteria. Readers at Level 2 can, when explicitly cued, reflect on the overall purpose, or on the purpose of specific details, in texts of moderate length. They can compare claims and evaluate the reasons supporting them based on short, explicit statements.	21.7	(0.8)	23.7	(0.1)	24.2	(0.2)
1a (335 to less than 407)	Understanding the literal meaning of sentences or short passages. Readers at this level can also recognise the main theme or the author's purpose in a piece of text about a familiar topic, and make a simple connection between several adjacent pieces of information, or between the given information and their own prior knowledge. They can select a relevant page from a small set based on simple prompts, and locate one or more independent pieces of information within short texts. Level 1a readers can reflect on the overall purpose and on the relative importance of information (e.g. the main idea vs. non-essential detail) in simple texts containing explicit cues.	9.5	(0.6)	15.0	(0.1)	15.5	(0.1)

Level (Cut-point)	Students at this level are capable of. . .	Ireland		OECD		EU	
		%	SE	%	SE	%	SE
1b (262 to less than 335)	Readers at Level 1b can evaluate the literal meaning of simple sentences. They can also interpret the literal meaning of texts by making simple connections between adjacent pieces of information in the question and/or the text. They can scan for and locate a single piece of prominently placed, explicitly stated information in a single sentence, a short text or a simple list. Level 1b readers can access a relevant page from a small set based on simple prompts when explicit cues are present.	2.1	(0.3)	6.2	(0.1)	6.8	(0.1)
1c (189 to less than 262)	Readers at Level 1c can understand and affirm the meaning of short, syntactically simple sentences on a literal level, and read for a clear and simple purpose within a limited amount of time.	0.2	(0.1)	1.4	(0.0)	1.6	(0.1)
Below 1C (less than 189)	There is insufficient information on which to base a description of the reading skills of these students.	0.0	(0.0)	0.1	(0.0)	0.1	(0.0)

Source: e-Appendix Table A3.1, and adapted from OECD (2019c), Table I.B1.1.

In Ireland, 11.8% of students performed at the lowest levels of proficiency (i.e., below Level 2), compared to 22.6% on average across OECD countries, and the difference is statistically significant (see E-Appendix Table A3.2). The percentage in Ireland is about that same as in Estonia and Singapore (Figure 3.5). According to the OECD (2019d), these students have insufficient reading skills to deal with future needs in real life or in further learning. Students who do not attain Level 2 proficiency in reading often have difficulty when confronted with material that is unfamiliar to them or that is of moderate length and complexity. They usually need to be prompted with clues or instructions before they can engage with a text.

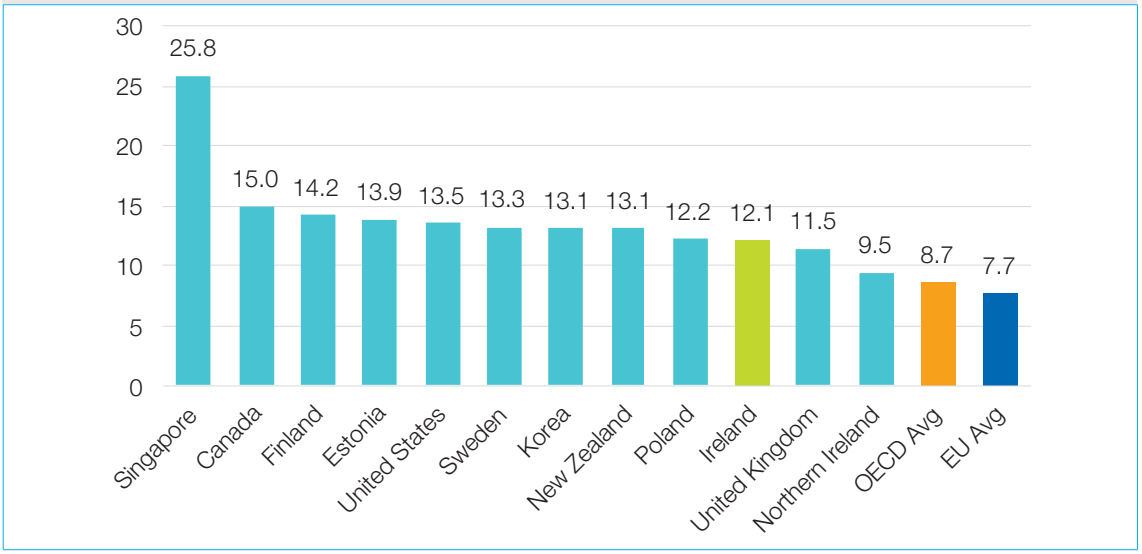
Figure 3.5: Percentages of students performing below Level 2 on the PISA 2018 reading literacy scale in Ireland, in selected comparison countries, and on average across OECD and EU countries



See e-Appendix Table A3.1 for percentages of students (and standard errors) at each proficiency level in Ireland for reading literacy, in selected comparison countries and on average across the EU and the OECD.

In Ireland, 12.1% of students performed at the highest proficiency levels in reading (Levels 5-6 combined). This is more than in Northern Ireland (9.5%), and about the same as in the United Kingdom, Poland, New Zealand, Korea, Sweden and the United States, but below the proportions in Singapore and Canada (Figure 3.6). Ireland has significantly more higher-achieving students than the average for OECD countries (8.7%) (OECD, 2019d, Tables I.B1.7, I.B2.1).

Figure 3.6: Percentages of students performing at or above Level 5 on the PISA 2018 reading literacy scale in Ireland, in selected comparison countries/economies/regions, and on average across OECD and EU countries



See e-Appendix Table A3.2 for percentages of students (and standard errors) at each proficiency level in Ireland for reading literacy, in selected comparison countries and on average across the EU and the OECD.

3.5 Performance on Reading Literacy Subscales

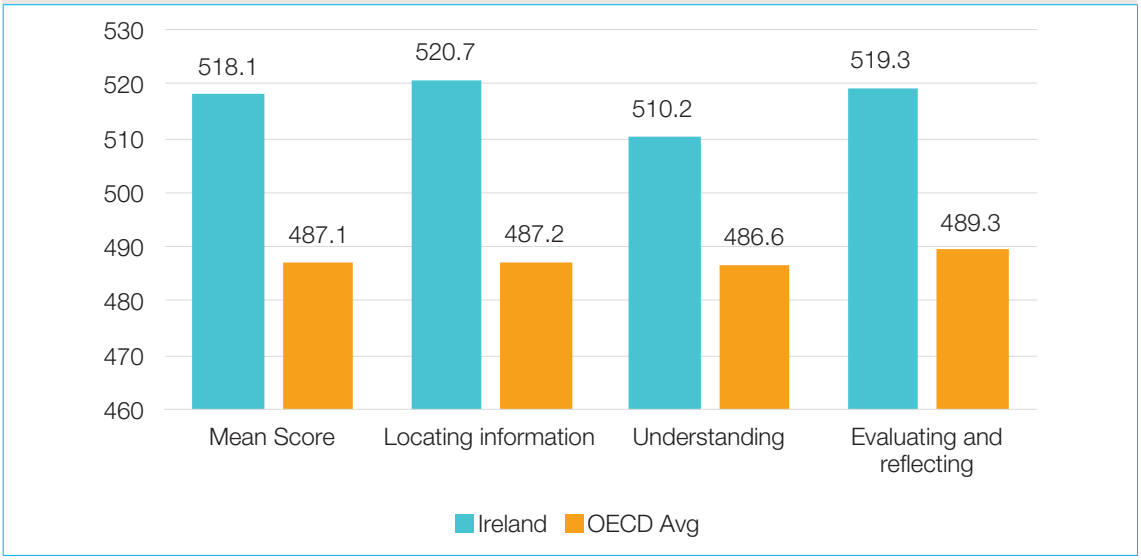
Five subscales were established in the PISA 2018 Reading literacy framework (OECD, 2019a). As noted earlier in this chapter, all reading literacy items were assigned a cognitive process (Locating Information, Understanding, Evaluating and Reflecting) and a text category (Single or Multiple). This section presents a brief overview of performance on each subscale, with performance in Ireland compared with average performance across OECD countries. More detailed information on student performance on each subscale at various proficiency levels can be found in OECD (2019d).

3.5.1 Performance on process subscales

Student performance on three superordinate cognitive subscales, Locating Information, Understanding, and Evaluating and Reflecting, along with mean scores on the overall reading literacy scale, is presented for Ireland and for the average across OECD countries in Figure 3.7. Ireland's mean score is significantly higher than the corresponding OECD average on each reading process subscale, with a difference of 33.5 points on Locating Information, 23.6 points on Understanding and a difference of 30.0 points on Evaluating and Reflecting (OECD 2019d, Tables I.B.21, I.B.22, I.B.23).

Comparisons can be made between the three process subscales. Ireland's profile of performance across the three reading process subscales was strong. According to the OECD (2019d, Table I.5.3), students in Ireland were relatively stronger in Locating Information and Evaluating and Reflecting than in Understanding.[31]

Figure 3.7: Mean scores on the overall reading literacy scale and the reading literacy process subscales, in Ireland and on average across OECD countries



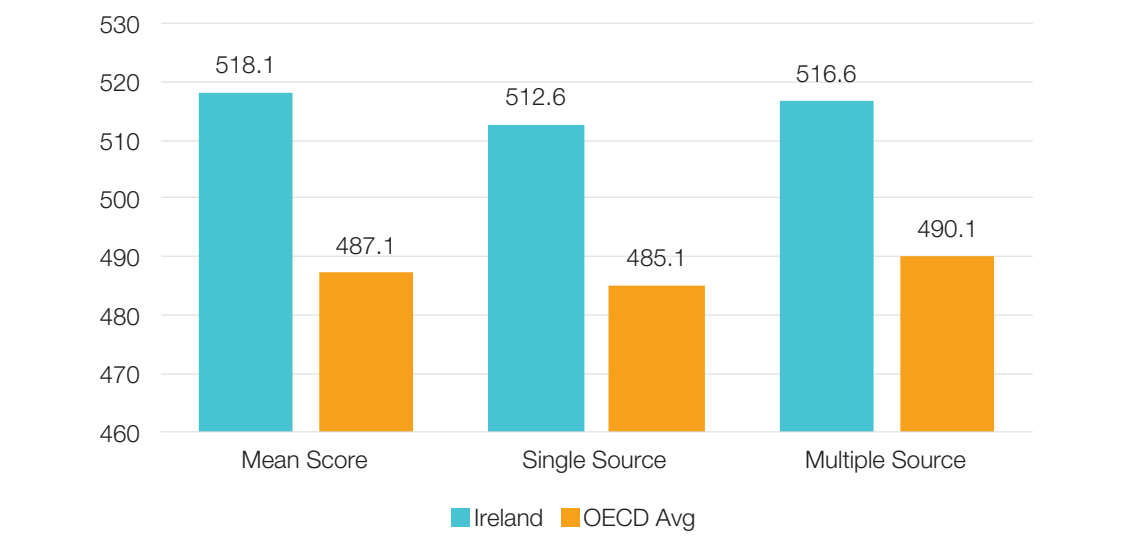
Source: OECD 2019d, Tables I.B1.21, I.B1.22, I.B1.23.

3.5.2 Performance on source subscales

In PISA 2018, student performance on reading literacy is also reported by source subscale, based on the number of text sources (Single, Multiple) required to give the correct answer to test questions. Figure 3.8 presents mean scores on the overall reading scale and on two reading source subscales in Ireland, and on average across OECD countries. Ireland scores significantly above the OECD average on both Single and Multiple Text subscales, with score-point differences of 27.5 and 26.5 respectively. As with the cognitive process subscales, the OECD (2019d) states that it is possible to compare within the set of subscales in order to identify relative strengths. In the case of Source subscales, for Ireland and on average across OECD countries, a relative strength is visible on the Multiple Text subscale compared to the Single Text subscale. However, it is important to note that the Multiple Text subscale includes all items drawing on more than one text source, ranging from less complex items with lower item difficulty (e.g., search engine results and noticeboard information), to items from the higher difficulty (and more complex) item pool. Furthermore, the Multiple Source subscale contributes relatively less to overall performance since just 20% of items are classified as being based on multiple sources, while 80% are classified as belonging to single sources.

31 According to the OECD (2019d, Table I.5.3), a country/economy is relatively stronger in one subscale than another if its standardised score, as determined by the mean and standard deviation of student performance in that subscale across all participating countries/economies, is significantly higher on one subscale than on another subscale.

Figure 3.8: Mean scores on the overall reading scale and the two source subscales, in Ireland, and on average across OECD countries



Source: OECD 2019d, Tables I.B1.24, I.B1.25.

3.6 Performance by Selected Variables

Student performance on reading literacy is examined with reference to selected background variables: student gender, student socio-economic status, school gender composition, school fee-paying status and school DEIS status. Between-school variance (differences) in reading literacy is also examined.

3.6.1 Gender differences on reading performance

Female students in Ireland significantly outperform male students on PISA 2018 overall reading (Table 3.8). The difference, 23.2 score points, is among the lowest across comparison countries, and is at a similar level to Singapore, the United States, Korea and the United Kingdom. On average across OECD countries, the gender difference in favour of female students is 29.7 points, while the difference in Northern Ireland is 36.5 points in favour of females. However, the gender difference in Northern Ireland is not statistically different from the gender difference in Ireland. This arises, in part, because of the large standard errors around the mean scores of male and female students in Northern Ireland. In Finland, the difference in favour of females is 51.5 points.

Table 3.8: Gender differences in reading literacy performance in Ireland, in selected comparison countries and on average across OECD and EU countries

	Males		Females		Difference (males-females)	
	Mean	SE	Mean	SE	Score diff	SE
Estonia	507.7	(2.4)	538.4	(2.2)	**-30.7**	(2.6)
Canada	505.7	(2.1)	534.7	(2.0)	**-28.9**	(2.1)
Finland	494.8	(2.9)	546.3	(2.3)	**-51.5**	(2.7)
Ireland	506.4	(3.0)	529.6	(2.5)	**-23.2**	(3.3)
Korea	502.8	(4.0)	526.4	(3.6)	**-23.6**	(4.9)
Poland	495.5	(3.0)	528.2	(2.9)	**-32.8**	(2.6)
Sweden	488.6	(3.2)	523.0	(3.4)	**-34.3**	(2.8)
New Zealand	491.4	(2.7)	520.3	(2.7)	**-28.8**	(3.7)
United States	493.8	(4.2)	517.4	(3.6)	**-23.5**	(3.5)
United Kingdom	493.6	(3.2)	513.7	(3.1)	**-20.1**	(3.6)
OECD	472.4	(0.5)	502.1	(0.5)	**-29.7**	(0.6)
Singapore	538.1	(2.0)	561.3	(1.9)	**-23.2**	(2.3)
Northern Ireland	482.4	(6.2)	518.9	(4.5)	**-36.5**	(7.7)

Source: OECD 2019e, Table II.B1.7.1.
Significant differences are in **bold**.

3.6.2 Gender differences on reading performance by subscales

Female students in Ireland significantly outperform male students on all three reading literacy process subscales (Table 3.9). Score-point differences in favour of females ranged from 18.7 points for Evaluating and Reflecting to 23.8 points for Locating Information and 23.7 for Understanding.

Table 3.9: Mean scores for males and females on the three process subscales in Ireland

	Males		Females		Difference (males-females)	
	Mean	SE	Mean	SE	Score diff	SE
Locating Information	508.7	(3.0)	532.5	(3.1)	**-23.8**	(4.1)
Understanding	498.3	(3.3)	522.0	(2.7)	**-23.7**	(3.7)
Evaluating and Reflecting	509.9	(3.4)	528.6	(2.9)	**-18.7**	(3.9)

Source: OECD 2019e, Tables II.B1.7.7, II.B1.7.8, II.B1.7.9.
Significant differences are in **bold**.

On average across OECD countries, females have significantly higher mean scores on the three process subscales; these range from a difference of 29.8 score points for Locating Information and Understanding subscales, to a difference of 25.7 points on Evaluating and Reflecting (OECD 2019e, Tables II.B1.7.7, II.B1.7.8, II.B1.7.9).

On the reading literacy source subscales (Table 3.10), there are significant gender differences on both Single Source and Multiple Source subscales in Ireland, with a difference of 26.2 score points in favour of females on Single Source texts, and a difference of 19.2 points in favour of females on Multiple Source texts.

Table 3.10: Mean scores on reading literacy source subscales in Ireland, by gender

	Males		Females		Difference (males-females)	
	Mean	SE	Mean	SE	Score diff	SE
Single Source	499.4	(3.2)	525.6	(2.9)	**-26.2**	(3.6)
Multiple Source	506.9	(3.1)	526.1	(2.8)	**-19.2**	(3.5)

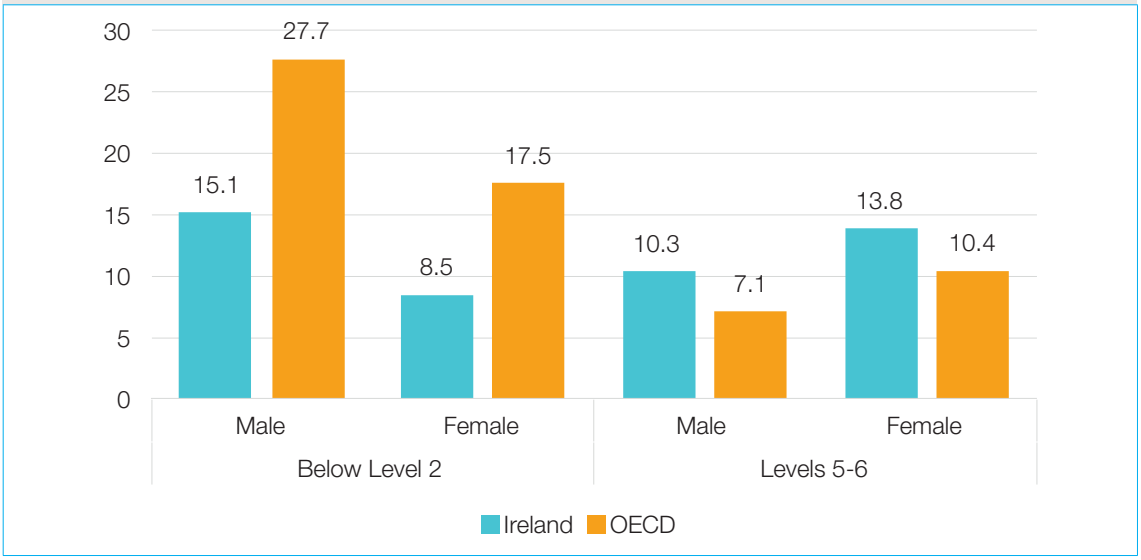
Source: OECD 2019e, Tables II.B1.7.10, II.B1.7.11.
Significant differences are in **bold**.

On each Source subscales, a gender gap in favour of females is also observed on average across OECD countries. In line with Ireland, there was a larger gender gap on the Multiple Source subscale relative to the Single Source subscale on average across OECD countries, with a difference of 31.6 points on Single Source texts and of 26.3 points on Multiple Source texts (OECD 2019e, Tables II.B1.7.10, II.B1.7.11.).

3.6.3 Gender differences on reading performance by proficiency levels

Gender differences in performance on the reading proficiency levels can also be examined. As per Figure 3.9, 15.1% of male students in Ireland performed below Level 2 on the PISA overall reading scale. This is well below the OECD average of 27.7%, indicating that there are relatively fewer male students performing below the baseline on reading literacy in Ireland. Similarly, 8.5% of female students in Ireland perform below Level 2, compared with 17.5% on average across OECD countries. The gender difference in favour of female students performing below Level 2 is statistically significant in Ireland and on average across OECD countries.

Figure 3.9: Percentages of male and female students achieving below Proficiency Level 2 and at or above Proficiency Level 5 on the overall reading scale, in Ireland, and on average across OECD countries



Source: OECD 2019e, Table II.B1.7.12.

Examining higher performers on reading literacy, Figure 3.9 shows that more male and female students in Ireland are higher performers than on average than across OECD countries. In Ireland,

10.3% of male students perform at proficiency Levels 5-6, compared with an OECD average of 7.1%, while 13.8% of female students in Ireland are performing at the highest levels, compared to the OECD average of 10.4%. The gender difference in favour of female students performing at Levels 5-6 is statistically significant in Ireland and on average across OECD countries.

3.6.4 Student socio-economic status and reading literacy performance

Students' economic, social and cultural status (ESCS) is a known predictor of student achievement and is associated with significant differences in student performance across many PISA countries and economies (OECD, 2016a). Analyses of the PISA datasets consistently show that ESCS is associated with performance at the student, school and system levels. This section examines the relationship between student performance in reading literacy and ESCS at the student level.

In PISA 2018, the ESCS index[32] was derived from three variables: home possessions (a composite of cultural, educational and material possessions, and books in the home), parental occupation, and parental education. Cultural possessions include books on art, music, or design, and musical instruments. Home educational resources include a desk and quiet place to study at home, as well as a computer for school work, and educational software. Material possessions (a proxy for family wealth) include a student's own bedroom, a laptop or tablet computer, as well as the number of televisions and cars at the student's home. Books at home represents a student's estimation of the number of books (excluding magazines, newspapers and schoolbooks) that are in the home, using a scale ranging from 0-10 books, to more than 500 books[33]. Parental occupation and parental education are also derived from students' responses on the student questionnaire. Parental education is expressed in years calculated from parents' highest educational qualifications/ attainments as reported by students. Parental occupation, as described by students, is scored on the International Socioeconomic Index (ISEI) following classification using the International Standard Classification of Occupation Index. Higher scores on the ESCS index indicate higher student economic, social and cultural status.

The correlation between ESCS and reading achievement was in the moderate range (r = 0.33, SE = 0.02, t = 16.5, df = 80). Table 3.11 shows the mean scores in reading for students in each ESCS quartile.

Table 3.11: Mean scores on reading by ESCS quartile[34] in Ireland

Quartiles of ESCS	%	Mean Score	SE	SD
Highest	25.0	**557.0**	(3.0)	86.2
Medium-High ESCS	25.0	**526.8**	(2.8)	86.1
Low-Medium ESCS	25.0	**510.8**	(3.0)	84.3
Lowest (ref.)	25.0	481.8	(3.0)	87.6

Significantly different mean scores are in **bold** (compared with the reference group).

32 In 2018, there were limited changes made to improve the measure of ESCS, including equal weighting of all components, scores assigned to parents in education, in receipt of welfare, or at home (previously treated as missing), and country-specific parameters assigned for several international home possession items.

33 The categories were recoded to provide national averages as follows: 0-10 books was recoded as 5 books, 11-25 books to 18 books, 26-100 books to 63 books, 101-200 books to 150.5 books, 201-500 books to 350 books, and more than 500 books to 750.5 books.

34 The ESCS quartiles in this chapter were computed by the ERC and may differ slightly from the OECD reported quartiles, due to different random allocation of students on the cut-off points for quartiles.

Compared to students in the lowest quartile of ESCS (the reference group), students in low-medium, medium-high and high ESCS quartiles had significantly higher reading mean scores. Students in the highest category of ESCS in Ireland had a mean score of 557.0 compared to the mean score of 481.8 for students in the lowest quartile, a difference of 75.2 score points.

3.6.5 School sector gender composition and reading literacy performance

As part of the preparation of the PISA sample in Ireland, schools were categorised as 'all girls', all boys', mixed, community/comprehensive, and ETB vocational. Table 3.12 shows the mean scores for students in each school category. Mean scores ranged from 541.7 (girls' secondary) to 500.0 (vocational). Compared with vocational schools, mean scores were significantly higher in girls' secondary and mixed secondary schools.

Table 3.12: Mean reading scores in Ireland by school type and gender composition

Classification	%	Mean Score	SE	SD
Girls' secondary	21.2	**541.7**	(3.5)	82.6
Boys' secondary	15.0	511.1	(6.0)	91.1
Community/comprehensive	16.9	507.6	(3.8)	90.5
Mixed secondary	17.4	**536.0**	(7.7)	90.7
ETB vocational (ref.)	29.5	500.0	(4.2)	90.6

3.6.6 School fee-paying status and reading performance

Post-primary schools in PISA can be categorised as 'fee-paying' or 'non fee-paying'. Table 3.13 shows the mean scores in reading for students attending both school types. Students in fee-paying schools had a mean score (567.8) in reading that was significantly higher than the mean score of students in non-fee-paying schools (514.4). The difference, 53.4 score points, is over one-half of a national standard deviation.

Table 3.13: Mean reading scores in Ireland by fee-paying status

Classification	%	Mean Score	SE	SD
Fee-paying	7.0	**567.8**	(7.8)	81.9
Non fee-paying (ref.)	93.0	514.4	(2.1)	90.2

Significant differences in **bold**.

3.6.7 School DEIS status and reading performance

In 2018, students attending DEIS schools achieved a mean score of 479.2 in reading (Table 3.14). This was significantly lower than the mean score of students in non-DEIS schools (530.4). Again, the difference, 51.2 score points, is over one-half of a national standard deviation.

Table 3.14: Mean reading scores in Ireland by DEIS status

Classification	%	Mean Score	SE	SD
DEIS	24.1	**479.2**	(4.8)	90.1
Non-DEIS (ref.)	75.9	530.4	(2.5)	87.4

Significant differences in **bold**.

3.6.8 Between- and within- school variance in reading performance

Across OECD countries on average, 29.0% of the total variation in reading performance lies between schools and the remainder lies within schools (OECD 2019e, Table II.B1.4.1). This measure of between-school variation can be used as a broad indicator of equity in educational outcomes between schools. The lower the between-school variation, the more similar schools are to one another with respect to achievement.

Total variation in reading performance in Ireland amounts to 84.3% of the average total variation across OECD countries. In Ireland, the variation in reading performance between schools (as a proportion of the OECD average total variation) is 11.1%, while 72.8% of variation is within schools. In some countries, such as the Netherlands, Bulgaria and Germany, over 50% of the variation in reading performance (as a percentage of the OECD average variation) lies between schools. In others (e.g., Finland and Iceland), between school differences account for less than 10% of the variation in performance. Ireland is amongst the group of countries with the lowest variation in reading performance between schools. Differences between countries in the percentage of variation between schools are in part related to the extent to which the school system 'tracks' students into academic, technical or vocational streams and so should be interpreted with respect to these system-level characteristics.

3.7 Trends in performance on reading literacy, 2009-2018

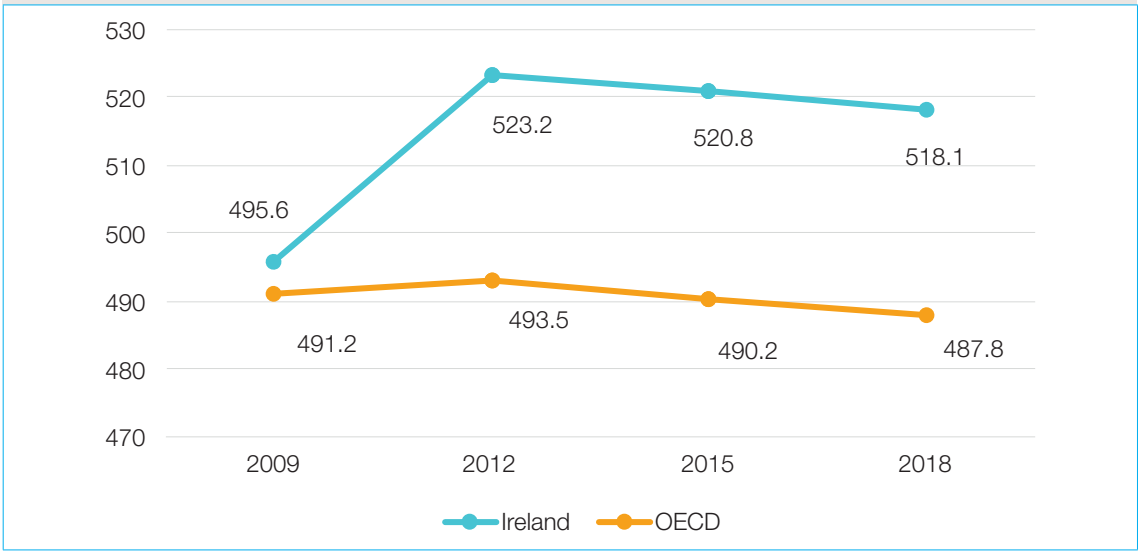
This section considers trends in reading performance between 2009 (the last cycle in which reading literacy was a major assessment domain in PISA) and 2018. It was noted in Chapter 2 that there was a substantial drop in average print reading performance in Ireland in 2009 (a drop of 31 score points from 2000), almost one-third of the OECD average standard deviation in 2000. The drop in performance of students in Ireland on PISA reading in 2009 is an outlier compared to all other cycles. Therefore, while the trend comparison 2009-2018 for Ireland shows significant increases, it is important to consider the results from other cycles, including 2015, when exploring trends in performance on reading literacy.

First, overall trends in reading achievement in Ireland, on average across OECD countries, and in comparison countries between 2009 and 2018 are examined. Second, performance at the highest and lowest reading proficiency levels across the four most recent cycles are examined. Finally, trends in the performance of males and females in PISA reading literacy are considered.

3.7.1 Trends in overall reading literacy mean scores

In this section, trends in overall reading performance 2009-2018 are examined for Ireland and on average across OECD countries. Ireland's mean score was 22.4 points higher in 2018 than in 2009, and just 2.7 score points lower than in 2015 (Figure 3.9). The OECD average was 4.0 score points lower in 2018 than in 2009. While reading performance on average across the OECD went up very slightly by 2.3 points between 2009 and 2012, the trend since 2012 has been negative, with a drop of 6.3 points over the period 2012-2018, though this difference is not statistically significant (OECD 2019d, Table I.B1.10). OECD average scores are based on 35 OECD member countries (Austria and Spain are not included, because of data quality issues in 2009 and 2018 respectively). It might be noted that, while the 2015 cycle was the first time PISA was fully-administered on computer, the reading test content was based on the 2009 reading framework. Notwithstanding these points, Figure 3.10 shows relative stability in the mean reading scores since 2012, since a decline of 5 score points equates to just one-twentieth of the OECD average standard deviation.

Figure 3.10: Mean scores on the overall reading literacy scale in Ireland and on average across OECD countries, 2009-2018

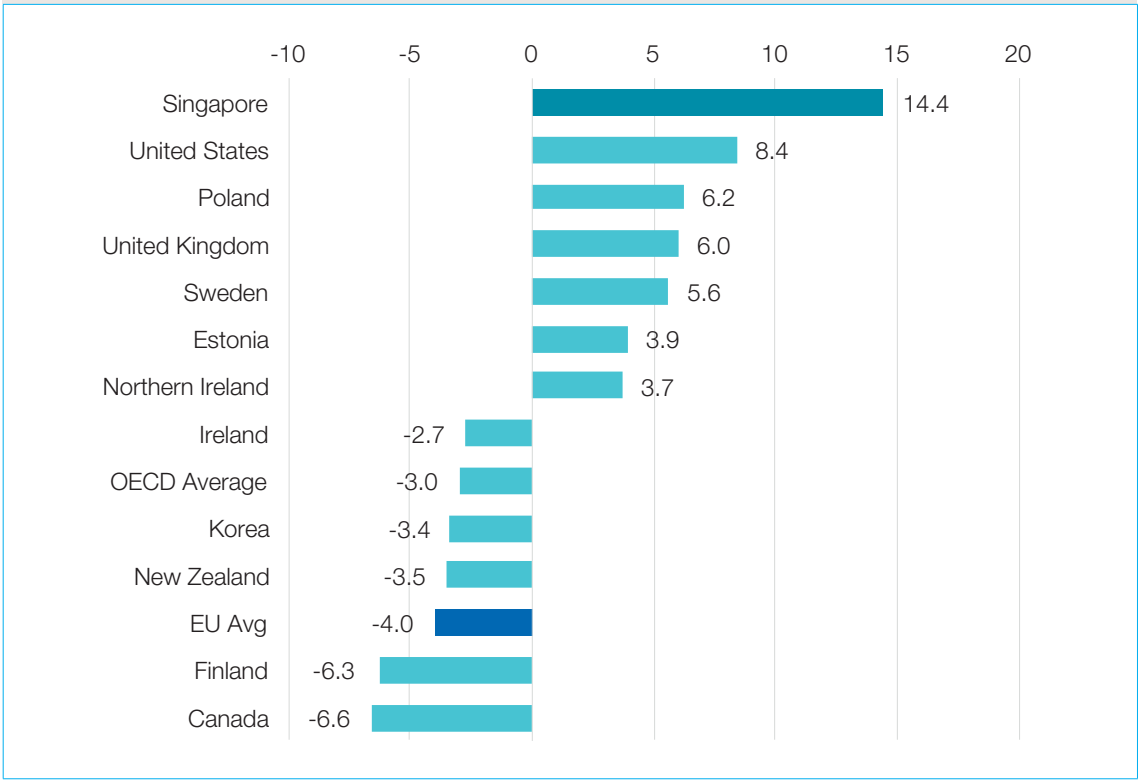


Source: OECD 2019e, Table II.B1.10.

Figure 3.11 presents the mean score differences in reading performance between 2015 and 2018 for selected comparison countries/economies, the OECD, the EU and Northern Ireland. On average across the OECD countries, there was a slight drop in performance (3.0 points). Singapore experienced a significant increase in reading performance 2015-2018, with an improvement of 14.4 score points, followed by the United States at 8.4 points, and Poland and the United Kingdom with increases of 6.2 and 6.0 score points respectively.

Ireland was amongst a group of countries that experienced a small drop in reading performance (-2.7), but the non-significant decrease was lower than that experienced on average across OECD countries, and lower on average than across EU countries. The decline in reading performance 2015-2018 on average across EU countries was 4.0 score points, which is statistically significant. Within the pool of selected comparison countries/economies, Finland and Canada experienced the largest declines in performance, with drops of 6.3 and 6.6 respectively. Outside of the selected comparison countries, Norway and the Netherlands declined significantly in overall reading performance in 2015-2018, by 13.7 and 18.2 score points respectively.

Figure 3.11: Mean score difference in reading for selected comparison countries, and on average across OECD and EU countries, 2015-2018



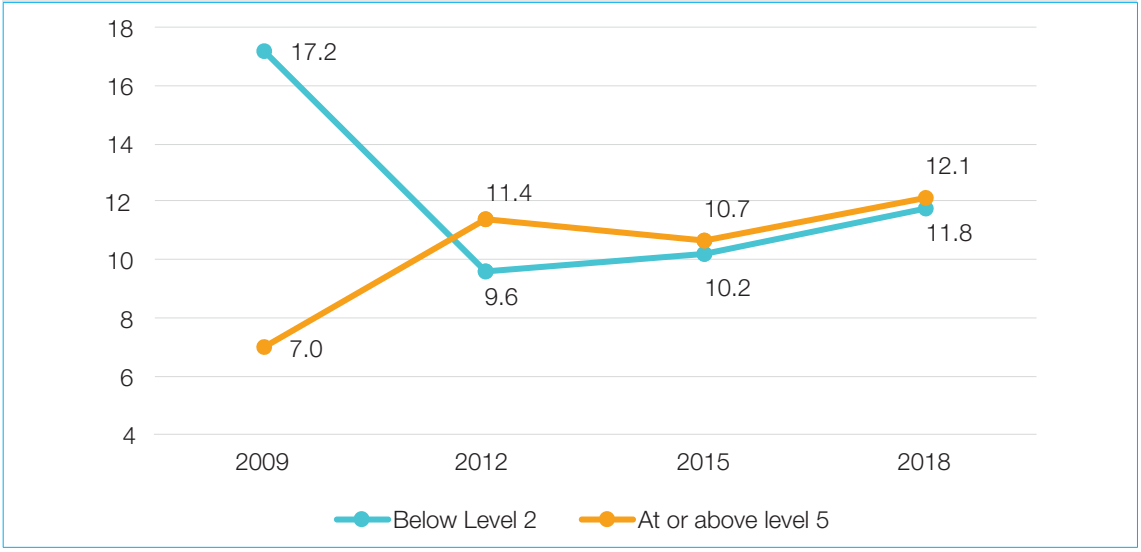
Source: E-Appendix Table A3.3.
Significant differences denoted by **darker** bars.

3.7.2 Trends in reading literacy performance by proficiency levels

Figure 3.12 shows the percentages of students in Ireland below Level 2 in 2009 (17.2%), in 2012 (9.6%), in 2015 (10.2%) and in 2018 (11.8%). The difference in the percentage of students in Ireland below Level 2 between 2009 and 2018, -5.4 percentage points, is statistically significant (OECD 2019d, Table I.B1.7). On average across OECD countries between 2009 and 2018, the difference in the percentages performing below Level 2 is also significantly different, though in the opposite direction to Ireland, showing a 3.2 percentage point increase (19.4% in 2009 and 22.6% in 2018).

Figure 3.12 also shows the percentages of students in Ireland performing at Level 5 or higher in 2009 (7.0%), in 2012 (11.4%), in 2015 (10.7%) and in 2018 (12.1%). The percentage of students in Ireland performing at or above Level 5 has remained relatively consistent 2012-2018. However, the difference between 2009 and 2018 is large and significant (+5.1). On average across (35) OECD countries, a significantly higher percentage (8.8%) performed at Level 5 or above in 2018 compared with 2009 (7.3%) (OECD 2019d, Table I.B1.7).

Figure 3.12: Percentage of students in Ireland performing below Level 2 and at or above Level 5 in reading, PISA 2009-2018



Source: OECD 2019d, Tables I.B1.7

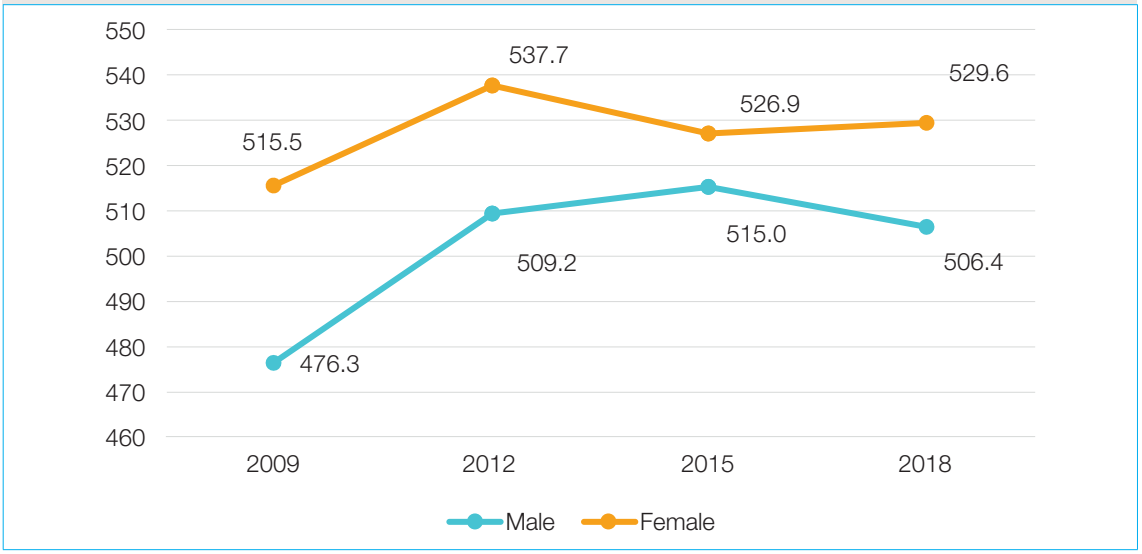
3.7.3 Trends in reading literacy performance by gender

This section looks changes in overall performance on reading literacy by gender, first by mean score and then by proficiency levels. Figure 3.13 gives the mean scores of male and female students in Ireland across the cycles 2009 to 2018.

In Ireland, the mean score for males in 2009 was 476.3, while the mean score for females was 515.5. Since 2009, the mean score in reading literacy for female students has fluctuated cycle to cycle, with an overall increase of 14.1 points over the period 2009-2018. For male students, there was a large and significant increase 2009-2015 of 30.1 points, followed by a decline of 8.6 points in between 2015 and 2018 (OECD 2019e, Tables II.B.1.7.27, II.B.1.7.28, II.B.1.7.29, II.B.1.7.30).

There was a large and significant difference in favour of female students 2009-2018, with the largest gender difference in reading performance in 2009 with a gap of 39.2 points. Over cycles 2012 and 2015, the gender gap converged, with a difference of 11.9 points in 2015. However, the gender gap has somewhat increased in 2018 to 23.2 points. On average across OECD countries (based on 35 countries), the mean score for males in 2018 was 472.4 while that for females was 502.2 (OECD 2019e, Table II.B1.7.1). The difference in favour of females, 29.7 score points, is statistically significant. In 2009, on average across OECD countries, the mean score of males was 471.7, while that of females was 511.0. The difference in favour of females, 39.3 score points, is again statistically significant (OECD 2019e, Tables II.B.1.7.27, II.B.1.7.28, II.B.1.7.29, II.B.1.7.30).

Figure 3.13: Mean scores on the overall reading literacy scale by gender in Ireland, 2009-2018



Source: OECD 2019e, Tables II.B1.7.1, II.B1.7.27, II.B1.7.28, data for 2012 are from Shiel et al. (2016).

Table 3.15 presents the performance of student in Ireland below Level 2 and at or above Level 5, between 2009 and 2018. In Ireland, fewer male students performed below Proficiency Level 2 in 2018 (15.1%) compared with 2009 (23.1%). The difference (-8.0 percentage points) is statistically significant. Fewer females in Ireland also performed below Level 2 in 2018 (8.5%) compared with 2009 (11.2%). The difference, -2.7 percentage points, is statistically significant.

In 2018, over twice as many male students in Ireland (10.3%) performed at or above Level 5, compared with 2009 (4.5%). The difference, 5.8 percentage points, is statistically significant. There was also a statistically significant increase in the proportions of female students who performed at or above Level 5 in 2018 when compared to both 2009 and 2015 (4.3% and 3.1% respectively).

On average across OECD countries, 25.7% of males performed below Level 2 in 2009, while 27.7% did so in 2018. The difference, though small, is statistically significant (OECD 2019e, Tables II.B1.7.12, II.B1.7.13, II.B1.7.14, II.B1.7.15, II.B1.7.16). In 2018, 17.5% of females performed below Level 2, significantly increasing from 13.1% of females in 2009. In 2009, 5.0% of males performed at Levels 5-6, and this increased significantly to 7.1% in 2018, while 9.7% of females performed at Levels 5-6 in 2009, and this increased non-significantly to 10.5% in 2018.

Table 3.15: Percentage of male and female students below Proficiency Level 2 and at or above Proficiency Level 5 on reading literacy in Ireland, 2009-2018

	Below Level 2				At or above Level 5			
	Male		Female		Male		Female	
	%	SE	%	SE	%	SE	%	SE
2009	23.1	(1.7)	11.2	(1.0)	4.5	(0.6)	9.5	(0.9)
2012	13.0	(1.4)	6.1	(0.9)	8.5	(0.7)	14.4	(1.0)
2015	12.3	(1.1)	8.0	(0.8)	10.7	(0.9)	10.7	(1.0)
2018	15.1	(1.0)	8.5	(0.7)	10.3	(0.9)	13.8	(0.8)
	Diff	**SED**	**Diff**	**SED**	**Diff**	**SED**	**Diff**	**SED**
2018-2009	**-8.0**	(2.0)	**-2.7**	(1.2)	**5.8**	(1.1)	**4.3**	(1.2)
2018-2012	2.1	(1.7)	2.4	(1.1)	1.8	(1.2)	-0.6	(1.3)
2018-2015	2.8	(1.5)	0.5	(1.1)	-0.4	(1.3)	**3.1**	(1.1)

Significant differences in **bold**; comparisons within genders (male vs. male, female vs female).
Data from 2012 are taken from Shiel et al. (2016).

3.8 Summary

Reading was a major assessment domain in PISA 2018. Prior to the assessment, the reading literacy framework underwent considerable revision, to better reflect how reading has evolved in recent years, often because of new technologies. A new element, fluency, was added to the framework and to the assessment for 2018. While cognitive processes such as locating information, understanding and evaluating were assessed on the PISA reading literacy test, other framework components, such as setting goals and plans, monitoring progress and self-regulating reading strategies were only measured indirectly, through questionnaire items.

Ireland's mean score of 518.1 on the reading scale in 2018 is significantly higher than the OECD average of 487.1. Ireland ranked 4th out of 36 OECD countries (or between 1st and 5th if a 95% confidence interval is applied) and 8th out of all 77 participating countries/economies for whom valid data were available (between 5th and 9th if a 95% confidence interval is applied). The highest-performing countries/economies were B-S-J-Z (China), Singapore and Macao (China). They significantly outperformed all other countries/economies, including Ireland. Six countries (Hong Kong (China), Estonia, Canada, Finland, Korea, and Poland) had mean scores that did not differ significantly from Ireland's, while the remaining 67 countries/economies, including 30 OECD countries, had significantly lower scores. Northern Ireland had a mean score (500.7) that was significantly lower than Ireland's.

In Ireland, 11.8% of students perform at the lowest levels of proficiency on overall reading literacy (i.e., below Level 2), compared to 22.6% on average across OECD countries, indicating that there are relatively fewer students with very low achievement in reading literacy in Ireland. Almost one-in-eight students in Ireland (12.1%) perform at the highest proficiency levels in reading (Levels 5-6 combined), and hence can be considered higher-achieving readers. On average across OECD countries, 8.7% perform at Levels 5-6, indicating that Ireland has more higher-achieving readers.

Not unexpectedly, given Ireland's strong overall performance, students in Ireland performed well on all three reading process subscales. In Ireland, the mean score on Locating Information that was 33.5 score points above the OECD average; it was 23.6 score points above the OECD average for Understanding; and it exceeded the OECD average by 30.0 points for Evaluating and Reflecting. Hence, in Ireland, performance was relatively stronger on Locating Information and on Evaluating and Reflecting than on Understanding.

Students in Ireland also scored significantly above the OECD average on both Single and Multiple Text subscales, with a difference of 27.5 points for Single Texts and a difference of 26.5 points for Multiple Texts. Students in Ireland performed slightly better (by 4 score points) on the Multiple Sources scale, compared with the Single Source scale.

Selected variables

Female students in Ireland significantly outperform male students on PISA 2018 overall reading. The difference, 23.2 score points, is among the lowest across comparison countries, at a similar level to Singapore, the United States, Korea and the United Kingdom. On average across OECD countries, the gender difference in favour of female students is 29.7 points. Female students in Ireland also significantly outperformed male students on all three reading literacy process subscales, with the similar differences on Locating Information (-23.8) and Understanding (-23.7 score points) and the smallest difference on Evaluating and Reflecting (-18.7). Females in Ireland also outperformed males on the Single Source subscale (by 26.2 score points) and on the Multiple Source subscale (by 19.2 score points). On the overall reading proficiency scale, 8.5% of females, and 15.1% of males performed below Level 2. Hence, there are more lower-achieving males than females in Ireland, a finding that also emerged on average across OECD countries. In Ireland, more females (13.8%) than males (10.3%) performed at Levels 5-6. The corresponding OECD average estimates were 10.4% and 7.1% respectively, indicating that there are relatively more higher-achieving female and male students in Ireland than on average across OECD countries.

Compared to students in the lowest quartile of ESCS, students in low-medium, medium-high and high ESCS had significantly higher reading mean scores. Students in the highest category of ESCS in Ireland had a mean score of 557.0 compared to students in the lowest quartile (481.8), a difference of 75.2 score points.

Both students attending girls' secondary schools (541.7) and those attending mixed secondary schools (536.0) had significantly higher mean scores than students attending vocational schools (500.0). Students attending fee-paying schools and those attending non-DEIS schools had mean scores that were over one-half of a standard deviation higher than the mean scores of students attending non fee-paying and DEIS schools respectively.

Ireland is amongst the group of countries with the lowest variation in reading performance between schools. On average across OECD countries, 29.0% of the total variation in reading performance lies between schools and the remainder lies within schools. In Ireland, the variation in reading performance between schools is 11.1% of the total OECD average variation, while 72.8% of variation is within schools. In some countries, such as the Netherlands, Bulgaria and Germany, over 50% of the differences in reading performance (as a percentage of the OECD average variation) lies between schools. Ireland's relatively high average achievement and relatively low between-school differences in achievement indicate that Ireland has a post-primary system which results in a combination of relative educational equity and high performance in reading.

Trends

Low student engagement and issues with the statistical model used to scale the PISA 2009 data, which may have resulted in an underestimate of Ireland's reading literacy score, mean that comparisons between 2009 and 2018 should be made cautiously. These issues did not apply to PISA 2012 or 2015.

Ireland was amongst a group of countries that experienced a small and non-significant drop in reading performance since 2015 (-2.7 score points), but the decrease was lower than that experienced on average across OECD countries (-3.0 points), and lower on average than across EU countries (-4.0), with the latter reaching statistical significance.

In Ireland, 17.2% performed below Level 2 in 2009, and this dropped significantly to 11.8% in 2018. On average across OECD countries[35], between 2009 and 2018, there was a significant increase in the percentages performing below Level 2, from 19.4% to 22.6%. The percentage of students in Ireland performing at or above Level 5 increased from 7.0% in 2009 to 12.1% in 2018. There was a large and significant increase in the percentage of students in Ireland performing at or above Level 5 between 2009 and 2018 (+5.1). On average across OECD countries, a significantly higher percentage of students (8.8%) also performed at Level 5 or above in 2018 compared with 2009 (7.3%).

Female students in Ireland achieved a mean score in 2018 that was some 14.1 score points higher than in 2009. Over cycles 2012 and 2015, the gender gap converged to its lowest level of 11.9 points, before increasing to 23.2 in 2018. This was amongst the lowest on average across OECD countries. There was a gender gap of 39.3 score points across the OECD in 2009, which fell to 29.7 score points in 2018.

In Ireland, fewer male students performed below Proficiency Level 2 in 2018 (15.1%) compared with 2009 (23.1%). The difference (-8.0 score points) is statistically significant. Fewer females in Ireland also performed below Level 2 in 2018 (8.5%) compared with 2009 (11.2%). The difference, -2.7 score points, is also statistically significant. On average across OECD countries, 25.7% of boys performed below Level 2 in 2009, while 27.7% did so in 2018. The difference, though small, is statistically significant.

In 2018, twice as many male students in Ireland (10.3%) performed at or above Level 5, compared with 2009 (4.5%). The difference, 5.8 percentage points, is statistically significant. There was also a statistically significant increase in the proportions of female students who performed at or above Level 5 in 2018 when compared to 2009 and 2015 (4.3% and 3.1% respectively). On average across OECD countries, 5.0% of boys performed at Levels 5-6 in 2009 and this increased significantly to 7.1% in 2018. In 2009, 9.7% of girls performed at Levels 5-6, and there was a non-significant increase to 10.5% by 2018.

35 As noted earlier, 35 member countries included in the OECD average for reading literacy when compared across PISA cycles.

Chapter 4
Student Performance on Scientific Literacy

Key Points from Chapter 4

- Ireland's mean score of 496.1 on the science scale is significantly higher than the OECD average of 488.7.
- Ireland ranked 17th among 37 OECD countries (or between 13th and 21st if a 95% confidence interval is applied), 22nd among 78 participating countries/economies with valid data (or between 18th and 26th if a 95% confidence interval is applied), and 11th out of 28 EU countries.
- Ireland's standard deviation on science, 88.3 score points, indicated a narrower range of achievement, compared with the averages across OECD countries (93.5) and EU countries (93.8).
- In Ireland, male students achieved a mean score of 495.4, while females achieved a mean score of 496.9. The difference, 1.5 score points in favour of females, is not statistically significant.
- Student performance on PISA science in Ireland is characterised by an average percentage of high performers (5.8%), and a significantly lower percentage of low-performing students (17.0%) than on average across OECD countries.
- Ireland's mean score in science fell by a non-significant 6.5 score points between 2015 and 2018. This followed a significant drop of 19.4 score points between 2012 and 2015.

Having been a major domain in PISA 2015, science literacy assumed the status of a minor domain in 2018. This means that performance is reported on an overall scale only. Scientific literacy in PISA addresses the ability of students to engage with, and to understand, the issues and ideas of science and technology (OECD, 2019a). As in PISA 2015, scientific literacy in PISA 2018 encompasses not only what students know, but also how they use what they know and how they apply this knowledge creatively in everyday situations (OECD, 2019a). Scientific literacy (henceforth, science) requires key competencies in science, as well as knowledge of the content and methods of science, and of the major fields of science – physics, chemistry, biology and earth and space sciences.

This chapter is divided into seven sections:

- Description of the framework underpinning PISA science (in both 2015 and 2018).
- Presentation of sample items drawn from PISA 2015 science.
- Students' performance on PISA 2018 science, with reference to performance in other participating countries
- Performance on PISA 2018 science, in terms of the percentages of students achieving different science proficiency levels

- Key factors associated with achievement: two student-level factors – gender and socioeconomic status – and three school-level factors – gender composition, fee-paying status and DEIS status
- Trends in science performance since 2015 (the last occasion when science was a major assessment domain)
- Summary of the key findings.

Mean scores on overall science are presented for all participating countries and economies and are ordered from highest to lowest. Most other analyses involve the same set of comparison countries used in Chapters 3 and 5, including Northern Ireland.

Additional data tables related to this chapter can be accessed in the PISA 2018 E-Appendix at www.erc.ie/pisa.

4.1 PISA 2018 Science Framework

This section describes the definition of science used in PISA 2015, the range of science competencies assessed, the types of scientific knowledge examined, the content knowledge systems assessed, and the contexts of the assessment items. It concludes with a breakdown of the item types used in PISA 2018.

4.1.1 Definition of science/scientific literacy

Scientific literacy in PISA 2018 is defined as:

> the ability to engage with science-related issues, and with ideas of science, as a reflective citizen. A scientifically-literate person, therefore, is willing to engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically (OECD, 2019a, p. 100).

PISA uses the terms 'scientific literacy' or 'science literacy' rather than science to underscore the focus on the application of scientific knowledge in the context of life situations. Reference is made to the 'scientifically literate citizen' who has 'a knowledge of the major conceptions and ideas that form the foundation of scientific and technological thought, how such knowledge has been derived, and the degree to which such knowledge is justified by evidence or theoretical explanation' (OECD, 2019a, p. 98). It is significant that PISA science literacy incorporates both science and science-based technology. This recognises the relationship between science and technology, where progress in science (scientific knowledge) can feed into technology and vice versa.

4.1.2 Range of science competencies

As per the definition presented above, PISA science is defined by three competencies or basic sets of practices:

- **Explain phenomena scientifically** – recognise, offer and evaluate explanations for a range of natural and technological phenomena, demonstrating the ability to:
    - Recall and apply appropriate scientific knowledge, including major explanatory ideas of science
    - Identify, use and generate explanatory models and representations
    - Make and justify predictions
    - Offer explanatory hypotheses
    - Explain the potential implications of scientific knowledge for society.
- **Evaluate and design scientific enquiry** – describe and appraise scientific enquiries and propose ways of addressing questions, scientifically demonstrating ability to:
    - Identify the question explored in a given scientific study
    - Distinguish questions that are possible to investigate scientifically
    - Propose a way of exploring a given question scientifically
    - Identify whether appropriate procedures have been used
    - Evaluate ways of exploring a question scientifically
    - Describe and evaluate a range of approaches that scientists use to ensure the reliability of data and the objectivity and generalisability of explanations.
- **Interpret data and evidence scientifically** – analyse and evaluate scientific information, claims and arguments in a variety of representations and draw appropriate conclusions by demonstrating the ability to:
    - Transform data from one representation to another
    - Analyse and interpret data and draw appropriate conclusions
    - Identify assumptions, evidence and reasoning in science-related texts
    - Distinguish between arguments which are based on scientific evidence and theory and those based on other considerations
    - Evaluate scientific arguments and evidence from different sources (e.g., newspaper, Internet, journal).

4.1.3. Types of scientific knowledge

All three science competencies require knowledge. According to the framework, three types of 'related but distinguishable' knowledge are required:

- **Content Knowledge** – a knowledge of the facts, concepts, ideas and theories about the natural world that science has established. This knowledge is mainly used in explaining phenomena scientifically.
- **Procedural Knowledge** – knowledge of the features that characterise scientific enquiry, including the diverse methods and practices used to establish scientific knowledge
- **Epistemic Knowledge** – an understanding of the rationale for the common practices of scientific enquiry, the status of the knowledge claims that are generated, and the role that questions, observations, theories, hypotheses, models and arguments play in science.

4.1.4. Content knowledge systems

Three content areas – Physical Systems, Living Systems and Earth and Space Systems – are represented among PISA science items. Thus, all items were classified in terms of the main knowledge system drawn on:

- **Physical Systems** – these items draw on knowledge of the structure and properties of matter, including its chemical properties, chemical reactions, motion and forces (e.g., velocity and friction), magnetic fields, energy and its transformation (e.g., conservation, dissipation), and interactions between energy and matter.
- **Living Systems** – these draw on knowledge of the cell and its structures (e.g., DNA), the concept of an organism (uni- vs. multi-cellular), human biology, populations (e.g., species and their evolutionary dynamics), and ecosystems and the biosphere.
- **Earth and Space Systems** – these draw on knowledge about the structure of earth systems (e.g., atmosphere), changes in earth systems (e.g., plate tectonics, geothermal cycle), the earth's history, earth in space (gravity, solar systems, galaxies), and the history and scale of the universe.

4.1.5. Contexts of the science items

PISA 2018 examines the extent to which students are capable of displaying science competencies appropriately within a range of applications in the following settings:

- Personal – self, family and peer groups
- Community – local/national
- Global – life across the world.

Contexts for items in the PISA science assessment have also been categorised into five applications of science and technology: health and disease, natural resources, environmental quality, hazards, and the frontiers of science and technology. The framework document (OECD, 2019a) notes that the PISA science is not an assessment of contexts, but instead focuses on the knowledge and competencies required in different contexts. Furthermore, 'these contexts have been chosen in light of their relevance to students' interests and lives and because they are the areas in which scientific literacy has particular value in enhancing and sustaining quality of life and in the development of public policy' (p. 103).

4.1.6. Science units, item types and distribution of items by framework components

Three types of items are used to assess knowledge and competencies in PISA 2018 science:

- **Simple multiple choice** – including selection of a single response from four options, selection of a 'hot spot' within a graphic or text, and selection of an option from a drop-down menu. Simple multiple-choice items are computer-scored.
- **Complex multiple choice** – selection of responses to a series of yes/no questions that are treated as a single question; selection of more than one response from a list; completion of a sentence by selecting drop-down choices to fill multiple blanks; and 'drag and drop' responses allowing students to move elements on screen to complete a task of matching, ordering or categorising. Complex multiple-choice items are computer-scored.

- **Constructed response** (open response) – which must be coded by humans (written responses range from a phrase to a paragraph; a small number of such responses called for a drawing, supported by a simple drawing editor where required). A small number of constructed response items are computer-scored (e.g., where students were asked to 'drag and drop' to indicate the relative size of objects). The others are scored by trained markers.

In PISA 2018, 24 items across five units or scenarios comprise interactive tasks (e.g., a student's makes choices when manipulating variables in a simulated scientific enquiry). Such responses are typically scored as complex multiple-choice items, or, if sufficiently open-ended, as constructed responses.

Table 4.1 shows the distribution of the 115 science items by dimensions of the framework. Thus, 42.6% of the items in the science competency dimension are classified as explain phenomena scientifically, 26.1% are classified as evaluate and design scientific inquiry, and 31.3% are described as interpret evidence and data scientifically. When classified by scientific knowledge type, the same pool of 115 items is classified as Content (42.6%), Procedural (40.9%) and Epistemic (16.5%). When items are classified according to content knowledge systems, one-third (33.0%) are in the Physical Systems domain, 40.9% in Living Systems, and the remainder (26.1%) in Earth and Space Systems. The science items have also been classified by context dimension, with 29.6% presented in a global context, 60.9% in a local/national context, and 9.6% in a personal context.

As shown in the table, 28.7% of items are described as simple multiple choice, 40.9% as complex multiple choice, 27.8% as open-constructed response – human-coded, and just 2.6% as open constructed response – computer coded.

Table 4.1: Distribution of PISA 2018 science items by competence, knowledge type, system, context and format – number and percent

	Number	%		Number	%
Science Competences			***Knowledge Types***		
Explain phenomena scientifically	49	42.6	Content	49	42.6
Evaluate and design scientific enquiry	30	26.1	Procedural	47	40.9
Interpret evidence and data scientifically	36	31.3	Epistemic	19	16.5
Content Knowledge Systems			***Context 1***		
Physical	38	33.0	Global	34	29.6
Living	47	40.9	Local/National	70	60.9
Earth & Space	30	26.1	Personal	11	9.6
Format			***Context 2***		
Simple multiple choice – Comp Sc.	33	28.7	Environmental Quality	24	20.9
Complex multiple choice – Comp Sc.	47	40.9	Frontiers	30	26.1
Open constructed response: Human Cd.	32	27.8	Hazards	12	10.4
Open constructed response: Comp. Sc.	3	2.6	Health and Disease	17	14.8
			Natural Resources	32	27.8

Source: Adapted from OECD, 2016c.

While the distribution of items across framework categories is broadly similar in 2015 and 2018, there are some differences. For example, under Knowledge Types, 53.2% of items in 2015 were classified as Content, whereas this was 42.6% in 2018. Similarly, 32.6% of items in 2015 were classified as Procedural, whereas this was 40.9% in 2018. This may reflect the fact that all 24 interactive science items included in 2015, which tended to emphasise procedural knowledge, were

carried over to 2018, where they had a greater impact on a smaller item pool. An imbalance is also seen for science competencies, where 48.3% of items were described as Explain Phenomena Scientifically in 2015, and 42.6% were described in this way in 2018. In parallel, 21.2% of items in 2015 were described as Evaluate and Design Scientific Inquiry, whereas 26.1% were defined in this way in 2018.

4.2 Sample Science Items

Since PISA science was a minor assessment domain in 2018, no science items were released by the OECD following the assessment. In this section, some online science items released following PISA 2015 are presented as examples to support readers in understanding the structure and complexity of science items.

4.2.1 Running in Hot Weather

This interactive unit, which was administered in the PISA 2015 Field Trial, comprises a short introductory screen on which students can practice manipulating air humidity and air temperature measures, as well as whether or not an athlete drinks water, and examine the impact on sweat volume, water loss and body temperature. Five items of varying difficulty follow. When the conditions trigger dehydration or heat stroke, red flags are raised.

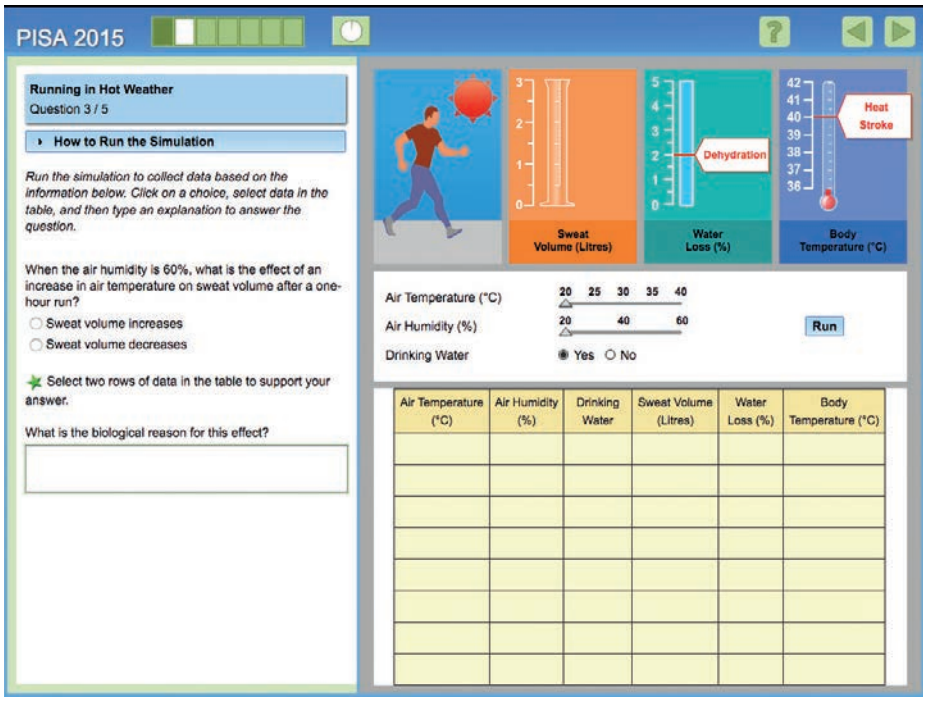
Question 3 (Figure 4.1) comprises two parts. In 3A, students are asked to run a scenario in which they examine the effect of an increase in air temperature on sweat volume after a one-hour run, where the air humidity is a constant 60%. Students received full credit if they indicated that sweat volume increases, *and* they highlighted two rows in the accompanying table in which air humidity is 60% and two different air temperatures are selected (e.g., 20°C in the first row, and 25°C in the second). In addition, drinking water must have the same setting (Yes or No) in *both rows*.

In 3B, students were asked to explain why sweat volume increases under specified conditions. For credit to be awarded on this part, students must indicate or imply that the function of sweat is to cool the body and/or regulate body temperature. Answers such as the following were awarded credit:

- Sweat evaporates to cool the body temperature when temperatures are high
- Increasing sweat levels in high temperatures keeps the body from overheating
- Sweat helps maintain body temperature at a safe level.

Question 3A is described as assessing the science competence, 'evaluate and design scientific inquiry', and assesses 'procedural knowledge' in the area of 'living systems' (Table 4.2). Question 3A corresponds to the multiple choice item, 'Sweat volume increase/decreases' and to the direction to students to select two rows of data to support their answer. The context is 'personal' in the sub-area of 'health and disease'. It combines multiple-choice and open response (select data) item types and is scored or marked by computer. Question 3A is moderately difficult, with a scale score of 531 across OECD countries in the PISA 2015 Field Trial, and has a proficiency Level of 3 (see section on performance on science proficiency levels below).

Figure 4.1: Running in Hot Weather, Questions 3A and 3B



Question 3B is described as assessing the science competence, 'explain phenomena scientifically' (Table 4.3) and corresponds to the open-ended question, 'What is the biological reason for this effect?'. It assesses content knowledge in the area of living systems. Like Question 3A, the context is described as 'personal' in the area of 'health and disease'. It is a more complex item than Question 3A as it has a scale score of 641, and a proficiency Level of 5.

Table 4.2: Running in Hot Water: Mapping question 3A to the framework, and item difficulty

Framework Element and Difficulty	Description
Question Type	Multiple Choice and Open Response (select data) – Computer-scored
Competency	Evaluate and Design Scientific Enquiry
Knowledge – System	Procedural – Living
Context	Personal – Health and Disease
Item Difficulty	531, Level 3

Table 4.3: Running in Hot Water: Mapping question 3B to the framework, and item difficulty

Framework Element and Difficulty	Description
Question Type	Open Response – Human-coded
Competency	Explain Phenomena Scientifically
Knowledge – System	Content – Living
Context	Personal – Health and Disease
Item Difficulty	641, Level 5

4.2.2 Sustainable Fish Farming

This unit, which was administered in PISA 2015 but not carried over to 2018, asks students to investigate ways to grow fish sustainably in fish farms, taking into account the volumes of food required, and the need to ensure that waste from the fish does not build up to dangerous levels.

Question 1 in this unit (Figure 4.2), one of the most difficult in PISA 2015, asked students to drag common sole, ragworms, shellfish and marsh grass into the appropriate tanks, based on a description of their functions, found on the screen. To receive full credit for this item (no partial credit is offered), students are required to drag ragworms and common sole into tank 2 (bottom right) and marsh grass and shellfish into tank 3 (left side).

The item is described as assessing the science competence, 'explain phenomena scientifically', and content knowledge in the area of 'living systems' (Table 4.4). The context is described as 'local/national' in the area of 'natural resources'.

Whereas several of the items in Running in Hot Weather required students to run experiments, items in Sustainable Fish Farming, including Question 1, required them to develop an understanding of the processes and constraints involved in fish farming, based on information and a diagram (the fish tanks) provided in the unit.

As noted above, the item is difficult. It has a scale score of 750 on the PISA science scale, meaning that students on 750 score points have a 62% chance of answering it correctly. The item is at proficiency Level 6, the highest Level on the PISA science scale. In Ireland, just 7% of students answered this item correctly in PISA 2015, while on average across OECD countries, 5.9% did so.

Figure 4.2: Sustainable Fish Farming, Question 1

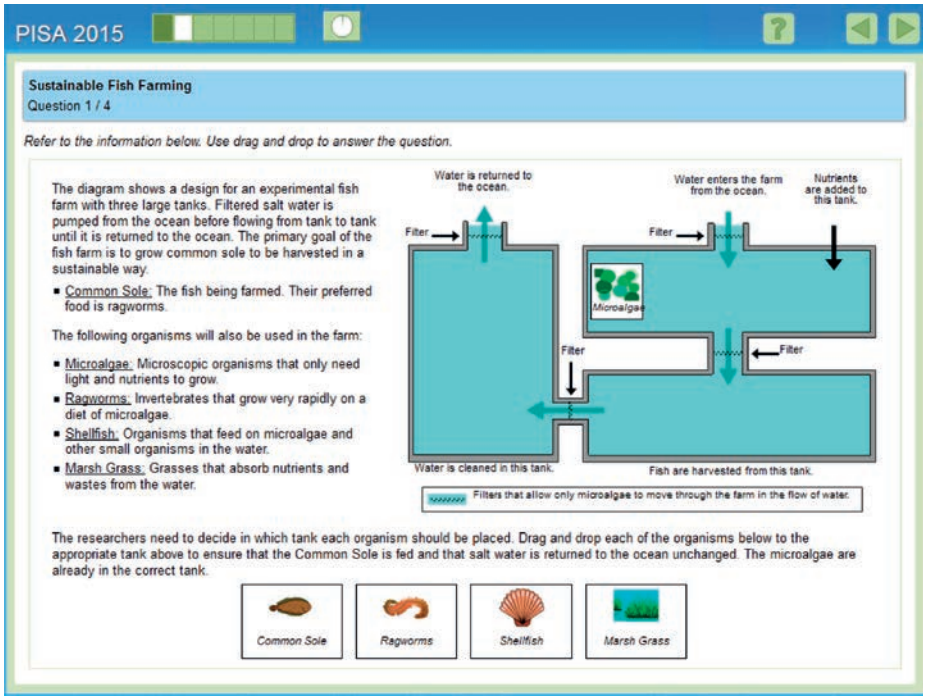


Table 4.4: Sustainable Fish Farming: Mapping question 1 to the framework and item difficulty

Framework Element and Difficulty	Description
Question Type	Complex Multiple Choice
Competency	Explain Phenomena Scientifically
Knowledge – System	Content – Living
Context	Local/National – Natural Resources
Item Difficulty	750, Level 6

4.3 Overall Performance on Science

This section describes the overall average performance and variation in performance in Ireland and in other participating countries/economies with valid data on PISA 2018 science.

Students in Ireland achieved a mean science score of 496.1, which was significantly above the OECD average of 488.7, by 7.4 score points (Table 4.5). Ireland ranked 17th among 37 OECD countries, and 22nd among 78 participating counties/economies. With a 95% confidence interval applied, Ireland's true rank in science lies between 13th and 21st among OECD countries, and between 18th and 26th among all countries/economies.

Sixteen countries/economics, including the highest performers (B-S-J-Z China and Singapore) had significantly higher mean scores than Ireland. Eleven countries (all OECD members) had mean scores that are not significantly different from Ireland's (Germany, the United States, Sweden, Belgium, Czech Republic, Switzerland, France, Denmark, Portugal, Norway and Austria), while 50 countries/economies had significantly lower mean scores than Ireland. Of these, 16 were OECD member countries, including Spain, Lithuania, Hungary, Luxembourg and Iceland.

Table 4.5: Mean country/economy scores, standard deviations and standard errors for the overall science scale, and positions relative to the OECD average and mean score for Ireland

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
BSJZ China	590.5	(2.7)	83.2	(1.7)	▲	Slovak Rep.	464.0	(2.3)	95.8	(1.5)	▼
Singapore	550.9	(1.5)	97.5	(1.0)	▲	Israel	462.2	(3.6)	110.8	(1.9)	▼
Macao China	543.6	(1.5)	83.0	(1.0)	▲	*Malta*	456.6	(1.9)	106.9	(1.2)	▼
Estonia	530.1	(1.9)	87.8	(1.2)	▲	Greece	451.6	(3.1)	85.9	(1.6)	▼
Japan	529.1	(2.6)	92.1	(1.6)	▲	Chile	443.6	(2.4)	83.5	(1.4)	▼
Finland	521.9	(2.5)	96.4	(1.3)	▲	*Serbia*	439.9	(3.0)	91.6	(1.3)	▼
Korea	519.0	(2.8)	97.9	(1.7)	▲	*Cyprus*	439.0	(1.4)	93.0	(1.1)	▼
Canada	518.0	(2.2)	95.7	(1.0)	▲	*Malaysia*	437.6	(2.7)	76.8	(1.5)	▼
HK China	516.7	(2.5)	86.2	(1.2)	▲	*United Arab Emirates*	433.6	(2.0)	103.2	(0.8)	▼
Chinese Taipei	515.7	(2.9)	99.3	(1.5)	▲	*Brunei Darussalam*	431.0	(1.2)	95.9	(1.1)	▼
Poland	511.0	(2.6)	91.5	(1.4)	▲	*Jordan*	429.3	(2.9)	88.2	(1.5)	▼
New Zealand	508.5	(2.1)	102.3	(1.4)	▲	*Moldova*	428.5	(2.3)	89.0	(1.4)	▼
Slovenia	507.0	(1.3)	88.1	(1.1)	▲	*Thailand*	425.8	(3.2)	81.8	(1.6)	▼
United Kingdom	504.7	(2.6)	99.0	(1.4)	▲	*Uruguay*	425.8	(2.5)	86.5	(1.4)	▼
Netherlands	503.4	(2.8)	104.4	(1.9)	▲	*Romania*	425.8	(4.6)	90.1	(1.8)	▼
Germany	503.0	(2.9)	102.9	(1.6)	O	*Bulgaria*	424.1	(3.6)	94.6	(2.0)	▼
Australia	503.0	(1.8)	100.7	(1.1)	▲	Mexico	419.2	(2.6)	74.4	(1.6)	▼
United States	502.4	(3.3)	99.1	(1.6)	O	*Qatar*	419.1	(0.9)	103.0	(0.9)	▼
Sweden	499.4	(3.1)	98.0	(1.5)	O	*Albania*	416.7	(2.0)	74.1	(1.1)	▼
Belgium	498.8	(2.2)	98.8	(1.3)	O	*Costa Rica*	415.6	(3.3)	73.3	(1.9)	▼
Czech Rep.	496.8	(2.5)	94.5	(1.6)	O	*Montenegro*	415.2	(1.3)	81.4	(1.0)	▼
Ireland	**496.1**	**(2.2)**	**88.3**	**(1.2)**		Colombia	413.3	(3.1)	82.0	(1.4)	▼
Switzerland	495.3	(3.0)	96.8	(1.4)	O	*Rep. of North Macedonia*	413.0	(1.4)	91.8	(1.2)	▼
France	493.0	(2.2)	96.0	(1.4)	O	*Peru*	404.2	(2.7)	80.1	(1.5)	▼
Denmark	492.6	(1.9)	91.5	(1.3)	O	*Argentina*	404.1	(2.9)	89.6	(1.6)	▼
Portugal	491.7	(2.8)	92.0	(1.3)	O	*Brazil*	403.6	(2.1)	90.3	(1.5)	▼
Norway	490.4	(2.3)	98.4	(1.2)	O	*Bosnia and Herzegovina*	398.5	(2.7)	76.6	1.3)	▼
Austria	489.8	(2.8)	95.6	(1.2)	O	*Baku (Azerbaijan)*	397.6	(2.4)	73.7	(1.6)	▼
Latvia	487.3	(1.8)	84.3	(1.2)	▼	*Kazakhstan*	397.1	(1.7)	75.7	(1.4)	▼
Spain	483.3	(1.6)	89.5	(0.8)	▼	*Indonesia*	396.1	(2.4)	69.3	(1.7)	▼
Lithuania	482.1	(1.6)	90.3	(1.0)	▼	*Saudi Arabia*	386.2	(2.8)	78.7	(1.4)	▼
Hungary	480.9	(2.3)	93.9	(1.4)	▼	*Lebanon*	383.7	(3.5)	95.4	(1.6)	▼
Russian Fed.	477.7	(2.9)	83.9	(1.7)	▼	*Georgia*	382.7	(2.3)	80.9	(1.3)	▼
Luxembourg	476.8	(1.2)	98.5	(1.2)	▼	*Morocco*	376.6	(3.0)	66.9	(1.2)	▼
Iceland	475.0	(1.8)	91.1	(1.0)	▼	*Kosovo*	364.9	(1.2)	64.7	(0.8)	▼
Croatia	472.4	(2.8)	89.9	(1.6)	▼	*Panama*	364.6	(2.9)	85.4	(1.9)	▼
Belarus	471.3	(2.4)	85.0	(1.3)	▼	*Philippines*	356.9	(3.2)	75.2	(2.3)	▼
Ukraine	469.0	(3.3)	91.4	(1.8)	▼	*Dominican Rep.*	335.6	(2.5)	70.6	(1.6)	▼
Turkey	468.3	(2.0)	83.5	(1.6)	▼	OECD Average	488.7	(0.4)	93.5	(0.2)	▼
Italy	468.0	(2.4)	90.1	(1.7)	▼	EU Average	484.0	(0.5)	93.8	(0.3)	▼

	Significantly above OECD average
	At OECD average
	Significantly below OECD average

▲	Significantly higher than Ireland
O	Not significantly different from Ireland
▼	Significantly lower than Ireland

OECD countries are in regular font, partner countries/economies are in *italics*.
Data for Vietnam are excluded they have not been fully validated for international comparability.

The mean score for Northern Ireland is 491.3 (SE = 4.6; SD = 91.5; SESD = 2.1). This is not significantly different from Ireland's mean score of 496.1 (OECD, 2019d, Table I.B2.11). The average science score across EU counties is 484.0, which is significantly lower than Ireland's mean score.

Ireland's standard deviation on science – a measure of the spread of scores – was 88.3 score

points (Table 4.5). This is lower than the OECD average standard deviation of 93.5, indicating a wider range of achievement across OECD countries than in Ireland. Among OECD countries with mean scores at or above the OECD average, only Slovenia (SD = 88.1) and Latvia (SD = 84.3) had standard deviations that were similar to or smaller than Ireland's.

4.4 Performance on Science Proficiency Levels

PISA 2018 describes seven levels of proficiency for the overall science literacy scale (Table 4.6). Proficiency levels define the skills, abilities and competencies that students scoring within specific score ranges are likely to demonstrate, and the descriptors around the science proficiency levels were established when PISA Science was a major assessment domain in 2015. Table 4.6 also provides the percentages of students in Ireland, and on average across OECD and EU countries performing at each Science proficiency level.

Students at Proficiency Level 2 are those who score from 410 up to 484 score points on PISA science (Table 4.6). At Level 2, students are beginning to display the key competencies that will enable them to participate effectively and productively in life situations related to science and technology and in future education in these fields (OECD, 2019d). As such, Level 2 is considered the baseline level of science proficiency necessary for students to engage reflectively with science and technology issues. On average across OECD countries, 22.0% of students perform below Level 2. This is significantly higher than the percentage in Ireland (17%) (See E-Appendix Table A4.2).

Students performing at Levels 1a, 1b and those performing below Level 1b (whose competencies are not described by PISA) are often referred to as lower-achieving students or low performers. Proficiency Levels 1a and 1b describe what is needed to reach the baseline proficiency in science. Students at Level 1b, the lowest proficiency level, score from 261 up to 355 score points. These students display the skills necessary to answer correctly only the very simplest of science items. PISA does not define the skills and abilities of those whose scores fall below Level 1b (i.e., below 261 score points). Students at Level 1a, who score from 355 up to 410, can use basic or everyday content and procedural knowledge to recognise or identify explanations of simple scientific phenomena. They can also identify simple causal or correlational relationships and interpret graphical information. In Ireland, 17.0% of students perform below Level 2, with the majority of these (13.4%) performing at Level 1a. Most of the others (3.3%) perform at Level 1b.

The highest proficiency level is Level 6 (708 points and above) and students at this level demonstrate the competencies necessary to answer the most complex science items. Those at Level 5 (from 633 score points up to 708) can use abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. The term 'high achievers' is often used to describe the combined percentages of students at Levels 5 and 6.

Table 4.6 also shows that, in Ireland, 5.8% of students perform at Levels 5-6. On average across OECD countries, 6.8% perform at this level. The difference is not statistically significant (see E-Appendix Table A4.2). Since Ireland's mean score on science is significantly above the OECD average, it is noteworthy that there are relatively few very high achievers (as well as relatively few very lower achievers).

Table 4.6: Summary description of the seven levels of proficiency in science in PISA 2018, and percentages of students achieving each level in Ireland, on average across OECD and EU countries

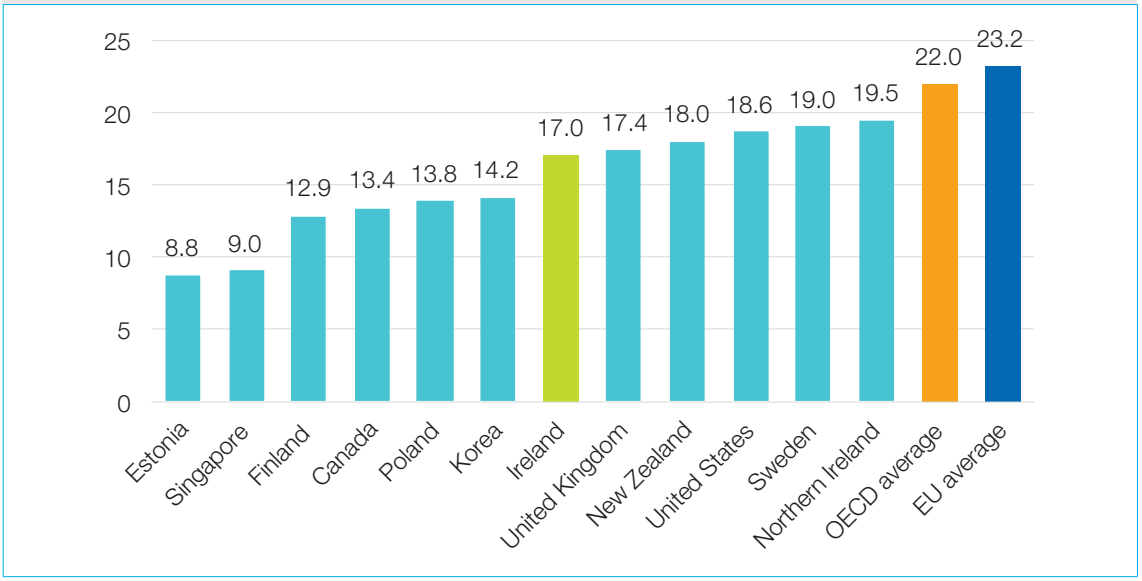
Level (Cut-point)	Students at this level are capable of. . .	Ireland		OECD		EU	
		%	SE	%	SE	%	SE
6 (708 and above)	Drawing on a range of interrelated scientific ideas and concepts from the physical, life, and earth and space sciences and use content, procedural and epistemic knowledge in order to offer explanatory hypotheses of novel scientific phenomena, events and processes or to make predictions. In interpreting data and evidence, they are able to discriminate between relevant and irrelevant information and can draw on knowledge external to the normal school curriculum. They can distinguish between arguments that are based on scientific evidence and theory and those based on other considerations. Level 6 students can evaluate competing designs of complex experiments, field studies or simulations and justify their choices.	0.5	(0.2)	0.8	(0.0)	0.7	(0.0)
5 (663 to less than 708)	Using abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. They are able to apply more sophisticated epistemic knowledge to evaluate alternative experimental designs and justify their choices and use theoretical knowledge to interpret information or make predictions. Level 5 students can evaluate ways of exploring a given question scientifically and identify limitations in interpretations of data sets, including sources and the effects of uncertainty in scientific data.	5.4	(0.5)	5.9	(0.1)	5.3	(0.1)
4 (559 to less than 633)	Using more complex or more abstract content knowledge, which is either provided or recalled, to construct explanations of more complex or less familiar events and processes. They can conduct experiments involving two or more independent variables in a constrained context. They are able to justify an experimental design by drawing on elements of procedural and epistemic knowledge. Level 4 students can interpret data drawn from a moderately complex data set or less familiar context, draw appropriate conclusions that go beyond the data and provide justifications for their choices.	19.0	(0.7)	18.1	(0.1)	17.3	(0.1)
3 (484 to less than 559)	Drawing on moderately complex content knowledge to identify or construct explanations of familiar phenomena. In less familiar or more complex situations, they can construct explanations with relevant cueing or support. They can draw on elements of procedural or epistemic knowledge to carry out a simple experiment in a constrained context. Level 3 students are able to distinguish between scientific and non-scientific issues and identify the evidence supporting a scientific claim.	31.3	(0.9)	27.4	(0.1)	27.3	(0.2)
2 (410 to less than 484)	Drawing on everyday content knowledge and basic procedural knowledge to identify an appropriate scientific explanation, interpret data, and identify the question being addressed in a simple experimental design. They can use basic or everyday scientific knowledge to identify a valid conclusion from a simple data set. Level 2 students demonstrate basic epistemic knowledge by being able to identify questions that can be investigated scientifically.	26.9	(0.9)	25.8	(0.1)	26.1	(0.2)
1a (335 to less than 410)	Using basic or everyday content and procedural knowledge to recognise or identify explanations of simple scientific phenomena. With support, they can undertake structured scientific enquiries with no more than two variables. They are able to identify simple causal or correlational relationships and interpret graphical and visual data that require a low level of cognitive demand. Level 1a students can select the best scientific explanation for given data in familiar personal, local and global contexts.	13.4	(0.7)	16.0	(0.1)	16.5	(0.1)

Level (Cut-point)	Students at this level are capable of. . .	Ireland		OECD		EU	
		%	SE	%	SE	%	SE
1b (261 to less than 355)	Using basic or everyday scientific knowledge to recognise aspects of familiar or simple phenomena. They are able to identify simple patterns in data, recognise basic scientific terms and follow explicit instructions to carry out a scientific procedure.	3.3	(0.3)	5.2	(0.1)	5.8	(0.1)
Below 1b	PISA 2015 does not define the competencies and skills of those scoring below Level 1b.	0.3	(0.1)	0.7	(0.0)	0.9	(0.0)

Source: Adapted from OECD (2019b), Table I.B1.3. Also, see e-Appendix Table A4.1.

Figure 4.3 shows the percentage of students in Ireland performing below Level 2, compared to selected comparison countries. In general, there were fewer students below Level 2 in countries with mean scores that are significantly higher than Ireland's, including Estonia (8.8% below Level 2), Singapore (9.0%), Finland (12.9%) and Korea (14.2%). However, the United Kingdom and New Zealand, which also had significantly higher mean scores than Ireland had similar proportions performing below Level 2 (17.4% and 18.0% respectively). Several comparison countries with similar mean scores to Ireland had similar or slightly higher percentages performing below Level 2, including the United States (18.6%) and Sweden (19.0%). In Northern Ireland, almost one in five students (19.5%) performed below Level 2.

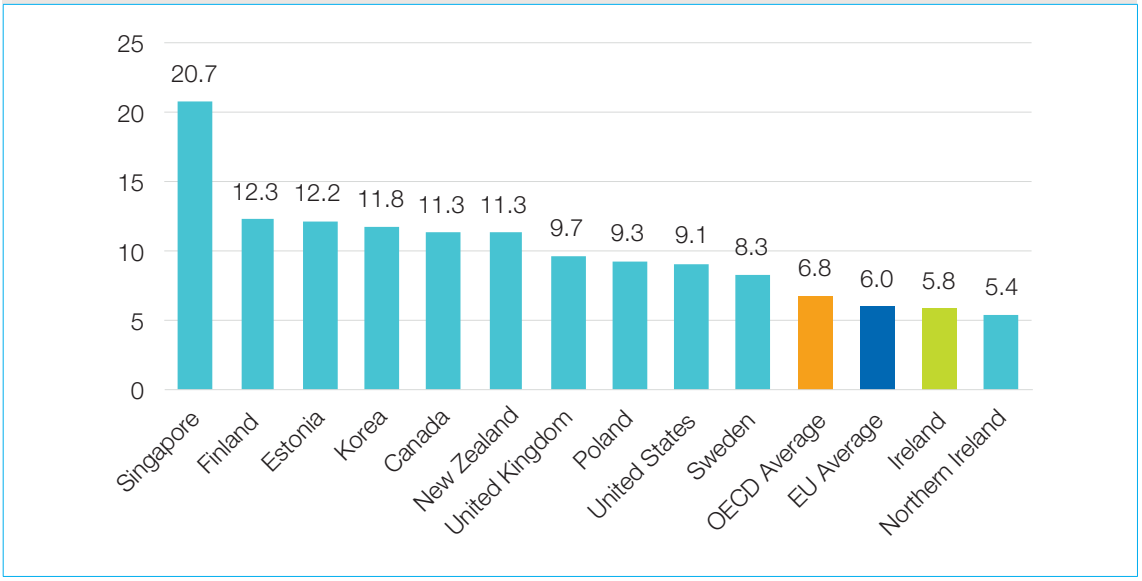
Figure 4.3: Percentage of students performing below Proficiency Level 2 on the overall science scale in Ireland, in the selected comparison countries, and on average across OECD and EU countries



See e-Appendix Table A4.1 for percentage of students (and standard errors) at each proficiency level in Ireland for science, in selected comparison countries and on average across the EU and the OECD.

Figure 4.4 shows the percentage of students performing at Levels 5-6 (combined). In Ireland, 5.8% of students performed at Levels 5 and 6. The corresponding estimate for Northern Ireland was similar (5.4%). In contrast, 20.7% of students in Singapore performed at Levels 5-6. Countries with mean scores similar to Ireland had higher percentages of students performing at Levels 5-6, including the Sweden (8.3%) and the United States (9.1%).

Figure 4.4: Percentage of students performing at Proficiency Levels 5-6 on the overall science scale in Ireland, in the selected comparison countries, and on average across OECD and EU countries



See E-Appendix table A4.1 for percentage of students (and standard errors) at each proficiency level in Ireland for science, in selected comparison countries and on average across the EU and the OECD.

4.5 Performance by Selected Variables

Student performance on science literacy is examined with reference to selected background variables: student gender, student socio-economic status, school gender composition, school fee-paying status and school DEIS status.

4.5.1 Gender differences and science performance

Table 4.7 shows the mean scores for male and female students on PISA 2018 science. Male students in Ireland achieved a mean score of 495.4, while female achieved a mean score of 496.9. The difference, 1.5 score points in favour of females, is not statistically significant. On average across OECD countries, the mean score for males was 487.5, while females had a mean score of 489.8. The small difference in favour of females, 2.3 score points, is statistically significant.

The largest difference among comparison countries was 23.9 points in favour of female students in Finland. There were smaller significant differences in favour of females in Northern Ireland (16.9 points), Sweden (7.6) and Estonia (5.0). While there were differences in favour of male students in five comparison countries, including Singapore (3.5 score points) and Korea (4.0 points), none were statistically significant.

With the exception of Finland and Northern Ireland, gender differences in science can be considered small. As noted above, the OECD average gender difference is just 2.3 score points, or 2.4% of the OECD standard deviation.

Table 4.7: Gender differences in science performance in Ireland, in selected comparison countries and on average across OECD countries

	Males		Females		Difference (Males-Females)	
	Mean	SE	Mean	SE	Score diff.	SED
Finland	510.2	(2.9)	534.0	(2.9)	**-23.9**	(3.0)
Sweden	495.6	(3.2)	503.2	(3.7)	**-7.6**	(3.1)
Estonia	527.6	(2.3)	532.6	(2.3)	**-5.0**	(2.5)
Canada	516.5	(2.7)	519.6	(2.5)	-3.1	(2.9)
Ireland	495.4	(3.0)	496.9	(2.6)	-1.5	(3.4)
Poland	510.9	(2.8)	511.2	(3.1)	-0.3	(2.7)
United States	502.7	(3.9)	502.0	(3.5)	+0.7	(3.3)
New Zealand	509.3	(2.9)	507.6	(2.8)	+1.7	(3.9)
United Kingdom	505.9	(3.1)	503.5	(3.2)	+2.5	(3.6)
Korea	520.9	(3.9)	516.9	(3.6)	+4.0	(5.0)
OECD average	487.5	(0.5)	489.8	(0.5)	**-2.3**	(0.5)
Singapore	552.7	(2.0)	549.1	(1.9)	+3.5	(2.5)
Northern Ireland	482.8	(6.5)	499.7	(5.3)	**-16.9**	(7.4)

Source: OECD 2019e, Table II.B1.7.5. Significant differences are in **bold**.

Gender differences can also be examined with reference to the percentages of students at each proficiency level. In Ireland, 18.1% of male students and 16.0% of female students performed below Level 2 (Figure 4.5). The difference, 2.1%, is not statistically significant. The corresponding percentages on average across OECD countries were 23.2% and 20.8% respectively. The difference is statistically significant. In sum, proportionately fewer males and females in Ireland than on average across OECD countries performed below Level 2.

In Ireland, more males (6.8%) than females (4.9%) performed at Levels 5-6. The difference (1.8%) is statistically significant. On average across OECD countries, there were also more males (7.3%) than females (6.2%) at Levels 5-6. The difference (1.2%) is also statistically significant. Marginally fewer males in Ireland (6.8%) than on average across OECD countries (7.3%), and fewer females in Ireland (4.9%) than on average across OECD countries (6.2%) performed at Levels 5-6 (Figure 4.5).

Figure 4.5: Percentage of males and females achieving below Proficiency Level 2 and at or above Proficiency Level 5 on science in Ireland, and on average across OECD countries

Source: OECD 2019e, Table II.B1.7.22.

4.5.2 Student socio-economic status and science performance

Economic, social and cultural status (ESCS), as described in Chapter 3, is a key variable in PISA. The correlation between ESCS and science in 2018 was moderate ($r = 0.33$, $SE = 0.02$, $t = 16.5$, $df = 80$, $p < .05$). Table 4.8 shows the mean scores in science for students in each ESCS quartile. The mean score of students in the lowest quartile (460.0) is significantly lower than the mean scores of students in the low-medium (487.4), medium-high (506.8), and high (533.6) quartiles.

Table 4.8: Mean science scores in Ireland by ESCS quartile[36]

Quartile of ESCS	%	Mean Score	SE	SD
Highest	25.0	**533.6**	(3.4)	83.5
Medium-High ESCS	25.0	**506.8**	(2.8)	82.5
Low-Medium ESCS	25.0	**487.4**	(2.9)	82.8
Lowest (ref.)	25.0	460.0	(3.3)	86.2

Significant differences in **bold**.

4.5.3 School sector gender composition and science performance

As noted in Chapter 3, schools in Ireland can be categorised into five types based on sector and gender composition: girls' secondary, boys' secondary, community/comprehensive, mixed secondary and ETB vocational. Table 4.9 presents the overall science mean scores by each school type. Students

36 The ESCS quartiles in this chapter were computed by the ERC and may differ slightly from the OECD reported quartiles, due to different random allocation of students on the cut-off points to quartiles.

attending mixed secondary schools are found to have the highest mean score (515.0), while students in ETB vocational schools have the lowest (480.5). Students in ETB vocational schools have a mean science score that is significantly lower than students in mixed secondary, girls' secondary, and boys' secondary schools. No significant difference in mean science performance is found between ETB vocational schools and community/comprehensive schools.

Table 4.9: Mean science scores in Ireland by school type and gender composition

Classification	%	Mean Score	SE	SD
Girls' secondary	21.2	**506.6**	(3.8)	80.9
Boys' secondary	15.0	**498.8**	(5.5)	89.4
Community/comprehensive	16.9	488.3	(4.0)	87.7
Mixed secondary	17.4	**515.0**	(7.7)	90.7
ETB vocational (ref.)	29.5	480.5	(4.0)	88.3

Significant differences in **bold**.

4.5.4 School fee-paying status and science performance

In Ireland, 7.0% of students attended fee-paying post-primary schools. These students had a mean science score (548.5) that was significantly higher than the mean score of students schools in non-fee-paying schools (492.2) (Table 4.10); the difference, 56.3 score points (over three-fifths of a national standard deviation in science), is statistically significant.

Table 4.10: Mean science scores in Ireland by school fee-paying status

Classification	%	Mean Score	SE	SD
Fee-paying	7.0	**548.5**	(10.5)	81.7
Non fee-paying (ref.)	93.0	492.2	(2.0)	87.5

Significant differences in **bold**.

4.5.5 School DEIS status and science performance

Students in schools outside of DEIS achieved a mean score of 506.0 in PISA science (Table 4.11). This was significantly higher than the mean score of students in DEIS schools (465.0). The difference, 41.0 points, is a little under half of a national standard deviation.

Table 4.11: Mean science scores in Ireland by DEIS status

Classification	%	Mean Score	SE	SD
DEIS	24.1	**465.0**	4.7	89.7
Non-DEIS (ref.)	75.9	506.0	2.6	85.5

Significant differences in **bold**.

4.6 Trends in Science Performance, 2015-2018

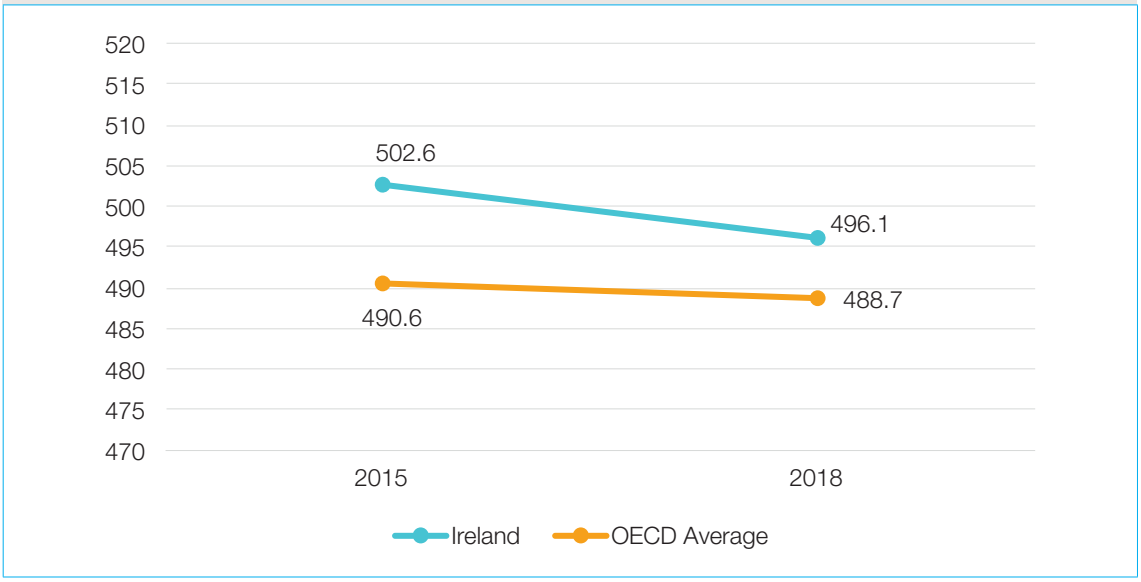
This section examines trends in science performance between 2015 (the last cycle in which science was a major assessment domain in PISA) and 2018, when science was a minor assessment domain. It was noted in Chapter 2 that there was a substantial change in average science performance in Ireland between 2012 and 2015 (a drop of 19.4 score points) coinciding with the introduction of computer-based testing, and, in particular, the inclusion of virtual experiments in the item pool.

First, overall trends in science achievement in Ireland, on average across OECD countries, and in comparison countries between 2015 and 2018, are examined. Reference is made to PISA 2012 where relevant. Second, performance at the highest and lowest science proficiency levels across the two cycles is examined. Third, the performance of males and females across the two cycles is considered.

4.6.1 Trends in overall science mean scores

Here, performance on science between 2015 (the last cycle in which science was a major assessment domain in PISA) and 2018 is examined. Ireland's mean score was some 6.5 score points lower in 2018 than in 2015 (Figure 4.6). However, this difference is not statistically significant. The OECD average was 2.0 score points lower in 2018 than in 2015. This difference is not statistically significant either. Coinciding with the introduction of computer-based testing in 2015, the overall trend in science performance in Ireland over the period 2012 to 2018 shows a significant decline (25.9 points). The corresponding decline for the average across OECD countries over the same period was a significant drop of 9.6 score points.

Figure 4.6: Mean science scores in Ireland and on average across OECD countries, 2015-2018

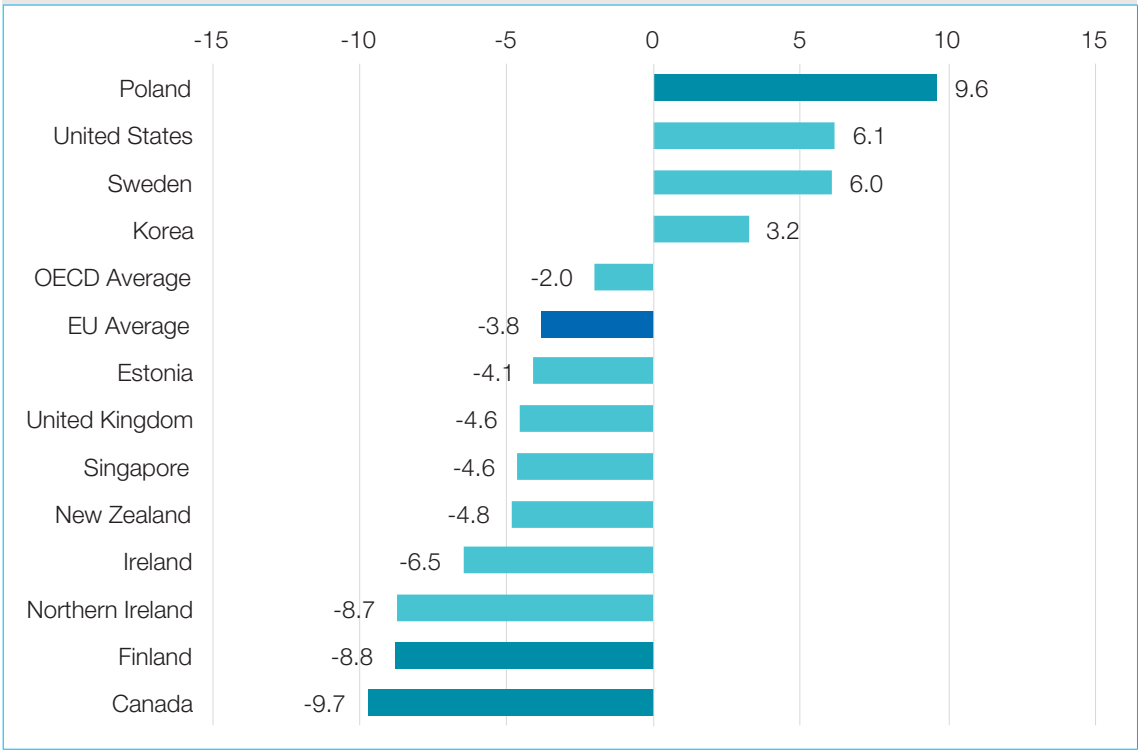


Source: OECD 2019d, Table I.B1.12.

While a number of OECD countries experienced significant declines in science between 2015 and 2018 (e.g., Italy, 12.5; Canada, 9.7; Denmark, 9.3; Switzerland, 10.2; Japan, 9.3; Finland, 8.8), others experienced significant increases (e.g., Poland, 9.6; Turkey, 42.8) (OECD 2019d, Table I.B1.12).

Figure 4.7 shows the mean score differences in science between 2015 and 2018 for Ireland, for selected comparison countries, and on average across OECD and EU countries. In addition to the significant increase in Poland and the significant declines in Finland and Canada noted above, there was a significant decline of 3.8 score points on average across EU countries. Hence, the size of the change in Ireland (-6.5) is slightly greater than the EU average change (-3.8).

Figure 4.7: Mean score differences in science in Ireland, for selected comparison countries, and on average across OECD and EU countries, 2015-2018



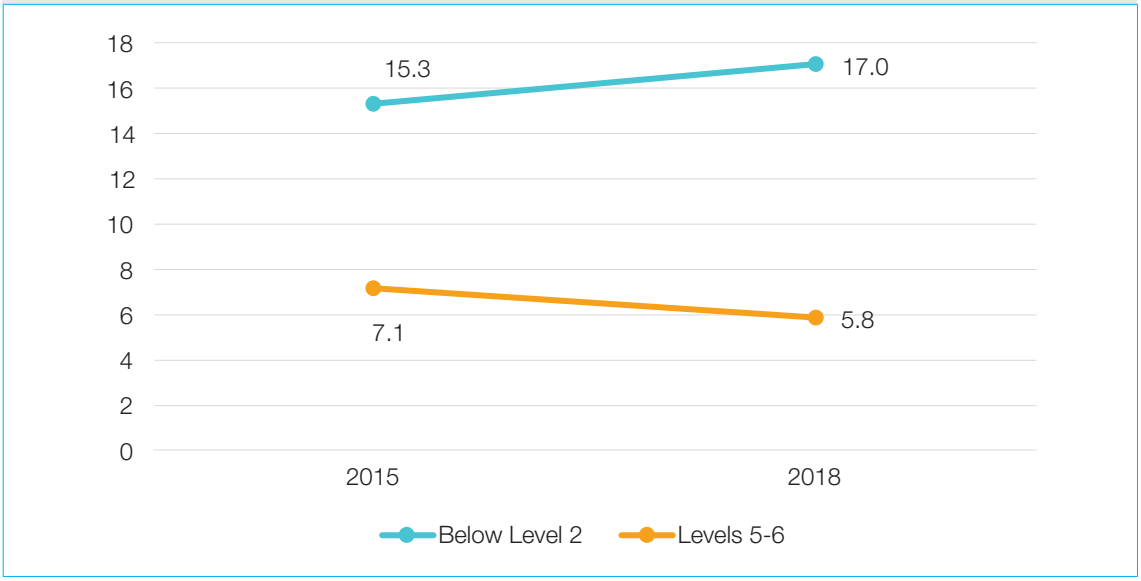
Significant differences denoted by **darker** bars. See E-Appendix Table A4.3 for details.

4.6.2. Trends in science performance by proficiency levels

Figure 4.8 shows the percentages of students in Ireland below Level 2 in 2015 (15.3%) and 2018 (17.0%). The difference, 1.7 percentage points, is not statistically significant. On average across OECD countries, the percentages performing below Level 2 in 2015 (22.1%) and 2018 (22.0%) were not significantly different from one another.

Figure 4.8 also shows the percentages of students in Ireland performing at Level 5 or higher in 2015 (7.1%) and 2018 (5.8%). The difference, 1.2%, is not statistically significant. On average across OECD countries, a significantly higher percentage (7.4%) performed at Level 5 or above in 2015 compared with 2018 (6.8%).

Figure 4.8: Percentage of students in Ireland performing below Level 2 and at or above Level 5 in science, 2015-2018



Source: OECD 2019d, Table I.B1.9.

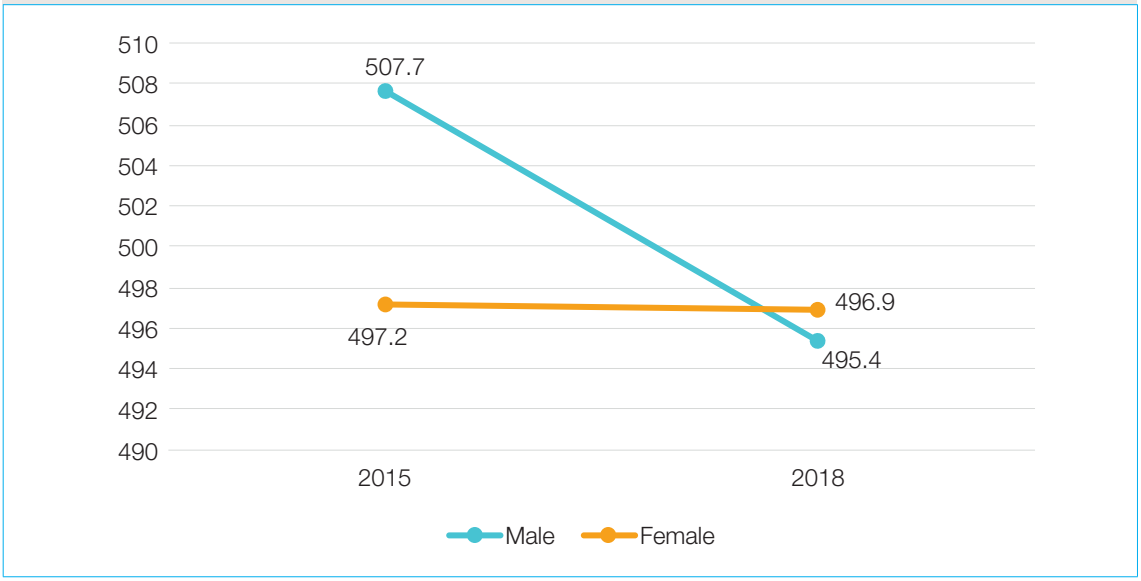
4.6.3. Trends in science performance by gender

This section looks changes in performance by gender in Ireland and on average across OECD countries. Figure 4.9 gives the mean scores of male and female students in Ireland in 2015 and 2018. Whereas there was a large and significant difference of 10.5 score points in favour of male students in 2015, in PISA 2018, there was a non-significant difference of 1.5 score points in favour of female students. While the mean score of males dropped by 12.3 score points between 2015 and 2018, the mean score of females was almost the same in both years (497.2 and 496.9 respectively).

On average across OECD countries (based on 37 countries), the mean score for males in 2015 was 492.3, while that for females was 488.9 (OECD 2019e, Table II.B1.7.37). The difference in favour of males, 3.4 score points, is statistically significant. In 2018, the mean score of males was 487.5, while that of females was 489.8. The difference in favour of females, 2.3 score points, is also statistically significant. Hence, on average across OECD countries, the mean score of male students dropped by 4.8 score points, while the mean score of females was higher by 0.9 score points (OECD 2019e, Table II.B1.7.42).

In both Ireland, and on average across OECD countries, the mean scores of male students fell between 2015 and 2018, while the mean scores of female students remained constant.

Figure 4.9: Mean science scores of male and female students in Ireland, 2015-2018



Source: OECD 2019e, Tables II.B1.7.5, II.B1.7.37, II.B1.7.42.

In Ireland, more male students performed below Proficiency Level 2 in 2018 (18.1%) compared with 2015 (15.7%) (Table 4.12). However, the difference (2.4 percentage points) is not statistically significant. More females in Ireland also performed below Level 2 in 2018 (16.0%) compared with 2015 (14.9%). Again, the difference, 1.1 percentage points, is not statistically significant.

In 2015, more male students in Ireland (9.0%) performed at or above Level 5, compared with 2018 (6.8%). The difference, 2.3 percentage points, is statistically significant. Similar proportions of female students performed at or above Level 5 in both 2015 and 2018 (5.0% and 4.9% respectively).

In Ireland, neither the difference in favour of males below Level 2 in 2018 relative to 2015 (+1.3%), nor the difference in favour of females at Levels 5-6 (+2.2%) is statistically significant (OECD 2019e, Table II.B1.7.26).

Table 4.12: Percentage of male and female students performing below Proficiency Level 2 and at or above Proficiency Level 5 in science in Ireland, 2015-2018

	Below Level 2				At or above Level 5			
	Male		Female		Male		Female	
	%	SE	%	SE	%	SE	%	SE
2015	15.7	(1.2)	14.9	(1.1)	9.0	(0.8)	5.0	(0.5)
2018	18.1	(1.2)	16.0	(1.1)	6.8	(0.8)	4.9	(0.6)
Within Gender	**Diff**	**SED**	**Diff**	**SED**	**Diff**	**SED**	**Diff**	**SED**
2018-2015	-2.4	(1.7)	1.1	(1.6)	**-2.3**	(1.1)	-0.1	(0.8)

Significant differences in **bold** (reference group is 2018).

On average across OECD countries, more male students (23.2%) performed below Level 2 in 2018 compared with 2015 (22.6%). The difference, 0.6 percentage points, is not statistically significant. Slightly fewer female students, across the OECD on average, performed below Level 2 in 2018 (20.8%) compared with 2015 (21.5%). The difference, 0.8%, is statistically significant (OECD 2019e, Tables II.B1.7.22, II.B1.7.23, II.B1.7.26).

In 2018, fewer male students performed at Levels 5-6 (7.3%) compared with 2015 (8.5%) on average across OECD countries. The difference, 1.2%, is statistically significant. In 2015 and 2018, similar percentages of females performed at Levels 5-6 (6.3% and 6.2% respectively).

On average across OECD countries, both the difference in the proportion of males (over females) below Level 2 in 2018 relative to 2015 (+1.3%), and the difference in the proportion of males (over females) at Levels 5-6 (+1.1%) are statistically significant (OECD 2019e, Tables II.B1.7.22, II.B1.7.23, II.B1.7.26).

4.7 Summary

Science was a minor assessment domain in PISA 2018. While the science frameworks for both 2015 (when science was a major assessment domain) and 2018 were broadly similar, some differences in the composition of the tests were noted, including a greater emphasis on procedural knowledge (from 32.6% of items in 2015 to 40.9% in 2018). This was linked to the observation that, while the number of items requiring students to perform and interpret the outcomes of virtual experiments had remained the same between 2015 and 2018 (24 in both years), the actual number of science items had decreased (from 184 to 115), meaning that items based on virtual experiments comprised a greater proportion of the item pool in 2018.

Overall science performance in 2018

Ireland's mean score of 496.1 on the science scale is significantly higher than the OECD average of 488.7. Ireland ranked 17th among 37 OECD countries, and 22nd among 78 participating countries/economies with valid data. Sixteen countries had significantly higher mean scores than Ireland, including the highest-scoring systems, B-S-J-Z China (590.5) and Singapore (550.9). Eleven countries had mean scores that were not significantly different from Ireland, while 50 countries/economies had significantly lower mean scores. Northern Ireland had a mean science score (491.3) that was lower than but not significantly different from Ireland's.

The OECD (2019d) has designated proficiency Level 2 in science as the minimum level students should have achieved by age 15 in order to participate fully in future education and in the world of work. In Ireland, 17.0% of students were below Level 2. In general, there were fewer students below Level 2 in comparison countries with higher mean scores than Ireland's, such as Estonia (8.8%), Singapore (9.0%), Canada (13.4%) and Finland (12.9%). On average across OECD countries, 22.0% performed below Level 2, while in Northern Ireland almost 1 in 5 students (19.5%) did so.

PISA designates proficiency Levels 5-6 as the highest levels of performance. In Ireland, 5.8% of students performed at Levels 5-6. This is fewer than on average across OECD countries (6.8%), even though Ireland's mean score is significantly higher than the OECD average. Among comparison countries, only Northern Ireland (5.4%) had (marginally) fewer students performing at Levels 5-6 than Ireland.

Selected factors associated with science performance

Male students in Ireland achieved a mean score of 495.4, while females achieved a mean score of 496.9. The difference, 1.5 score points in favour of females, is not statistically significant. On average across OECD countries, male students had a mean score of 487.5, while females had a mean score of 489.8. The difference in favour of females, 2.3 score points, is statistically significant. In Finland,

female students had a mean score that was 23.9 score points higher than males, while in Northern Ireland, the mean score difference (also in favour of males) was 16.9 points.

In Ireland, more male students (18.1%) performed below Level 2, compared with female students (16.0%), though the difference is not significant. On average across OECD countries, significantly more males (23.2%) than females (20.8%) performed below Level 2 in science. In Ireland, more male than female students achieved Levels 5-6 (6.8% and 4.9% respectively), with the difference being significant in this instance. On average across OECD countries, significantly more males (7.3%) than females (6.2%) also achieved Levels 5-6 in PISA science.

Students in Ireland who were in the lowest quartile on the PISA scale for economic, social and cultural status (ESCS), achieved a mean score that was some 73.6 score points (four-fifths of a national standard deviation on science) lower than the mean score of students in the highest quartile. There was a moderate correlation between ESCS and science performance (r = 0.33).

Students attending girls', boys' and mixed secondary schools had significantly higher mean science scores than students attending ETB vocational schools, while the mean scores of students in community/comprehensive and ETB vocational schools are not significantly different from one another. Students attending fee-paying schools had a mean score that was three-fifths of a standard deviation higher than the mean score of students attending schools that did not charge fees. Students in schools outside the DEIS scheme achieved a mean score that was some 41.0 score points (almost one-half of a national standard deviation) higher than the mean score of students in DEIS schools.

Trends in performance

Ireland's overall mean score on PISA science in 2018 (496.1) was some 6.5 score points lower than in 2015 (502.6). The change in performance is not statistically significant. Countries with negative changes in achievement that are statistically significant include Canada (-9.7 score points), Denmark (-9.3), Switzerland (-10.2), Japan (-9.3) and Finland (-8.8). In contrast, performance increased in Poland (+9.6) and Turkey (+42.8). On average across OECD countries, there was a small and non-significant decline (-2.0 score points) in performance between 2015 and 2018. Between 2012 and 2018, coinciding with the transition to computer-based assessment in 2015, the overall trend in science performance in Ireland shows a significant decline (25.9 points). The corresponding decline for the average across OECD countries was a significant 9.6 score points.

Although the percentages of students in Ireland performing below Level 2 on the PISA science scale increased from 15.3% to 17.0% between 2015 and 2018, the difference is not statistically significant. There was a non-significant drop in the proportions of students in Ireland performing at Levels 5-6, from 7.1% in 2015 to 5.8% in 2018. On average across OECD countries, there was a non-significant increase, from 22.1% in 2015 to 22.0% in 2018 among those performing below Level 2, while there was a significant decline, from 7.4% in 2015 to 6.8% in 2018, among those performing at Levels 5-6.

Whereas there was a large and significant difference of 10.5 score points in favour of male students in Ireland in 2015, there was a non-significant difference of 1.5 score points in favour of female students in 2018. Hence, while the mean score of males dropped by 12.3 score points between 2015 and 2018, the mean score of females was almost the same in both years (497.2 and 496.9 respectively). On average across OECD countries, there was a statistically significant difference in favour of males in 2015 (3.4 score points) and a statistically significant difference (2.3 score points) in favour of females in 2018. Interestingly, while on average across OECD countries, the

mean score of males fell from 492.3 to 487.5 between 2015 and 2018, the mean scores of females were almost identical in both cycles (488.9 and 489.8 respectively).

In Ireland, more males (18.1%) performed below Proficiency Level 2 in 2018, compared with 2015 (15.7%), though the difference is not statistically significant. More females also performed below Level 2 in 2018 (16.0%) compared with 2015 (14.9%), though again, the difference is not statistically significant. In 2018, significantly fewer male students in Ireland (6.8%) performed at Levels 5-6, compared with 2015 (9.0%). Similar proportions of female students performed at or above Level 5 in both 2015 and 2018 (5.0% and 4.9% respectively). On average across OECD countries, more male students (23.2%) performed below Level 2 in 2018 compared with 2015 (22.6%), though the difference is not statistically significant. In 2018, on average across OECD countries, fewer male students performed at Levels 5-6 (7.3%) compared with 2015 (8.5%). The difference, 1.2%, is statistically significant. Similar percentages of females performed at Levels 5-6 in 2015 (6.3%) and 2018 (6.2%).

Chapter 5
Student Performance on Mathematical Literacy

Key Points from Chapter 5

- The overall mean mathematics score of students in Ireland in 2018 was 499.6. This is significantly higher than OECD average score of 489.3.
- Ireland's mean score ranked 16th of 37 OECD countries (or between 12th and 21st, if a 95% confidence interval is applied), and 21st among all 78 participating countries with valid data (or between 17th and 26th if a 95% confidence interval is applied), and 11th out of 28 EU countries.
- Ireland's standard deviation for mathematics (77.8) was smaller than the OECD average (90.6) and is among the smallest across all countries in PISA 2018. This indicates a narrower spread of mathematics achievement in Ireland than across countries in general.
- In Ireland, male students achieved a mean score of 502.6. Although higher than the mean score of females (496.7), the difference (5.9 score points) is not statistically significant.
- Student performance on PISA mathematics in Ireland is characterised by a significantly lower percentage of high achievers (8.2%), and a significantly lower percentage of low-performing students (15.7%), compared with the corresponding OECD average percentages.
- The mean mathematics score of students in Ireland in 2018 is not significantly different from 2012 (501.5) or 2015 (503.7).

This chapter looks at student performance in a second minor domain in PISA 2018, mathematical literacy. Like science, performance is reported on an overall scale only. PISA mathematics seeks to assess the ability of students to reason mathematically and to use mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. Mathematics was a major assessment domain in 2012, and the assessment framework and test items used in 2012, 2015 and 2018 will not undergo substantial revision until PISA 2021. This means that, whereas the frameworks and test items for PISA reading literacy and science have been updated to capitalise on the affordances of computer-based assessment and other changes in those domains, PISA mathematics continues to be based on older paper-based items, albeit presented on computer in most countries participating in 2015 and 2018.

This chapter is divided into the following 7 sections:

- A description of the framework underpinning PISA mathematics, initially developed for PISA 2012
- A presentation of sample items drawn from earlier assessments of mathematics in PISA

- A description of performance in mathematics with reference to mean scores, in Ireland and in other participating countries
- A description of mathematics performance based on the percentages of students achieving different mathematics proficiency levels in Ireland and on average across OECD countries
- An examination of key factors associated with achievement including student-level gender and socioeconomic status, and school gender-composition, fee-paying status and DEIS status
- An analysis of trends in mathematics performance since 2012
- A summary of key findings.

5.1 Framework for Mathematics

The mathematical literacy framework outlined below is a continuation of the framework developed for PISA 2012. A subset of the mathematics items administered to students on paper in 2012 was administered to students on computer in 2015 and 2018.

5.1.1 Definition of mathematical literacy

The definition of mathematical literacy in PISA 2018 (based on the 2012 definition) is as follows:

> Mathematical literacy is an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematics concepts, procedures, facts and tools, to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged and reflective citizens (OECD, 2019a, p. 73).

PISA mathematical literacy emphasises both the importance of combining an understanding of 'pure' mathematics and the capacity to use mathematics in context, though as noted above, the focus of the PISA mathematics assessment is on solving problems in real-world contexts. This is based on the view that, in everyday life, problems and situations arise that require some level of understanding of mathematics, mathematical reasoning and mathematical tools, before they can be fully understood and addressed. The ability to apply mathematical thought and action in a real-world context is viewed as being a key to success in modern educational and work environments.

5.1.2 Mathematical processes and underlying mathematical capabilities

PISA incorporates three key processes in the context of mathematical problem solving: formulating situations mathematically, employing mathematical concepts, facts, procedures and reasoning, and interpreting, applying and evaluating mathematical outcomes. These are described as follows:

- **Formulating** – involves recognising and identifying opportunities to apply and use mathematics, and seeing that mathematics can be applied to understand or resolve a particular problem or challenge presented. It includes translating a real-world problem

into a form amenable to mathematical treatment, providing mathematical structure and representations, and identifying variables and making simplifying assumptions to help solve the problem or meet the challenge.

- **Employing** – involves applying mathematical reasoning and using mathematical concepts, procedures, facts and tools to arrive at a mathematical solution. It includes performing calculations, manipulating algebraic expressions and equations or other mathematical models, analysing information in a mathematical manner from mathematical diagrams and graphs, and developing mathematical descriptions and explanations and using mathematical tools to solve problems.
- **Interpreting** – involves reflecting upon mathematical solutions or results and interpreting them in context. It includes evaluating mathematical solutions or reasoning in relation to the context of the problem and determining whether the results are reasonable and make sense in the situation.

In practice, individual PISA mathematics items mainly draw on one of these processes.

The framework also identifies seven mathematical abilities that underpin these processes: communication, mathematising, representation, reasoning and argument, devising strategies for solving problems, using symbolic, formal and technical language and operations, and using mathematical tools. Each of these abilities can be displayed at different levels of competence, and together form the basis of the description of proficiency levels used to report performance on mathematics.

5.1.3 Mathematical content areas

PISA identifies four mathematical content areas. It is argued that these 'meet the requirements of historical development, coverage of the domain of mathematics and the underlying phenomena which motivate its development, and reflect the major strands of school curricula' (OECD 2019a, p. 83). Each is described below:

- **Change & Relationships** – includes understanding types of change and recognising when these occur in order to use suitable mathematical models to describe and predict change. Mathematically, this involves using the appropriate functions and equations to model such changes and relationships, as well as creating, interpreting, and translating representations of relationships. Central to describing, modelling and interpreting such changes are aspects of mathematical content e.g. algebraic expressions, equations and inequalities, and tabular and graphic representations. Change & Relationships are described and represented using statistics, which require a solid understanding of basic numbers and units.
- **Space & Shape** – includes understanding perspective, creating and reading maps, transforming shapes with and without technology, interpreting views of three-dimensional scenes from various perspectives and constructing representations of shapes. This content area draws on geometry as its basis, but also draws on other areas such as spatial visualisation, measurement and algebra.
- **Quantity** – includes a knowledge of measurements, counts, magnitudes, units, indicators, relative size, and numerical trends and patterns. Aspects of quantitative reasoning deemed important for mathematical literacy include number sense, multiple representations of numbers, elegance in computation, mental calculation, and estimation and assessment of the reasonableness of results.

- **Uncertainty & Data** – includes recognising variation in processes, having a sense of the quantification of that variation, acknowledging uncertainty in measurement, and knowing about change. It also involves forming, interpreting and evaluating conclusions drawn in situations where uncertainty is central. The interpretation and presentation of data are viewed by PISA as important elements of Uncertainty & Data.

The following content topics are identified by PISA as central to all four mathematical content areas: functions; algebraic expressions; equalities and inequalities; co-ordinate systems; relationships within and among geometrical objects in two and three dimensions; measurement; numbers and units; arithmetic operations; percentages, ratios and proportions; counting principles; estimation; data collection, representation and interpretation; data variability and its description; samples and sampling; and chance and probability.

5.1.4 Mathematical contexts

Central to PISA mathematics is assessing the ability to engage with mathematical problems in a variety of contexts. The manner in which mathematical thinking is applied to a problem often depends on the setting in which it is encountered. The context is the aspect of the individual's world in which a problem is placed. PISA identifies four context categories: personal, occupational, societal and scientific. The main purpose of context categories in the mathematics framework is to ensure the test content reflects a broad range of settings that are relevant to 15-year-olds. Items which are intra-mathematical, where all the elements belong to the world of mathematics, fall within the scientific context. The four contexts are defined as follows:

- **Personal** – these items focus on activities of one's self, one's family or one's peer group. Such contexts include: food preparation, shopping, games, personal health, personal transportation, sports, travel, personal scheduling and personal finance.
- **Occupational** – these are centred on the world of work and include such activities as measuring, costing and ordering materials for building, payroll/accounting, quality control, scheduling/inventory, design/architecture and job-related decision-making. These contexts are viewed as relating to any level of the workforce, from unskilled work to the highest levels of professional work, though items in these contexts are designed to be accessible to 15-year-olds.
- **Societal** – these focus on community (whether local, national or global), and can involve voting systems, public transport, government, public policies, demographics, advertising, national statistics and economics. The focus of these problems is on a community (rather than a personal) perspective.
- **Scientific** – these relate to the application of mathematics to the natural world and issues and topics related to science and technology. Scientific contexts include weather or climate, ecology, medicine, space science, genetics, measurement, and the world of mathematics itself. Items where all elements fall within the mathematical area are included within this context.

The different elements of the mathematics framework can be seen working in tandem in Figure 5.1.

Figure 5.1: A model of mathematical literacy in practice

Challenge in Real World Context

Mathematical content categories: *Quantity, Uncertainty & Data, Change & Relationships, Space & Shape*

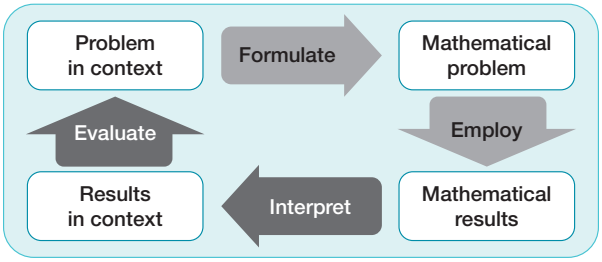
Real world context categories: *Personal, Societal, Occupational, Scientific*

Mathematical Thought and Action

Mathematical concepts, knowledge and skills

Fundamental mathematical capabilities: *Communication; Representation; Devising strategies; Mathematisation; Reasoning and argumentation; Using symbolic, formal and technical language and operations; Using mathematical tools.*

***Processes**: Formulate, Employ, Interpret/Evaluate*



Source: OECD 2019a, Figure 3.1.

5.1.5 Item types and distribution of mathematics items by framework components

Mathematical literacy was a minor domain in 2018. The 82 test questions were organised into six half-hour clusters – the same six clusters that were administered on computer in PISA 2015.

Three types of response format were used to assess mathematics in PISA 2018. Open constructed-response items focused on extended written responses from a student, which were manually coded by trained coders. Closed constructed-response items produced a structured setting for students' answers to be judged as correct or incorrect. Such answers can be scored manually or automatically coded. Lastly, selected-response (simple and complex multiple-choice) items required students to choose one or more responses from a number of response options. Responses to these questions can usually be automatically processed.

Table 5.1 provides information on the distribution of mathematics items across categories or dimensions of the assessment framework. While the content areas are almost equally represented across the 82 items on the test, there are more items assessing the Employing process (43%) than the Formulating (29%) or Interpreting (28%) processes. Table 5.1 also shows that 42% of items were either simple or complex multiple-choice items, while the remainder were constructed response items that were either human-coded or computer-coded.

Table 5.1: Distribution of PISA 2018 mathematics items by process, content area, item format and context

Component	Number*	%	Component	Number	%
Process			***Item Format***		
Formulating	24	29	Simple Multiple Choice	20	24
Employing	35	43	Complex Multiple Choice	15	18
Interpreting	23	28	Open Response – Human Coded	21	26
Total	82	100	Open Response – Computer-Coded	26	32
			Total	82	100
Content			***Context***		
Change & Relationships	21	26	Occupational	20	24
Quantity	21	26	Personal	13	16
Space & Shape	19	23	Scientific	21	26
Uncertainty & Data	21	26	Societal	28	34
Total	82	100	Total	82	100

Source: adapted from OECD, 2016c.
* In 2015, there were 83 items. One item was dropped in 2018 (it was assessed on paper only).

5.2 Sample Mathematics Items

This section includes a selection of released mathematics from PISA 2012. They provide a broad indication of the types of items used to assess mathematics in PISA. No additional items were released following the transition of PISA mathematics to computer in 2015 or in 2018. Hence, performance data accompanying the sample items in this section date back to 2012.

5.2.1. Sailing Ships

Items in the unit called 'Sailing Ships' were introduced with a short text and an illustration (Figure 5.2). Following this, students were asked to respond to three questions. Here, two of these questions are described.

Figure 5.2: Sailing Ships

Ninety-five percent of world trade is moved by sea, by roughly 50 000 tankers, bulk carriers and container ships. Most of these ships use diesel fuel.

Engineers are planning to develop wind power support for ships. Their proposal is to attach kite sails to ships and use the wind's power to help reduce diesel consumption and the fuel's impact on the environment.

© by skysails

Question 2 (Figure 5.3) asks students to find the length of the rope for a kite sail, in order to pull the ship at a specified angle. The vertical height of the kite sail was given as 150 m. A diagram showed this. The multiple-choice item, drawn from the Space & Shape content area, required students to 'employ mathematical concepts, facts, procedures and reasoning' and involved the application of the Pythagorean Theorem to a real geometric context (Figure 5.3). The item is at Proficiency Level 3, indicating a medium level of difficulty, with a score of 539 points on the PISA mathematics scale (see Section 5.4). In Ireland, 47.8% of students selected the correct answer, while on average across OECD countries, a similar proportion, 49.8%, did so.

Figure 5.3: Sailing Ships, Question 2

Approximately what is the length of the rope for the kite sail, in order to pull the ship at an angle of 45° and be at a vertical height of 150 m, as shown in the diagram opposite?

A 173 m
B 212 m
C 285 m
D 300 m

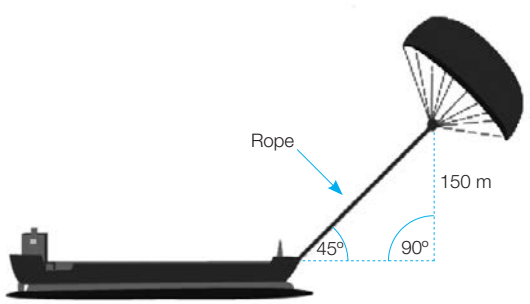


Table 5.2: Sailing Ships: Mapping question 2 to the framework, and item difficulty

Framework Element and Difficulty	Description
Question type	Multiple-choice
Mathematical content area	Space & Shape
Mathematical process	Employ mathematical concepts, facts, procedures and reasoning
Context	Scientific
Item difficulty	539; Level 3
Percent correct (Option B)	Ireland: 47.8%; OECD average: 49.8%

Question 3 (Figure 5.4) asked students to solve a problem involving cost savings and fuel consumption. This open constructed response, drawn from the Change & Relationships content area, asked students to calculate the approximate number of years of diesel fuel savings it would take to cover the cost of purchasing a kite sail, given that the kite sail was expected to reduce fuel costs by 20%.

To achieve full credit on this item (no partial credit was on offer), students had to provide a solution between 8 and 9 years with adequate mathematical calculations. For example, they could indicate that 3.5 million litres of diesel per year would cost 1 470 000 zeds. A 20% saving would give 294 000 zeds (1 470 000 X 0.2). They would then need to divide 2 500 000 zeds (the cost of a kite sale) by 294 000 to get 8.5 (8-9 years).

This item has a scale score of 702.1 on the PISA mathematics scale and is at Proficiency Level 6 (the highest Level in PISA mathematics). In Ireland, 15.8% of students achieved a correct answer. On average across OECD countries, the corresponding percentage was 15.3.

Figure 5.4: Sailing Ships, Question 3

Due to high diesel fuel costs of 0.42 zeds per litre, the owners of the ship *NewWave* are thinking about equipping their ship with a kite sail.

It is estimated that a kite sail like this has the potential to reduce the diesel consumption by about 20% overall.

Name: *NewWave*
Type: freighter
Length: 117 metres
Breadth: 18 metres
Load capacity: 12 000 tons
Maximum speed: 19 knots

Diesel consumption per year without a kite sail: approximately 3 500 000 litres

The cost of equipping the *NewWave* with a kite sail is 2 500 000 zeds.

After about how many years would the diesel fuel savings cover the cost of the kite sail? Give calculations to support your answer.

Number of years: .....

Table 5.3: Sailing Ships: Mapping question 3 to the framework, and item difficulty

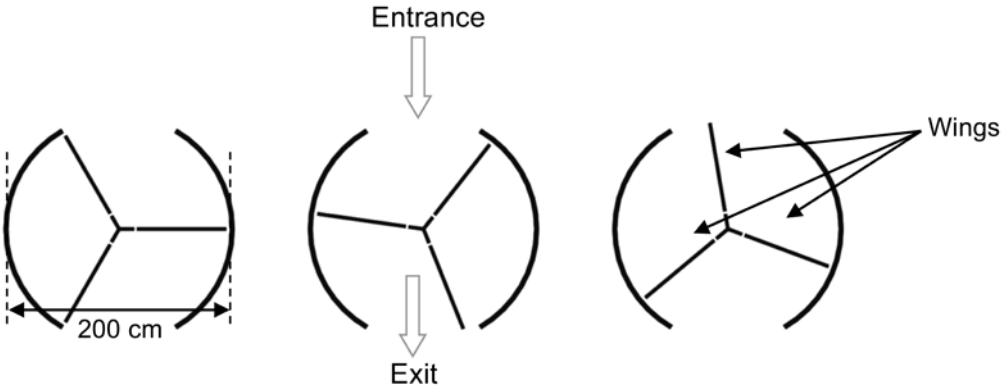
Framework Element and Difficulty	Description
Question type	Open response (human coded)
Mathematical content area	Change & Relationships
Mathematical process	Formulate situations mathematically
Context	Scientific
Item difficulty	702; Level 6
Percent correct (Option B)	Ireland: 15.8%; OECD average: 15.3%

5.2.2. Revolving Door

One question (Question 3) assessing Quantity is drawn from the 'Revolving Door' unit. Students were first introduced to a revolving door scenario, in which a door with three wings rotates within a circular-shaped space, with an inside diameter of 200 cm (Figure 5.5).

Figure 5.5: Stimulus for Revolving Door

A revolving door includes three wings which rotate within a circular-shaped space. The inside diameter of this space is 2 metres (200 cm). The three door wings divide the space into three equal sectors. The plan below shows the door wings in three different positions viewed from the top.



Question 3 (Figure 5.6) informed students that the door makes 4 rotations in a minute, and that there is room for two people in each of the door's sectors. They were asked to indicate, in a multiple-choice question, the maximum number of people who could enter the building through the door in 30 minutes. Students were not required to show their calculations on this item, which, like Sailing Ships – Question 3, is described as requiring students to formulate situations mathematically. The correct answer can be computed as follows: 4 rotations per minute X 30 minutes X 2 persons per sector X 3 sectors = 720 persons.

Revolving Door – Question 3 can be described as moderately difficult, with a scale score of 561 and a Proficiency Level of 4 (Table 5.4). In Ireland, 48.8% of students selected the correct response (Option D), while on average across OECD countries, 46.4% did so.

Figure 5.6: Revolving Door, Question 3

The door makes 4 complete rotations in a minute. There is room for a maximum of two people in each of the three door sectors.

What is the maximum number of people that can enter the building through the door in 30 minutes?

A 60
B 180
C 240
D 720

Table 5.4: Revolving Door: Mapping question 3 to the framework, and item difficulty

Framework Element and Difficulty	Description
Question type	Multiple choice
Mathematical content area	Quantity
Mathematical process	Formulate situations mathematically
Context	Scientific
Item difficulty	561; Level 4
Percent correct (Option B)	Ireland: 48.8%; OECD average: 46.4%

5.3 Overall Performance on Mathematics

Mathematics in PISA 2018 was assessed as a minor domain alongside science. Subscales are not reported on for minor domains and therefore only overall performance is reported on in this chapter. The PISA 2018 cycle is the second in which mathematics has been administered on computer in most participating countries.

Ireland's mean score on the overall mathematics scale is 499.6 and this is significantly higher than the OECD average of 489.3 (Table 5.5). Ireland is ranked 16th out of 37 OECD countries and 21st out of all 78 participating countries/economies for which valid data were available. Applying a 95% confidence interval, which takes account of measurement and sampling error, Ireland's true rank in mathematics among the OECD countries is between 12th and 21st and between 17th and 26th among all participating countries/economies.

In mathematics, B-S-J-Z (China) outperformed all other participating countries/economies with a mean of 591.4, and is one of 27 educational systems that score significantly above the OECD average. B-S-J-Z (China) is also one of 16 systems with a significantly higher mathematics mean score than Ireland. Ireland's mean score does not differ statistically from ten countries/economies (Sweden, United Kingdom, Norway, Germany, Czech Republic, Austria, Latvia, France, Iceland, and New Zealand). The remaining 51 countries/economies (13 of which are OECD countries, including Portugal, Italy and Greece) performed significantly less well than Ireland. The mean mathematics score for Northern Ireland which is not shown in Table 5.5 is 492.0 (SE = 4.2, SD = 85.4). This is not significantly different from the mean score for Ireland, or the OECD average. The EU average score is 488.6. This is significantly lower than the mean score for Ireland.

Table 5.5 also shows the standard deviation for each participating country/economy. Ireland's standard deviation for mathematics is 77.8, while the OECD average standard deviation is 90.6. This indicates a narrower spread of mathematics achievement in Ireland than on average across OECD countries. Indeed, the spread in Ireland is one of the lowest among OECD countries. Other systems with comparably low standard deviations include B-S-J-Z China, Estonia, Denmark and Latvia. Notably, the standard deviation for Northern Ireland (85.4) is larger than for Ireland, but lower than the average across OECD countries.

Table 5.5: Mean scores, standard deviations and standard errors for all countries/economies, the OECD average and the EU average on the overall mathematics scale, and positons relative to OECD average and mean score for Ireland.

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
BSJZ China	591.4	(2.5)	80.3	(1.8)	▲	Israel	463.0	(3.5)	108.5	(1.9)	▼
Singapore	569.0	(1.6)	94.0	(1.2)	▲	Turkey	453.5	(2.3)	88.2	(1.8)	▼
Macao China	557.7	(1.5)	80.7	(1.5)	▲	*Ukraine*	453.1	(3.6)	94.0	(1.9)	▼
HK China	551.2	(3.0)	93.9	(1.9)	▲	Greece	451.4	(3.1)	89.2	(1.8)	▼
Chinese Taipei	531.1	(2.9)	99.7	(1.7)	▲	*Cyprus*	450.7	(1.4)	94.7	(1.1)	▼
Japan	527.0	(2.5)	86.5	(1.6)	▲	*Serbia*	448.3	(3.2)	96.7	(1.7)	▼
Korea	525.9	(3.1)	100.4	(2.0)	▲	*Malaysia*	440.2	(2.9)	83.1	(1.7)	▼
Estonia	523.4	(1.7)	81.6	(1.1)	▲	*Albania*	437.2	(2.4)	83.1	(1.3)	▼
Netherlands	519.2	(2.6)	93.3	(1.8)	▲	*Bulgaria*	436.0	(3.8)	97.4	(2.1)	▼
Poland	515.6	(2.6)	90.1	(1.7)	▲	*United Arab Emirates*	434.9	(2.1)	105.7	(1.2)	▼
Switzerland	515.3	(2.9)	94.3	(1.4)	▲	*Brunei Darussalam*	430.1	(1.2)	91.4	(1.0)	▼
Canada	512.0	(2.4)	92.3	(1.1)	▲	*Romania*	429.9	(4.9)	94.0	(2.1)	▼
Denmark	509.4	(1.7)	82.4	(1.0)	▲	*Montenegro*	429.6	(1.2)	83.3	(1.0)	▼
Slovenia	508.9	(1.4)	89.0	(1.4)	▲	*Kazakhstan*	423.1	(1.9)	87.0	(1.1)	▼
Belgium	508.1	(2.3)	95.4	(1.7)	▲	*Moldova*	420.6	(2.4)	94.4	(1.7)	▼
Finland	507.3	(2.0)	82.4	(1.2)	▲	*Baku (Azerbaijan)*	419.6	(2.8)	89.3	(1.7)	▼
Sweden	502.4	(2.7)	90.7	(1.4)	O	*Thailand*	418.6	(3.4)	87.8	(1.8)	▼
United Kingdom	501.8	(2.6)	93.0	(1.4)	O	*Uruguay*	417.7	(2.6)	85.3	(1.7)	▼
Norway	501.0	(2.2)	90.5	(1.3)	O	Chile	417.4	(2.4)	84.6	(1.4)	▼
Germany	500.0	(2.6)	95.4	(1.5)	O	*Qatar*	414.2	(1.2)	98.1	(0.9)	▼
Ireland	**499.6**	**(2.2)**	**77.8**	**(1.0)**		Mexico	408.8	(2.5)	77.6	(1.6)	▼
Czech Rep.	499.5	(2.5)	93.2	(1.7)	O	*Bosnia and Herzegovina*	406.4	(3.1)	82.0	(1.3)	▼
Austria	498.9	(3.0)	93.5	(1.5)	O	*Costa Rica*	402.3	(3.3)	74.7	(2.0)	▼
Latvia	496.1	(2.0)	80.3	(1.1)	O	*Peru*	399.8	(2.6)	84.4	(1.5)	▼
France	495.4	(2.3)	92.6	(1.5)	O	*Jordan*	399.8	(3.3)	85.2	(1.7)	▼
Iceland	495.2	(2.0)	90.2	(1.2)	O	*Georgia*	397.6	(2.6)	88.5	(1.6)	▼
New Zealand	494.5	(1.7)	93.2	(1.1)	O	*Rep. of North Macedonia*	394.4	(1.6)	93.5	(1.2)	▼
Portugal	492.5	(2.7)	96.4	(1.3)	▼	*Lebanon*	393.5	(4.0)	105.6	(1.6)	▼
Australia	491.4	(1.9)	92.2	(1.2)	▼	Colombia	390.9	(3.0)	81.2	(2.0)	▼
Russian Fed.	487.8	(3.0)	86.0	(1.9)	▼	*Brazil*	383.6	(2.0)	87.5	(1.6)	▼
Italy	486.6	(2.8)	93.8	(1.8)	▼	*Argentina*	379.5	(2.8)	84.0	(1.7)	▼
Slovak Rep.	486.2	(2.6)	99.6	(1.7)	▼	*Indonesia*	378.7	(3.1)	79.3	(2.2)	▼
Luxembourg	483.4	(1.1)	98.3	(1.3)	▼	*Saudi Arabia*	373.2	(3.0)	78.7	(1.6)	▼
Spain	481.4	(1.5)	88.4	(1.0)	▼	*Morocco*	367.7	(3.3)	76.1	(1.5)	▼
Lithuania	481.2	(2.0)	91.4	(1.1)	▼	*Kosovo*	365.9	(1.5)	77.2	(1.3)	▼
Hungary	481.1	(2.3)	91.1	(1.6)	▼	*Panama*	352.8	(2.7)	77.5	(2.1)	▼
United States	478.2	(3.2)	92.1	(1.5)	▼	*Philippines*	352.6	(3.5)	78.5	(2.0)	▼
Belarus	471.9	(2.7)	93.0	(1.4)	▼	*Dominican Rep.*	325.1	(2.6)	71.5	(2.0)	▼
Malta	471.7	(1.9)	101.9	(1.4)	▼	OECD Average	489.3	(0.4)	90.6	(0.2)	
Croatia	464.2	(2.5)	86.5	(1.7)	▼	EU Average	488.6	(0.5)	91.2	(0.3)	

	Significantly above OECD average
	At OECD average
	Significantly below OECD average

▲	Significantly higher than Ireland
O	Not significantly different from Ireland
▼	Significantly lower than Ireland

OECD countries are in regular font, partner countries/economies are in *italics*.
Data for Vietnam are excluded they have not been fully validated for international comparability.

5.4 Performance on Mathematics Proficiency Levels

Six proficiency levels were also used to report on mathematics performance in PISA 2018. The levels are the same as those established for PISA 2012, and subsequently used in PISA 2015. These range from Level 1 to Level 6. There is also a 'Below Level 1' category (see Table 5.6 for a description of each level).

Students at Proficiency Level 2 are those who achieve from 420 up to 482 score points on PISA mathematics (Table 5.6). These students are beginning to display key competencies that will enable them to use mathematics effectively in real-life situations and in future study (OECD, 2019a). They can, for example, extract relevant information from a single source and make use of a single representational model, and can employ basic algorithms to solve problems involving whole numbers. In PISA, Level 2 is considered the baseline level of mathematics proficiency.

Students performing at Level 1 (those scoring from 358 up to 420) can answer the most basic PISA mathematics questions, when those questions are in familiar contexts, with all relevant information present, and when the questions call on routine procedures, which are always obvious.

Students performing below Level 1 (those achieving a score below 358 points) can perform very direct and straightforward mathematical tasks, such as reading a single value from a well-labelled chart or table or perform arithmetic calculations with whole numbers following clear and well-defined instructions. The term 'low achievers in mathematics' is used in PISA to describe those performing below Level 2 (i.e., at or below Level 1) as these students are viewed as having insufficient mathematics for future study and the world of work.

Level 6 is the highest proficiency level in PISA mathematics, encompassing students (and items) with scores of 669 or higher. Students at this level can develop and work with models of complex situations, using appropriate problem-solving strategies for dealing with complex problems related to these models (see, for example, Sailing Ships, Question 3). They can also successfully perform mathematical tasks at lower levels of proficiency.

Students performing at Level 5 score from 607 up to 669 score points. They can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, and symbolic and formal characterisations and insights pertaining to these situations. They are beginning to reflect on their work and formulating and communicating their interpretations and reasoning. Taken together, students performing at Levels 5 and 6 are referred to in PISA as high achievers or top performers in mathematics.

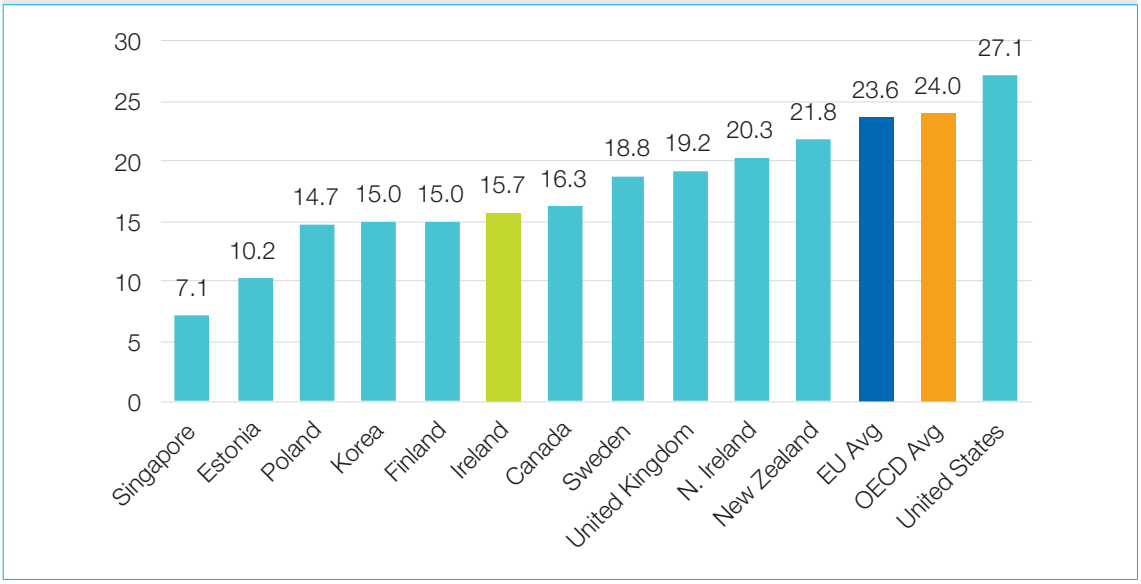
Table 5.6: Summary description of the six levels of proficiency on the mathematics scale and percentage of students achieving each Level, in Ireland and on average across OECD and EU countries

Level (Cut-point)	Students at this level are capable of:	Ireland		OECD Avg		EU Avg	
		%	SE	%	SE	%	SE
6 (669 and above)	Conceptualising, generalising and using information based on their investigations and modelling of complex problem situations; using knowledge in relatively non-standard contexts; linking different information sources and representations and moving flexibly among them; applying their insight and understanding, along with mastery of symbolic and formal mathematical operations and relationships, to develop new approaches and strategies for addressing novel situations; and reflecting on their actions and formulating and precisely communicating their actions and reflections regarding their findings, interpretations and arguments.	1.0	(0.2)	2.4	(0.1)	2.1	(0.1)
5 (607 to less than 669)	Developing and working with models of complex situations; selecting, comparing and evaluating appropriate problem-solving strategies for dealing with complex problems related to these models; working strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations and insights pertaining to these situations; and beginning to reflect on their work and formulating and communicating their interpretations and reasoning.	7.2	(0.6)	8.5	(0.1)	8.2	(0.1)
4 (545 to less than 607)	Working effectively with explicit models of complex, concrete situations that may involve constraints or making assumptions; selecting and integrating different representations (including symbolic representations) and linking them directly to aspects of real-world situations; reasoning with some insight in straightforward contexts; and constructing and communicating explanations and arguments based on their interpretations, arguments and actions.	20.8	(0.8)	18.5	(0.1)	18.6	(0.1)
3 (482 to less than 545)	Executing clearly described procedures, including those that require sequential decisions; making sufficiently sound interpretations to be a base for building a simple model or for selecting and applying simple problem-solving strategies; interpreting and using representations based on different information sources and reasoning directly from them; and showing some ability to handle percentages, fractions and decimal numbers, and to work with proportional relationships.	30.5	(0.8)	24.4	(0.1)	24.9	(0.2)
2 (420 to less than 482)	Interpreting and recognising situations in contexts that require no more than direct inference; extracting relevant information from a single source and making use of a single representational mode; employing basic algorithms, formulae, procedures or conventions to solve problems involving whole numbers; and making literal interpretations of the results.	24.7	(0.8)	22.2	(0.1)	22.6	(0.2)
1 (358 to less than 420)	Answering questions involving familiar contexts where all relevant information is present and the questions are clearly defined; identifying information and carrying out routine procedures according to direct instructions in explicit situations; and performing actions that are almost always obvious and follow immediately from the given stimuli.	11.9	(0.7)	14.8	(0.1)	14.7	(0.1)
Below Level 1 (less than 358)	Performing very direct and straightforward mathematical tasks, such as reading a single value from a well-labelled chart or table where the labels on the chart match the words in the stimulus and question, so that the selection criteria are clear and the relationship between the chart and the aspects of the contexts depicted are evident; and performing arithmetic calculations with whole numbers by following clear and well-defined instructions.	3.8	(0.5)	9.1	(0.1)	8.9	(0.1)

Source: Adapted from OECD 2019d, Table I.B1.2.

In Ireland, 15.7% of students performed below Level 2 on PISA mathematics, compared with 24.0% on average across OECD countries (Figure 5.7), the difference is statistically significant (See E-Appendix Table A4.2). Only a small number of comparison countries (Estonia with 10.2% and Singapore with 7.1%) had significantly fewer students than Ireland performing below Level 2.

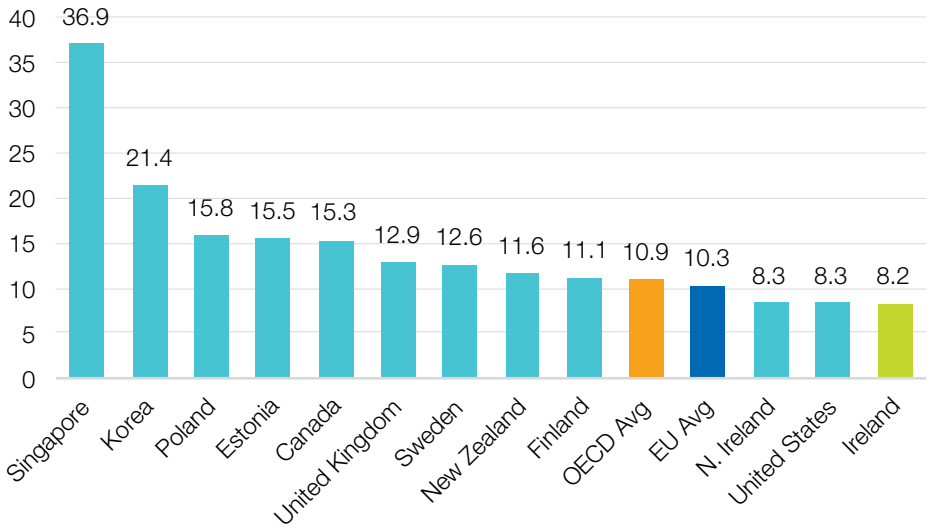
Figure 5.7: Percentage of students performing below Proficiency Level 2 in mathematics in Ireland, in selected comparison countries, and on average across OECD and EU countries



See e-Appendix table A5.2 for percentages of students (and standard errors) at each proficiency level in Ireland for mathematics, in selected comparison countries and on average across the EU and the OECD.

Examining the top-performing students in mathematics, 8.2% of students in Ireland performed at or above Level 5 (Figure 5.8). This is significantly lower than the OECD average of 10.9% (see E-Appendix Table A5.2). Comparison countries with higher proportions of students than Ireland performing at or above Level 5 include Poland (15.8%), Estonia (15.5%), Canada (15.3%), the United Kingdom (12.9%) and Sweden (12.6%). While the United Kingdom and Sweden had mean scores that are not significantly different from Ireland, they had higher percentages of students performing at or above Level 5 in mathematics.

Figure 5.8: Percentage of students performing at or above Proficiency Level 5 in mathematics in Ireland, in selected comparison countries, and on average across OECD and EU countries



See e-Appendix table A5.1 for percentages of students (and standard errors) at each proficiency level in Ireland for mathematics, in selected comparison countries and on average across the EU and the OECD.

5.5 Performance by Selected Variables

This section examines gender, economic, social and cultural social status (ESCS), school gender composition, school private-public status and DEIS status, and considers how these key context variables relate to the overall mathematics performance of students in Ireland.

5.5.1 Gender differences and mathematics performance

In Ireland, males achieved a mean score of 502.6 on PISA 2018 mathematics, while females achieved a mean score of 496.7 (Table 5.7). The gender difference (5.9 score points), which amounts to less than one-tenth of a national standard deviation, is not statistically significant, and is only slightly larger than the OECD average difference (5.2) in favour of males, though the latter is statistically significant. Several comparison countries had a slightly larger gender difference than Ireland in favour of males, including the United Kingdom (12.2 points), New Zealand (8.9), the United States (8.6), and Estonia (8.5), while Finland had a difference of 6.1 score points in favour of females. Females in Sweden and Northern Ireland had marginally higher scores than males, though differences in these countries are not statistically significant.

Table 5.7: Gender differences in mathematics performance in Ireland, in selected comparison countries and on average across OECD countries

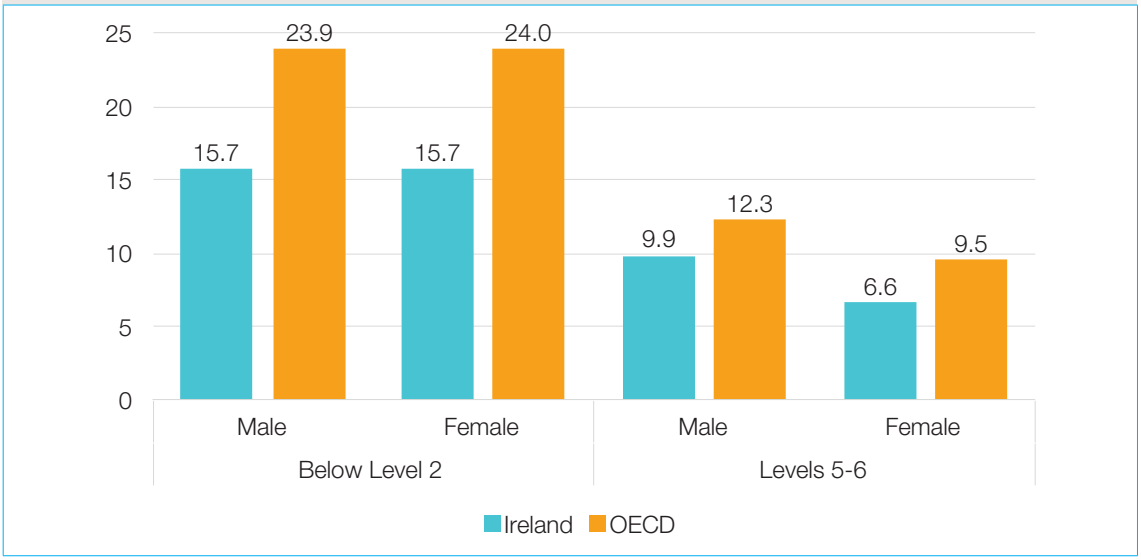
	Males		Females		Difference (males-females)	
	Mean	SE	Mean	SE	Score diff.	SED
UK	508.0	(3.2)	495.9	(3.0)	**12.2**	(3.6)
New Zealand	498.9	(2.5)	490.0	(2.3)	**8.9**	(3.3)
United States	482.5	(3.9)	473.8	(3.3)	**8.6**	(3.2)
Estonia	527.6	(2.2)	519.2	(2.0)	**8.5**	(2.5)
Ireland	502.6	(2.9)	496.7	(2.7)	5.9	(3.4)
Canada	514.5	(2.5)	509.5	(2.7)	4.9	(2.3)
Poland	516.3	(2.9)	514.9	(3.1)	1.4	(3.0)
Sweden	501.8	(3.1)	503.0	(3.1)	-1.2	(3.1)
Finland	504.3	(2.5)	510.4	(2.2)	**-6.1**	(2.6)
Korea	527.9	(4.1)	523.8	(4.0)	4.0	(5.3)
OECD Average	491.9	(0.5)	486.7	(0.5)	**5.2**	(0.6)
Singapore	571.0	(1.6)	566.9	(2.3)	4.1	(2.3)
Northern Ireland	488.7	(6.0)	495.3	(4.7)	-6.6	(6.9)

Source: OECD 2019e, Table II B1.7.3. Significant differences are in **bold**.

Figure 5.9 presents the percentage of females and males performing below Level 2 and at or above Level 5 on the overall mathematics scale in Ireland and on average across OECD countries. In Ireland, the same percentage of males and females performed below Level 2 in mathematics (15.7%). On average across OECD countries 23.9% of males and 24.0% of females performed below level 2 (OECD 2019e, Tables II.B.7.17).

In Ireland, a significantly higher percentage of males performed at or above Level 5 (9.9%) compared to females (6.6%). On average across OECD countries, a similar pattern emerged with a significantly higher percentage of males (12.3%) achieving proficiency Levels 5 and 6 than females (9.5%) (OECD 2019e, Tables II.B.7.17).

Figure 5.9: Percentage of male and female students achieving below Proficiency Level 2 and at or above Proficiency Level 5 on the mathematics scale, in Ireland and on average across OECD countries



Source: OECD 2019e, Table II.B.7.17.

5.5.2 Student socio-economic status and mathematics performance

As noted in Chapter 3, PISA has constructed an index of economic, social and cultural status (ESCS), based on such variables as parental occupation, highest level of parental education, and an index of home possessions related to family wealth, home educational resources and material possessions. For students in Ireland, a significant positive correlation, in the moderate range ($r = 0.34$, $SE = 0.02$, $t = 17.0$, $df = 80$, $p < .05$), was observed between scores on the ESCS index and achievement in mathematics. When the ESCS index was divided into quartiles, significant differences in mean scores were found between students in the lowest quartile and those in all other quartiles (Table 5.8). There is a difference of 67.0 score points between students in Ireland in the top and bottom ESCS quartiles.

Table 5.8: Mean scores on mathematics by ESCS quartile[37] in Ireland

Quartiles of ESCS	%	Mean Score	SE	SD
Highest	25.0	**533.9**	(3.2)	72.0
Medium-High ESCS	25.0	**509.0**	(2.8)	73.4
Low-Medium ESCS	25.0	**491.4**	(2.5)	72.6
Lowest (ref.)	25.0	466.9	(3.1)	76.3

Significantly different mean scores are in **bold** (compared with the reference group).

37 The ESCS quartiles in this chapter were computed by the ERC and mean mathematics scores may differ slightly from the OECD reported scores, due to different random allocation of students on the cut-off points for quartiles.

5.5.3 School sector gender composition and mathematics performance

In Ireland, schools are categorised into five types based on sector and gender composition: girls' secondary, boys' secondary, community/comprehensive, mixed secondary and vocational. Table 5.9 presents the overall mathematics mean scores by each school type. Students attending mixed secondary schools had the highest mean score (517.4), while students in ETB vocational schools had the lowest (483.2). Students in ETB vocational schools had a mean mathematics score that is significantly lower than the mean scores of students in mixed secondary, girls' secondary, and boys' secondary schools. No significant difference in mathematics scores was found between students in ETB vocational schools and community/comprehensive schools.

Table 5.9: Mean mathematics scores in Ireland by school type and gender composition

Classification	%	Mean Score	SE	SD
Girls' secondary	21.3	**506.6**	(3.9)	72.2
Boys' secondary	15.0	**510.0**	(5.6)	79.2
Community/comprehensive	16.9	492.2	(4.2)	78.1
Mixed secondary	17.4	**517.4**	(6.6)	77.4
ETB vocational (ref.)	29.5	483.2	(3.9)	77.1

Significantly different mean scores are in **bold** (in comparison to the reference group).

5.5.4 School fee-paying status and mathematics performance

Students in fee-paying schools had a mean score on mathematics (540.9) that is almost three-fifths of a national standard deviation higher than the mean score of students in non-fee-paying schools (496.5) (Table 5.10).

Table 5.10: Mean mathematics scores in Ireland by school fee-paying status

Classification	%	Mean Score	SE	SD
Fee-paying	7.0	**540.9**	(8.0)	70.5
Non-fee-paying (ref.)	93.0	496.5	(2.2)	77.4

Significantly different mean scores are in **bold** (in comparison to reference group).

5.5.5 School DEIS status and mathematics performance

In PISA 2018, students who attended DEIS schools had a significantly lower mean score on mathematics in comparison to students in non-DEIS schools (Table 5.11), with a difference of 43.8 score points or almost three-fifths of a national standard deviation.

Table 5.11: Mean scores on mathematics in Ireland by DEIS status

DEIS Status	%	Mean	SE	SD
DEIS	24.1	**466.4**	(4.5)	77.4
Non-DEIS (ref.)	75.9	510.2	(2.4)	74.8

Significantly different mean scores are in **bold** (compared with the reference group).

5.6 Trends in Mathematics Performance, 2012-2018

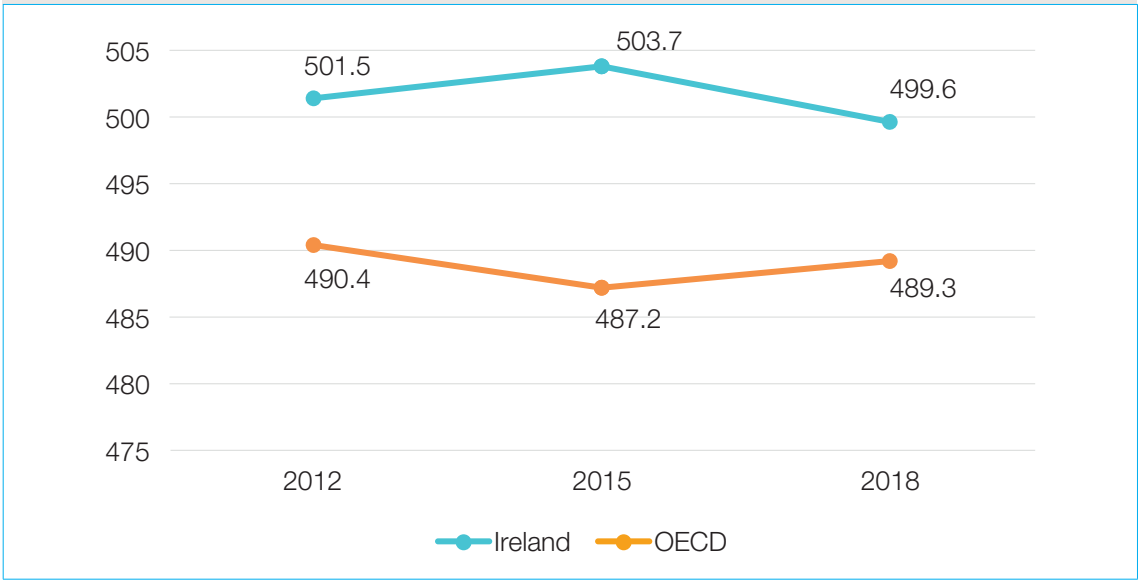
Mathematical literacy was a minor assessment domain in PISA 2018 and PISA 2015, having been a major domain in PISA 2012. Therefore, comparisons with 2012 are the main focus of this section.

5.6.1 Trends in overall mathematics mean scores

Students in Ireland achieved a mean mathematics score of 501.5 in 2012, and 503.7 in 2015 (Figure 5.10). In PISA 2018, the mean score of students in Ireland was 499.6. However, Ireland's mean score in 2018 is not statistically different from either 2012 or 2015.

On average across OECD countries, performance also changed, from 490.4 in 2012, to 487.2 in 2015 and 489.3 in 2018. The small drop in performance between 2012 and 2018 (1.1 points) and small increase between 2015 and 2018 (2.1) are not statistically significant (OECD 2019d, Table I.B.11).

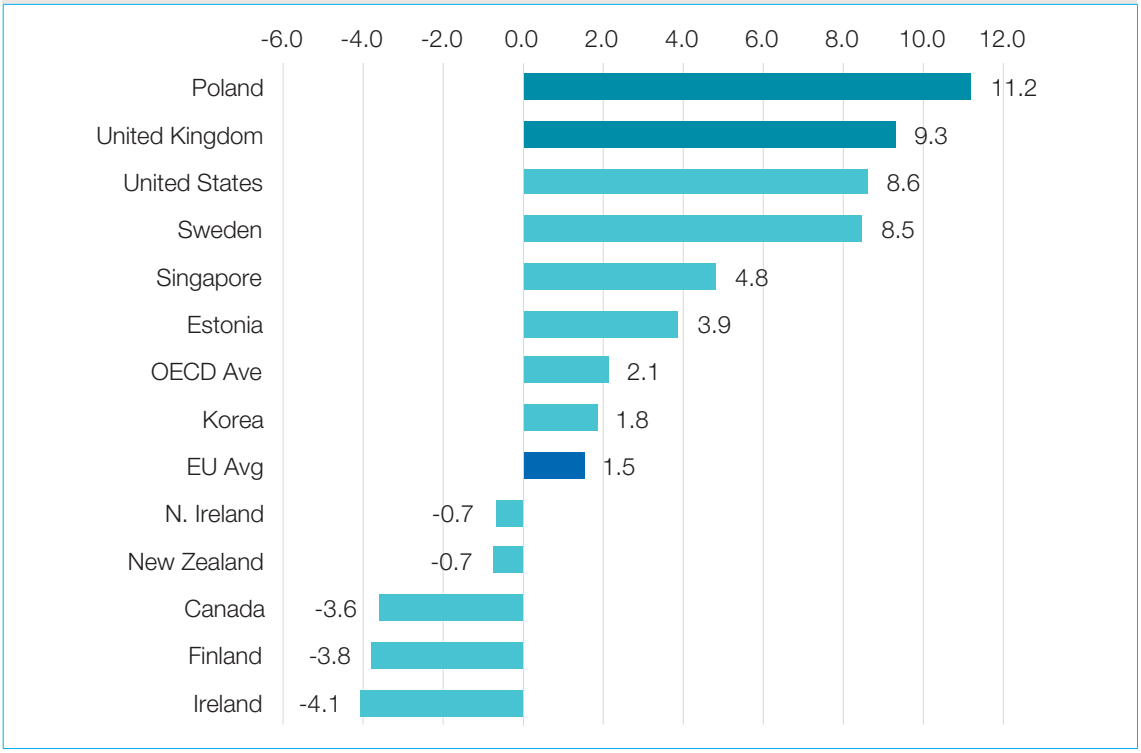
Figure 5.10: Mean scores in mathematics in Ireland and on average across OECD countries, 2012-2018



Source: OECD Table I.B.11. Note: OECD data are based on countries that participated in PISA 2012 and subsequent cycles, which draws on the value for countries in PISA 2015 and 2018 ('the OECD 37').

Figure 5.11 compares the mean score differences on mathematics between 2015 and 2018 for the selected comparison countries/regions in PISA 2018, the OECD average difference, the EU average and the difference for Northern Ireland. Two countries experienced a significant improvement: Poland (+ 11.2 points), and the United Kingdom (+9.3 points). None of the comparison countries/regions had a significant decline in performance between 2015 and 2018.

Figure 5.11: Mean score difference in mathematics for selected comparison countries and on average across OECD and EU countries, 2015-2018



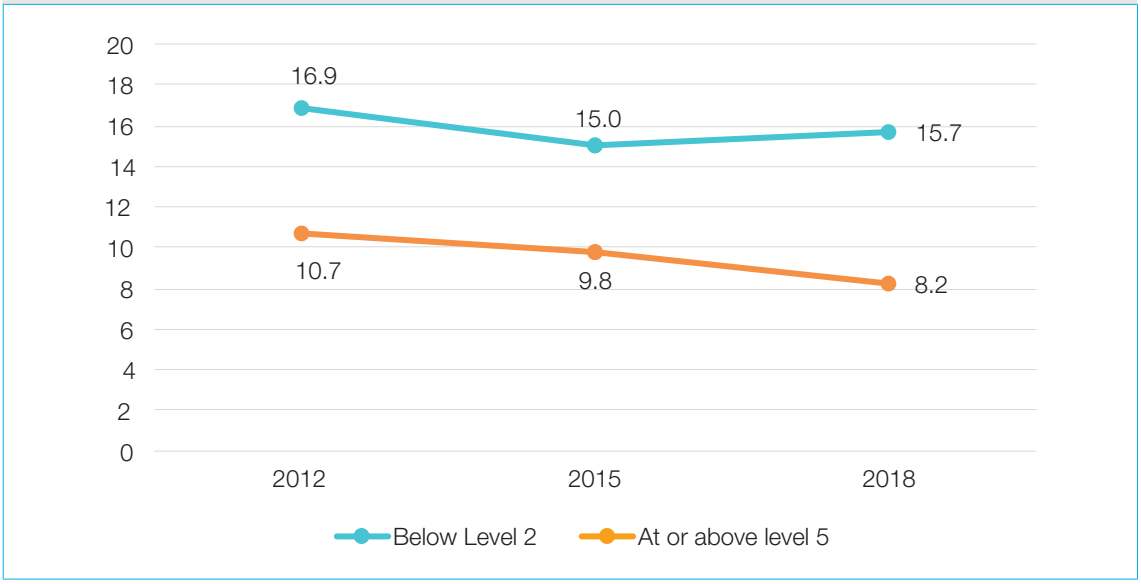
See E-Appendix Table A5.3. Significant differences are in **dark blue**.

5.6.2 Trends in mathematics performance by proficiency levels

In 2018, 15.7% of students in Ireland performed below Level 2, but this is not significantly different from 2012 (16.9%) or 2015 (15.0%) (Figure 5.12). On average across OECD countries, 24.4% of students performed below Level 2 in 2012, and this increased to 24.6% in 2015. In 2018, the percentage of students below Level 2 was almost equivalent to 2015, with 24.0% of students on average across OECD countries performing below Level 2. The small differences in the percentages of students performing below Level 2 on average across OECD countries between 2015 and 2018 and between 2012 and 2018 are not statistically significant (OECD 2019d, Table I.B1.8).

In 2012, 10.7% of students in Ireland performed at or above Level 5, and 9.8% did so in 2015. In 2018, the percentage of students performing above Level 5 was 8.2% (Figure 5.12). The estimate for 2018 is not significantly different from 2015; however, in comparison with 2012, it is significantly lower. On average across OECD countries, the percentage performing at or above Level 5 dropped from 12.1% in 2012 to 10.3% in 2015, with a small increase in 2018 to 10.9%. This small increase is significant and a significantly lower percentage of students on average across OECD countries performed at or above Level 5 in 2018, compared with 2012 (OECD 2019d, Table I.B1.8).

Figure 5.12: Percentage of students performing below Proficiency Level 2 and at or above Proficiency Level 5 in mathematics in Ireland, 2012-2018

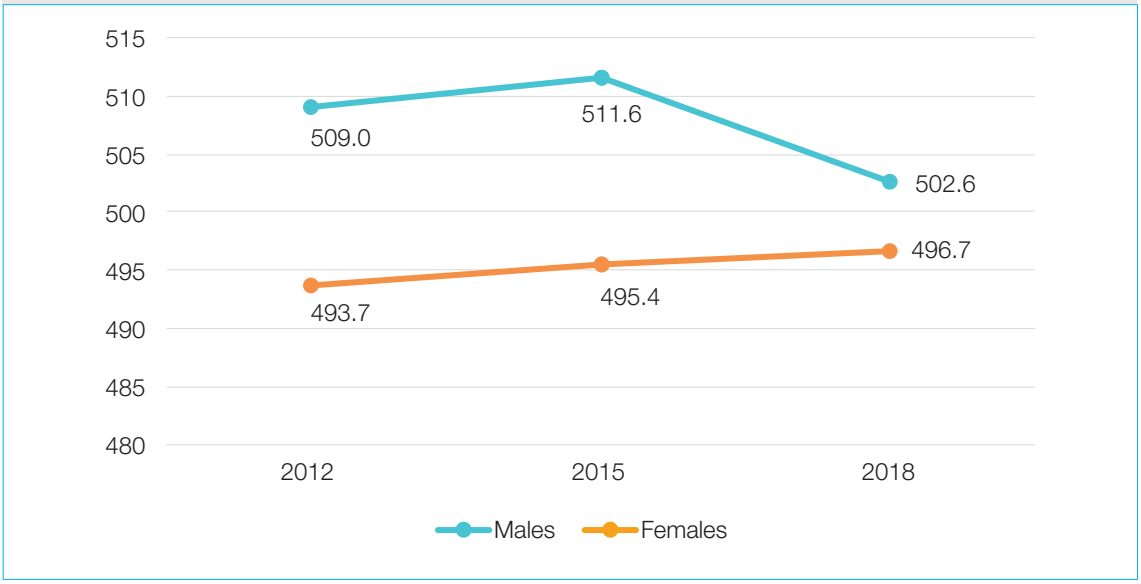


5.6.3 Trends in mathematics performance by gender

The overall mathematics mean score for females in Ireland increased slightly across PISA cycles, with scores of 493.7 in 2012, 495.4 in 2015 and 496.7 in 2018 (Figure 5.13). Although differences across cycles are not statistically significant, they show a positive trend for females. Across the three cycles, the mean scores for females in Ireland were also consistently higher than for females on average across OECD countries (mean scores of 485.0 in 2012, 483.3 in 2015, and 486.7 in 2018).

Males in Ireland continued to achieve higher mean scores in mathematics than females with scores of 509.0 in 2012, 511.6 in 2015 and 502.6 in 2018. While there were significant differences in favour of males over females in 2012 and 2015, the difference in 2018 (5.9 score points) is not statistically significant. Like female students in Ireland, males had consistently higher scores than males on average across OECD countries (495.6 in 2012, 491.0 in 2015, and 491.9 in 2018), though the gap narrowed in 2018, compared with 2012 and 2015 (OECD 2019e, Tables II.B.7.3, II.B.7.31, II.B.7.32, II.B.7.35, II.B.7.36).

Figure 5.13: Mean scores of male and female students in mathematics in Ireland, 2012-2018



Source: OECD, 2019e Tables II.B.7.3, II.B.7.32, II.B.7.31.

Gender differences can also be examined with reference to proficiency levels across cycles. In 2012, 15.2% of male students in Ireland performed below Level 2, and this increased marginally in 2018 to 15.7%. The percentage of female students in Ireland performing below Level 2 decreased steadily from 18.7% in 2012 to 15.7% in 2018. However, neither difference between 2012 and 2018 is statistically significant.

The proportion of male students performing at or above Level 5 decreased significantly across cycles, with 12.7% performing at this level in 2012, and 9.9% in 2018. The performance of female students at these levels changed non-significantly, with 8.5% of females achieving them in 2012, and 6.6% doing so in 2018.

Table 5.12: Percentage of male and female students performing below Proficiency Level 2 and at or above Proficiency Level 5 in mathematics in Ireland, 2012-2018

	Below Level 2				At or above Level 5			
	Male		Female		Male		Female	
	%	SE	%	SE	%	SE	%	SE
2012	15.2	(1.4)	18.7	(1.2)	12.7	(0.9)	8.5	(0.7)
2015	14.1	(1.2)	15.8	(1.1)	12.9	(1.0)	6.5	(0.8)
2018	15.7	(1.1)	15.7	(1.6)	9.9	(0.9)	6.6	(0.8)
	Diff	**SED**	**Diff**	**SED**	**Diff**	**SED**	**Diff**	**SED**
2018-2012	0.5	(1.8)	-3.0	(1.6)	**-2.8**	(1.3)	-1.9	(1.1)
2018-2015	1.5	(1.6)	-0.2	(1.5)	**-3.0**	(1.4)	0.1	(1.1)

Source: OECD, 2019e Tables II.B.7.17, II.B.7.18, II.B.7.19; II.B.7.20

On average across OECD countries, the percentage of males who performed below Level 2 increased from 23.5% in 2012 to 23.9% in 2018. The percentage of females performing below Level 2 decreased significantly, from 25.3% in 2012 to 24.0% in 2018. The proportions of students at or above Level 5 across OECD countries fell significantly for both genders, with 14.7% of males scoring below Level 2 in 2012, and 12.3% doing so in 2018. Similarly, in 2012, 10.1% of females on average

across OECD countries achieved at or above Level 5, compared to 9.5% in 2018 (OECD 2019e, Tables II.B.7.17, II.B.7.18, II.B.7.19, II.B.7.20, II.B.7.21).

5.7 Summary

Mathematics was a minor assessment domain in PISA 2018. Unlike reading literacy and science, no items specifically designed for computer-based assessment were included, though this will change in 2021, when PISA mathematics will be the major assessment domain. All PISA mathematics items administered in 2018 were drawn from the paper-based assessment in 2012.

Overall mathematics performance in 2018

The overall mean mathematics score of students in Ireland in 2018 was 499.6. This is significantly higher than OECD average score of 489.0. Ireland's mean score ranked 16th of 37 OECD countries (or between 12th and 21st, if measurement and sampling error are taken into account), and 21st among all 78 participating countries with valid data (or between 17th and 26th if error is taken into account). Sixteen countries had significantly higher mean scores than Ireland, including high-performing B-S-J-Z (591.4 score points) and Singapore (569.0). Ireland's mean score does not differ significantly from ten countries/economies, including Sweden, the United Kingdom and Germany, while 51 countries performed significantly less well than Ireland. The mean score for Northern Ireland (492.0), although some 8 points lower than Ireland's score, is not significantly different.

Ireland's standard deviation for mathematics (77.8) was smaller the OECD average (90.6). This indicates a narrower spread of mathematics achievement in Ireland than on average across OECD countries.

In Ireland, 15.7% of students performed below Level 2 on mathematics, indicating that they lacked the mathematical knowledge and skills required for future education and work. This was significantly below the OECD average of 24.0%. Just 7.1% of students in high-achieving Singapore performed below Level 2, while 20.3% of students in Northern Ireland did so. While Ireland had more lower-achieving students that countries with significantly higher average scores in mathematics, it had similar proportions to countries with mean scores that were not significantly different.

Turning to higher-achieving students, Ireland had 8.2% performing at Levels 5-6. This is significantly lower than the OECD average of 10.9%. A number of countries with overall mean scores not significantly different from Ireland's had proportionately more students than Ireland at Levels 5-6, including Sweden (12.6%) and the UK (12.9%). In Northern Ireland, a similar proportion of students to Ireland (8.3%) performed at Levels 5-6.

Selected factors associated with mathematics performance

In Ireland, male students achieved a mean score of 502.6. Although higher than the mean score of females (496.7), the difference (5.9 score points) is not statistically significant. On average across OECD countries, the difference in favour of male students was marginally smaller than in Ireland (5.2 points) but reached statistical significance. In Ireland, similar proportions of male and female students (15.7% in both cases) performed below proficiency Level 2, indicating that they were low achievers. The corresponding OECD average percentages were significantly higher, at 23.9% for males and 24.0% for females. Significantly more male students in Ireland (9.9%) compared with females (6.6%) performed at Levels 5-6. The corresponding OECD averages, also significantly different from one another, were 12.3% and 9.6% respectively.

Socioeconomic status, as measured by the PISA index of economic, social and cultural status (ESCS), was also found be associated with mathematics achievement in Ireland. Students in the top three quartiles achieved mean scores that were significantly higher than students in the bottom quartile, with a difference of 67.0 score points between the top and bottom quartiles.

Students attending girls' secondary schools, boys' secondary schools, and mixed secondary schools had higher mean mathematics scores than students attending ETB vocational schools, with the largest difference (26.8 score points, or one-third of a national standard deviation) between students in boys' secondary schools and ETB vocational schools. The difference between ETB vocational schools and community/comprehensive schools was not statistically significant.

Students attending fee-paying schools (7% of students in PISA 2018) achieved a mean score (540.9) that was significantly higher than the mean score of students attending schools that did not charge fees (496.5). The difference, 44.4 score points, is over one-half of a national standard deviation.

Students attending schools in the DEIS programme achieved a mean mathematics score (466.4) that was significantly lower than the mean score of students in non-DEIS schools (510.2). The difference, 43.8 score points, is almost three-fifths of a national standard deviation.

Trends in mathematics performance

In Ireland, overall mean scores in mathematics across cycles indicate a stable trend. Ireland's mathematics mean score is just 4.1 points lower than in 2015, and just 1.9 points lower than in 2012. Neither difference is statistically significant. The OECD average showed a small (-1.1 point) change between 2012 and 2018, and an increase of 2.1 points between 2015 and 2018, with neither difference significant.

The percentage of students in Ireland performing below proficiency Level 2 increased slightly between 2015 to 2018 (from 15.0% to 15.7%), but was marginally, though not significantly, lower in both cycles than in 2012 (16.9%). The percentage of students achieving at or above Level 5 dropped significantly from 10.7% in 2012 to 8.2% in 2018. On average across OECD countries, similar percentages of students (24.4% in 2012, 24.6% in 2015, 24.0% in 2018) performed below Level 2 across cycles. On average across OECD countries, the percentage performing at or above Level 5 dropped from 12.6% in 2012 to 10.7% in 2015 before increasing slightly to 10.9% in in 2018. As in Ireland, the percentage performing at Level 5 and above in 2018 is significantly lower on average across OECD countries than in 2012.

Performance by gender indicates a narrowing of the gender gap, with a non-significant difference in favour of males in 2018 (5.9 score points) compared with significant differences in favour of males in earlier cycles (15.3 score points in 2012, 16.1 in 2015). However, fluctuations in sampling from cycle to cycle need to be taken into account in considering this change.

Between 2012 and 2018 the percentage of males performing below level 2 increased marginally (+0.5%), while the percentage of females decreased (-3.0%); neither difference is statistically significant. On average across OECD countries, the percentage of males who performed below Level 2 increased non-significantly from 23.5% in 2012 to 23.9% in 2018. The percentage of females performing below Level 2 decreased significantly, from 25.3% in 2012 to 24.0% in 2018.

The percentage of males in Ireland achieving at or above Level 5 dropped significantly between 2012 and 2018 (2.8%), while the percentage of females dropped non-significantly (2.0%). The proportions of students at or above Level 5 across OECD countries also fell significantly for both genders, with 14.0% of males scoring below Level 2 in 2012, and 12.3% doing so in 2018. Similarly, in 2012, 10.1% of females on average across OECD countries achieved at or above Level 5, compared with 9.5% of females in 2018.

Chapter 6
Selected Key Findings from the PISA Questionnaires

Key Points from Chapter 6

- There has been a substantial and significant increase in the percentage of students in Ireland who do not read for enjoyment, from 33.4% (2000) to 41.9% (2009) to 47.7% in 2018, with significantly fewer males than females reading for enjoyment.
- Students in Ireland are significantly above the average across OECD countries in several reading strategy indices, including understanding and remembering, summarising and assessing the credibility of sources.
- Students in Ireland have relatively low familiarity with computer-based assessment, with 46.5% of students having taken a test on computer prior to PISA 2018.
- Principals in Ireland reported relative strengths on access to digital technology, such as sufficient Internet speed, availability of adequate software, and sufficiently-powerful digital devices. However, principals also reported relative weaknesses in relation to access to sufficiently qualified technical support staff, availability of effective professional resources for teachers to learn how to use digital technology, and skill levels of teachers for integrating digital technology into instruction.
- Responding to a national question, 22.6% of students in Ireland reported that they 'always' feel under pressure from teachers to do well in exams and tests. 10.7% reported they 'always' feel physically unwell thinking about doing exams and tests.
- Three-fifths of students in Ireland (61.4%) reported they were satisfied with their lives, compared to 66.9% of students on average across OECD countries. In Ireland, significantly fewer females reported satisfaction with life (55.5%), compared to males (67.3%).

This chapter presents the questionnaire framework for PISA 2018 and an overview of the national and international context questionnaires. The remainder of the chapter is divided into three sections that address student engagement in reading and use of reading strategies, students' use of digital technology in school, and student well-being.

6.1 PISA Questionnaires

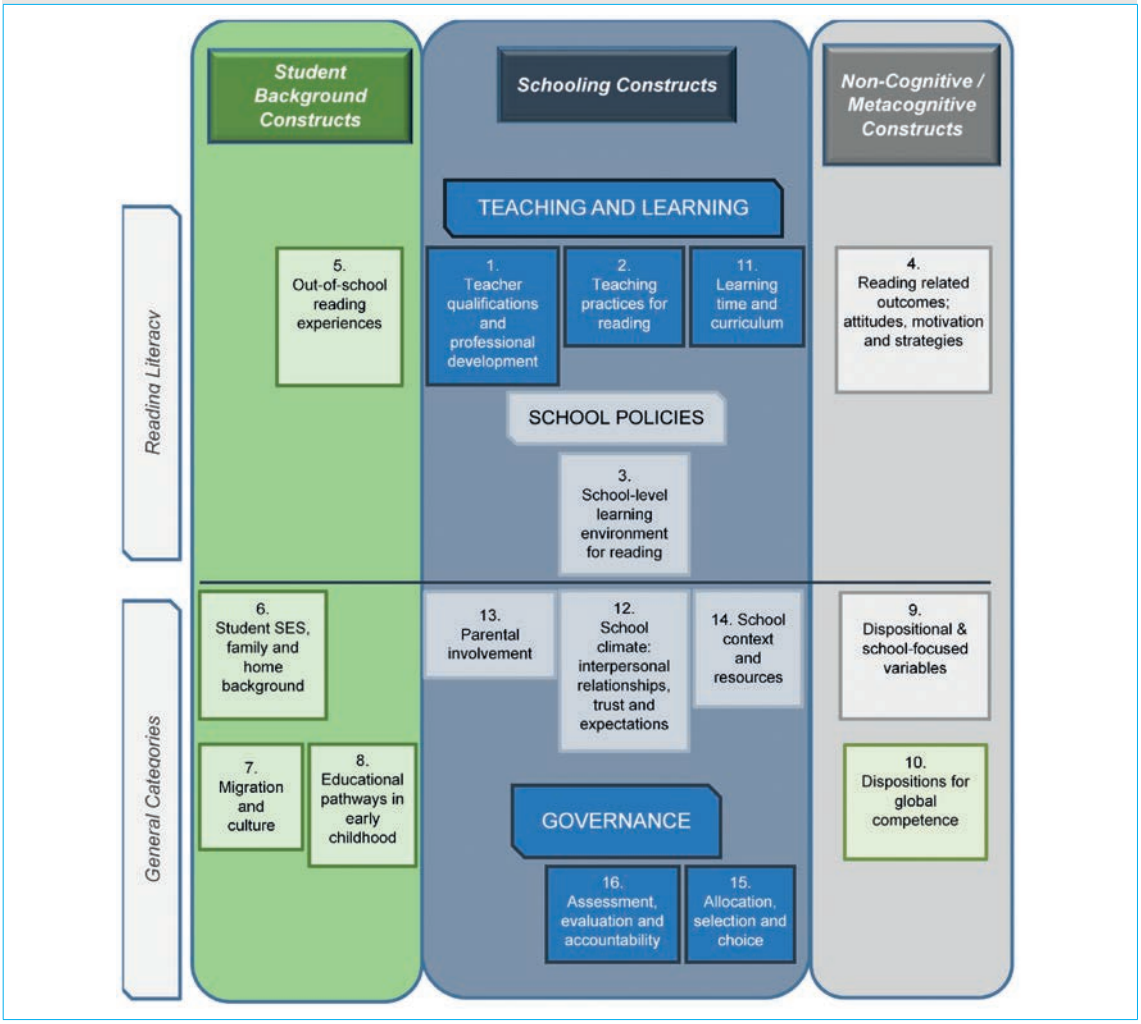
In addition to assessing reading literacy, science and mathematics, PISA collects background information from students, school principals, parents and teachers. This section includes an overview of the questionnaire framework for PISA 2018, with each questionnaire administered in PISA 2018 in Ireland described in more detail. Further information about the PISA questionnaires is available in the PISA 2018 assessment and analytic framework (OECD, 2019a).

6.1.1 The PISA questionnaire framework

A questionnaire framework was developed for PISA 2018 and underpinned the preparation of the international questionnaires. Readers who wish to learn more about the development of the OECD questionnaires can find detail in the PISA 2018 Technical Report (OECD, 2020, in press). The current questionnaire framework was first published in the PISA 2012 cycle and has continued as an overarching structure that allows for continuous monitoring of educational systems across cycles (OECD, 2013: p.189), whilst also allowing for a comparison of domain-specific content (e.g., reading literacy 2009-2018). The emphasis in the framework is on identifying constructs informed by previous PISA cycles and by recent or current literature.

The questionnaire framework for PISA 2018, which is specific to reading, is organised around four major constructs: (1) non-cognitive and metacognitive constructs, (2) student background constructs, (3) teaching and learning constructs, and (4) school policies and governance constructs. These address 16 policy areas (modules) (Figure 6.1).

Figure 6.1: PISA 2018 questionnaire modules



Source: OECD, 2019a: p. 220.

The following section gives a brief explanation of each cluster of constructs.

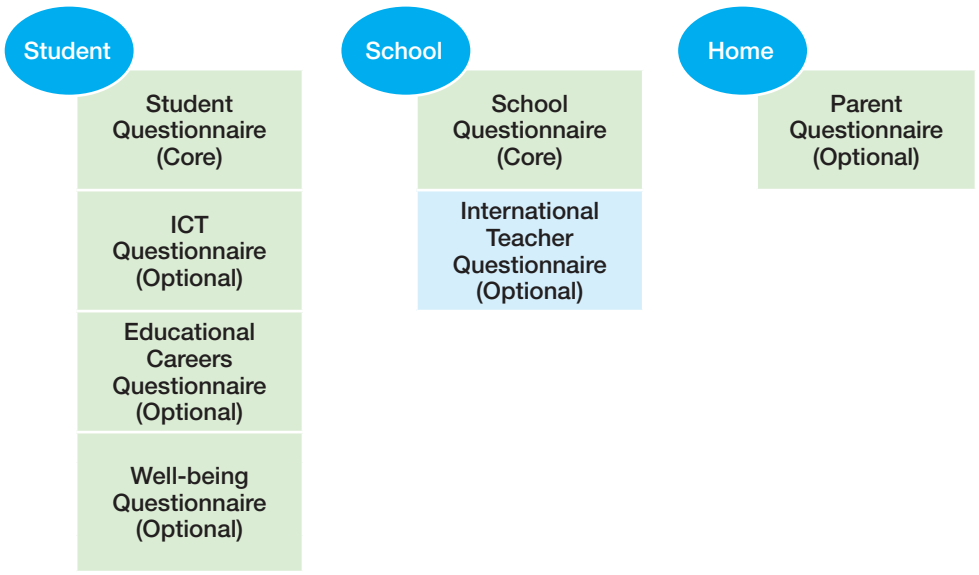
- **Non-cognitive and metacognitive outcomes** – attitudes, beliefs, motivation and aspirations, and learning-related behaviours, such as invested learning time, which are measured via the Student Questionnaire (often with reference to the main assessment domain – reading in 2018). These outcomes can be viewed as important in explaining variation in achievement, and may also be important as outcomes in their own right.
- **Student background factors** – socioeconomic status and immigrant background, as well as variables that contribute to PISA's long-standing measure of economic, social and cultural status (ESCS), an amalgam of parent occupational status, parent education, and an index of home possessions that includes cultural possessions, family wealth, home educational resources, and number of books in the home. PISA uses aggregated (school average) student background variables, such as the proportion of immigrant students in a school, or the average socioeconomic status of the school, to characterise school contexts. PISA also gathers retrospective and prospective information about previous and planned educational pathways and future careers.
- **Teaching and learning** – drawing on teacher effectiveness research, PISA gathers data on core factors associated with teaching, learning and school organisation. The data, which are mainly gathered via the School and Student Questionnaires, focus on teacher qualifications, teaching practices, classroom climate, learning time and learning opportunities provided within and outside the school. In general, questions about teaching and learning relate to the major assessment domain (reading in 2018).
- **School policies and governance** – drawing on school effectiveness research, PISA gathers data on factors associated with teachers' professional development, leadership and school management, parental involvement, school climate (e.g., high achievement expectations), and use of assessment and evaluation for improvement. Also included are school-level supports and resources for teaching the major assessment domain, such as libraries, ICT equipment, and school policies and practices for reading literacy, including multimodal aspects of reading in a digital era.

6.1.2 Overview of international PISA questionnaires

The PISA Questionnaire Framework underpins the questionnaires developed for administration in the 2018 cycle. Each questionnaire draws on various modules in Figure 6.2. The Student and School Questionnaires are core to PISA; all participating countries are required to administer these questionnaires in each cycle. There were five optional questionnaires available to participating countries: three short questionnaires for students (on ICT, Well-being and Educational Careers), and separate questionnaires for teachers and parents (Figure 6.2). The following is a list of all international questionnaires available in 2018:

- Student Questionnaire (Core)
- School Questionnaire (Core)
- Information and Communication Technology (ICT) Familiarity Questionnaire (Optional)
- Educational Careers Questionnaire (Optional)
- Well-being Questionnaire (Optional)
- Parent Questionnaire (Optional)
- Teacher Questionnaire (Optional)

Figure 6.2: Overview of the international PISA questionnaires



Ireland chose to administer all student options and the Parent Questionnaire, but not the Teacher Questionnaire. Each questionnaire included questions (both new and used in previous cycles) authored by the OECD's contractors and a small number of 'national' questions (developed in Ireland by the Educational Research Centre and the PISA National Advisory Committee)[38]. All PISA Student Questionnaires and the School Questionnaire were offered on computer, with the PISA Parent Questionnaire available in both paper and computer formats.

School Questionnaire

The core School Questionnaire is completed by the principal, their nominee or a combination. Topics included were: school background information; school management; teaching staff; assessment and evaluation; targeted groups; and school climate. National questions (administered in Ireland only) asked about student well-being, student attendance/punctuality, and the Literacy and Numeracy Strategy 2011-2020. All participating countries, including Ireland, administered this questionnaire.

Student Questionnaire

The PISA Student Questionnaire was completed on computer by students immediately after they had completed the cognitive tests, and took approximately 35 minutes. The topics included: the student; his/her family and home; students' views about life; students' school experiences; students' school schedule and learning time; learning English in school; types of texts read; amount of reading and use of the Internet; reading-related outcomes; views on reading; and strategies used in reading and understanding texts. All participating countries, including Ireland, administered this questionnaire. Questions related to the optional innovative domain, Global Competence, were administered in

38 See Appendix A for list of members.

69 countries[39]. National questions (administered in Ireland only) included: students' educational expectations; views on examinations and tests; computer use for mathematics; working during term-time; and student experiences related to bullying.

ICT Familiarity Questionnaire

The ICT Familiarity Questionnaire consisted of questions regarding the availability of ICT and the students' use of, and attitudes towards, computers. The questionnaire took approximately ten minutes to complete. Specific questions included: the age at which the student first used a digital device; frequency of Internet usage inside and outside of school on a typical weekday; and frequency of use of digital devices for various purposes at school and outside of school. Several of the questions administered were drawn from previous PISA cycles, allowing for an analysis of trends. Fifty-three participating countries, including Ireland, administered this questionnaire.

Educational Careers Questionnaire

The Educational Career Questionnaire presented questions on different aspects of the students' experience at school as well as their expectations for the future: pre-school education; study time or types of work; and future educational and occupational aspirations. Thirty-two participating countries, including Ireland, administered this questionnaire.

Well-being Questionnaire

The Well-being questionnaire included questions about: student health; relationships (family and friends); time spent with friends; time spent in school; and student participation in physical activity. Nine countries, including Ireland, administered this questionnaire.

Parent Questionnaire

Parents of students selected to participate in PISA 2018 were invited to complete the PISA Parent Questionnaire. Questions focused on a range of topics relevant to students including: family background information; the child's home environment; views on the student's school; interest and enjoyment in reading; interest in political and environmental issues; and the student's educational pathway in early childhood. National questions included: participation in the 'Babies Love Books' Scheme; impact of adverse life events that affected the family in the previous 12 months; financial stress; and students' special educational needs. Seventeen participating countries, including Ireland, administered this questionnaire.

6.1.3 National questionnaires administered as part of PISA 2018

As in previous cycles of PISA, a national questionnaire for teachers related to the main domain (reading literacy) was developed and administered in participating schools. A national Test-taking Behaviour Questionnaire was also administered to students immediately after the cognitive tests.

39 Countries that included at least one question related to Global Competence in the core Student Questionnaire.

National Questionnaire for Teachers of Junior Cycle English

The National Questionnaire for Teachers of Junior Cycle English, which presented questions about the teaching and learning of English at school level, was available only in a paper-based version. All Junior Cycle English Teachers in participating schools were invited to return a completed questionnaire. The questionnaire included a wide range of questions, and was developed by the ERC in conjunction with members of the National Advisory Committee. Topics included types of materials used in class, frequency of ICT use by students in class, teacher satisfaction, and assessment practices in Junior Cycle English classes. Questions also related to the skills and processes relevant to reading literacy, the implementation of the new Junior Cycle English Specification, and teacher views on the National Strategy to Improve Literacy and Numeracy, 2011-2020.

Test-taking Behaviour Questionnaire

This short paper-based questionnaire was administered to students in Ireland immediately after they had completed the PISA cognitive assessment, and before they were asked to complete the Student Questionnaire. This questionnaire, first developed and administered as part of PISA 2012, was updated for PISA 2018 to generate additional contextual information about students' experience of sitting the assessment. It includes questions on how students felt before taking the PISA test, how well they concentrated during the test, how easy or difficult they found the test, their interest in the test, the level of effort they expended, and strategies they used if they were unsure of the answer to a question. Students were also asked whether they had had sufficient time to take the test, and whether they had ever done a test on computer before they took the PISA test.

This chapter draws on a subset of the available questionnaire data, guided by current national educational policy, including the revised targets under the Literacy and Numeracy Strategy 2011-2020 (DES, 2017b), the Digital Strategy for Schools 2015-2020 (DES, 2015a), and the Well-being Policy Statement and Framework for Practice 2018-2023 (DES, 2019b). Each of these policies and strategies feature in the Department of Education and Skill's Action Plan for Education 2016-2019 and were briefly outlined in Chapter 2.

6.2 Student Reading Engagement and Use of Strategies

Detailed information about students' engagement in and attitudes towards reading, and their awareness and use of reading and learning strategies, was obtained in PISA 2018. These data had also been gathered in the 2009 cycle, when reading literacy was last a major domain. In this section, we relate these characteristics to student achievement and make comparisons with the 2009 cycle. The section is divided into two parts: engagement in reading and reading and learning strategies.

6.2.1 Engagement in reading

In this section, three indicators of reading engagement are examined: frequency of reading for enjoyment, level of enjoyment of reading and diversity of reading materials.

Frequency of Reading for Enjoyment

Students were asked to indicate how much time they usually spend reading for enjoyment each day.[40] In Ireland, 47.7% reported that they don't read at all for enjoyment, while 13.2% stated that they read for at least one hour a day (Table 6.1). Students who did not read at all for enjoyment had a mean score in reading (484.1) that was significantly lower than that of students who read for up to 30 minutes day (539.4). Students who reported that they read for between 30 minutes and an hour (552.5) and for more than one hour (571.0) had significantly higher mean reading scores than students who indicated that they read for up to 30 minutes a day (Table 6.1). In 2018, there was a statistically significant 18.5-point difference between students who read for more than an hour a day and students who read for between half an hour and one hour. In 2009, a 10-point difference between students in these categories was not statistically significant, which at the time suggested that there is a ceiling effect associated with the amount of time spent reading, where the association between time spent reading and reading performance was concerned.

Table 6.1: Percentage of students in Ireland reading for enjoyment and their mean reading achievement scores, in 2009 and 2018

	2018				2009 (print)			
	%	SE	Mean	SE	%	SE	Mean	SE
I do not read for enjoyment	47.7	(1.0)	**484.1**	(2.2)	41.9	(1.0)	**457.6**	(3.5)
30 minutes or less a day (Ref)	23.9	(0.7)	539.4	(3.1)	26.0	(0.7)	505.4	(3.9)
30-60 minutes a day	15.1	(0.6)	**552.5**	(2.9)	16.3	(0.7)	**540.1**	(3.8)
More than 1 hour a day	13.2	(0.5)	**571.0**	(4.0)	15.8	(0.7)	**550.1**	(3.9)

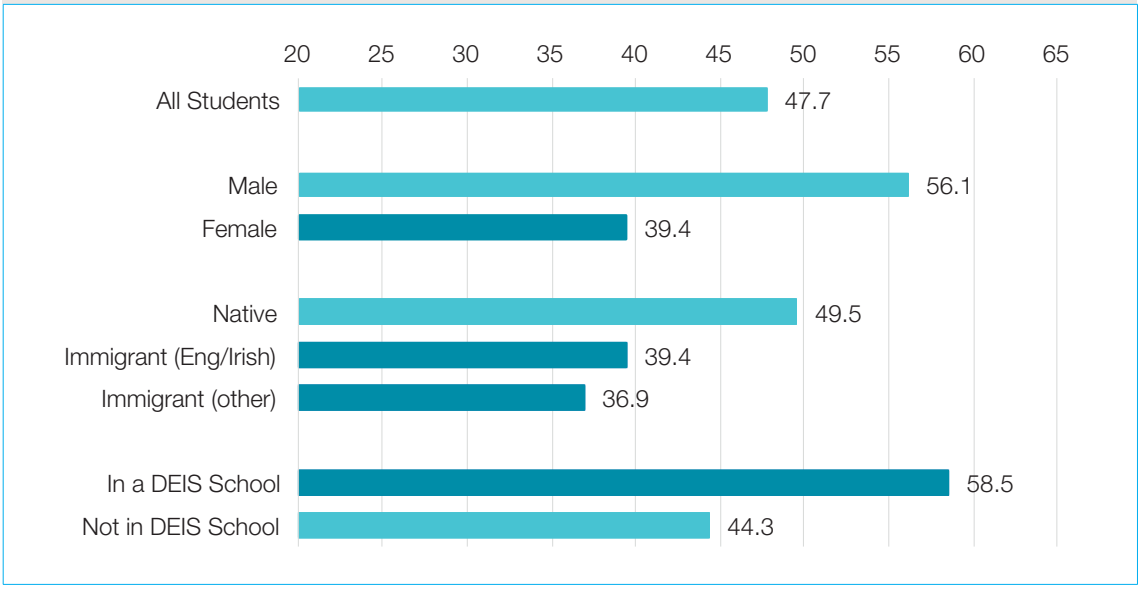
Note: Reading scores of students that differ significantly from the reference group (30 minutes or less a day) are in **bold** in the 'mean' column.

Since the first cycle of PISA, there has been a substantial and significant increase in the percentage of students in Ireland who did not read for enjoyment, from 33.4% (2000) to 41.9% (2009) to 47.7% in 2018 (See E-Appendix Table A6.1). In addition, there has been a significant decrease in the percentage of students in Ireland reading for more than 1 hour per day in 2018 compared to 2009 (13.2% and 15.8% respectively, see E-Appendix Table A6.1).

Considering some group differences, significantly more males (56.1%) than females (39.4%) in Ireland reported that they did not read for enjoyment (Figure 6.3). The mean reading score of females who did not read for enjoyment (491.8) is significantly higher than the mean of non-reading males (478.7), in line with the overall gender difference in reading (see Chapter 3). This is also the case for students who read for 30 minutes or less a day, where the mean reading score for female students is significantly higher than for male students. However, the mean reading scores of females who read for '30-60 minutes a day' or 'more than 1 hour a day' are not significantly different from males in the corresponding reading for enjoyment categories (see E-Appendix Table A6.2).

40 Students were asked to take into account diverse kinds of reading, such as books, magazines, newspapers, websites, blogs, emails, etc.

Figure 6.3: Percentages of students who report not reading enjoyment, by gender, immigrant/ language status, and DEIS status, in PISA 2018



See E-Appendix Table A6.3 (Significant differences are shown by **darker** bars).

There were statistically significant differences between the percentages of native speakers (49.5%) who did not read for enjoyment and immigrant speakers of English or Irish (39.4%), and between native speakers and immigrant speakers of other languages (36.9%)[41] who did not read for enjoyment (see E-Appendix Table A6.3). Significantly more students in DEIS schools (58.5%) than students in non-DEIS schools (44.3%) reported that they did not read for enjoyment.

Level of Enjoyment of Reading

Students were asked to indicate their level of agreement with five statements related to enjoyment of reading. In 2018, 30.8% agreed or strongly agreed that 'Reading is one my favourite hobbies', while a similar percentage agreed that they liked to talk to others about books (33.5%) (Table 6.2). Slightly over half of the students reported that they 'read only to get information' and a similar percentage (51.5%) agreed or strongly agreed that they 'read only if I have to'. In comparison to 2009, the percentage of students who reported only reading because they have to rose significantly from 39.2% to 51.5% in 2018 (Table 6.2). There were also significant increases in the percentages of students reporting that they 'read only to get information that I need' (44.9% in 2009 and 52.0% in 2009) and that 'for me, reading is a waste of time (24.1% in 2009 and 26.8% in 2018). Differences on the other two items are not statistically significantly different across 2009 and 2018.

41 Students are considered 'native' if they, and at least one parent, were born in the test country. Here, the indicator of students' immigrant background status is combined with an indicator of the language spoken in their home.

Table 6.2: Percentages of students who 'agree' or strongly agree' with various statements about their enjoyment of reading, 2009 and 2018

	2018		2009 (Ref)	
	%	SE	%	SE
I read only if I have to	**51.5**	(0.9)	39.2	(1.0)
Reading is one of my favourite hobbies	30.8	(0.6)	31.7	(0.9)
I like talking about books with other people	33.5	(0.7)	34.7	(1.1)
For me, reading is a waste of time	**26.8**	(0.8)	24.1	(0.9)
I read only to get information that I need	**52.0**	(0.9)	44.9	(1.1)

Significant differences between the two cycles in **bold**.

Female students had significantly higher rates of agreement than males for positively-worded statements about reading (e.g. 'Reading is one of my favourite hobbies' and 'I like talking about books with other people' and significantly lower rates for negatively-worded statements (e.g., 'I read only if I have to' and 'for me, reading is a waste of time'). This pattern of female students in Ireland liking and engaging with reading in a positive manner was also evident in 2009 (see E-Appendix Table A6.4).

A composite index of enjoyment of reading was constructed by the OECD, based on the statements in Table 6.2. The mean score for Ireland on the index was -0.07, indicating slightly below-average enjoyment of reading as Ireland's mean score is below the OECD average, but not significantly so (see E-Appendix A6.5). Males' enjoyment of reading is significantly below that of females in Ireland (-0.34 and 0.19 respectively), by just over half a standard deviation on this index. The same pattern can be seen on average across all OECD countries (see E-Appendix Table A6.5). On average across OECD countries, female students reported greater enjoyment of reading than did females in Ireland (0.24 compared to 0.19); the difference is statistically significant.

Diversity of Reading Materials

A key development in the reading framework for 2018 (see Chapter 3) is the recognition of the importance of digital texts, bringing together reading of traditional texts and new forms of reading associated with digital texts. Students were asked to indicate the most common format in which they read books, on any topic. One-third of students in Ireland (33.7%) reported that they read books more often in paper format and only 12.0% said that they read books more often on digital devices (e.g., e-reader, tablet, smartphone and computer) (Table 6.3). The mean reading score for those students who rarely or never read books (478.7) is significantly lower than for students who read in other formats or combinations of formats.

Table 6.3: Percentages of students in Ireland reading books in various formats and their mean reading score, all students and by gender

	All Students				Males (ref.)				Females			
	%	SE	Mean	SE	%	SE	Mean	SE	%	SE	Mean	SE
I rarely or never read books. (ref.)	40.7	(0.8)	478.7	(2.5)	48.6	(1.1)	472.9	(3.0)	32.8	(1.0)	**487.2**	(3.3)
I read books more often in **paper** format.	33.7	(0.9)	**561.4**	(2.5)	29.8	(1.1)	558.5	(4.0)	37.6	(1.1)	563.8	(2.8)
I read books more often on **digital** devices (e.g. e-reader, tablet, smartphone and computer).	12.0	(0.4)	**511.3**	(3.5)	11.8	(0.6)	507.6	(5.4)	12.2	(0.7)	514.9	(3.8)
I read books equally often in **paper** format and on **digital** devices.	13.7	(0.4)	**541.8**	(3.9)	9.9	(0.6)	523.0	(6.7)	17.4	(0.7)	**552.4**	(4.7)

Significant differences in **bold**; in the column 'all students', the reference category is 'I rarely or never read books'; 'males' is the reference category for the difference across genders.

Comparing mean reading scores of students who read more often in paper format (561.4) and those who read more often on digital devices (511.3), the mean score for the latter is about 50 points lower. There is no significant difference between male and female students' mean reading scores when comparing those who read books more often in paper format or more often on digital devices. Females who read books equally often in paper format and on digital devices have a significantly higher mean reading score than males who reported reading books equally often on paper and digitally (552.4 and 523.0 respectively).

6.2.2 Reading and learning strategies

Metacognition, an awareness of and ability to use appropriate strategies when engaging with texts, is especially relevant when considering student performance in reading literacy. As noted in Chapter 3, metacognition, mentioned briefly in the first framework in 2000, has featured more prominently since then due to recent research underlying its importance (OECD, 2019a). In this section, students' awareness of three reading strategies are described. Two of these strategies were examined using scenarios from PISA 2009 (see below): understanding and remembering, and summarising. In PISA 2018, a new metacognition scenario focused on the assessment of the quality and credibility of sources.

Understanding and Remembering

Students were asked to evaluate the extent to which they found a range of strategies to be useful for understanding and remembering information in texts, using a 6-point scale ranging from 'not

useful at all' to 'very useful'. Table 6.4 gives the percentages of students rating each strategy as 'very useful'.

The most strongly-endorsed strategies by students in Ireland when understanding and remembering a text were 'underlining important parts in the text' (53.0%) and 'summarising the text in my own words' (49.3%). Strategies such as 'I read the text aloud to another person' (20.1%) and 'I read quickly through the text twice' (22.9%) were less strongly endorsed. Female students assigned higher ratings than males to the two key strategies of 'underlining important parts in the text' and 'summarising the text in my own words'. Females were also significantly more likely than males to regard reading a text and discussing it with other people as a useful strategy for understanding and remembering.

Table 6.4: Percentages of students in Ireland indicating that they find various understanding and remembering strategies for reading and understanding a text 'very useful', all students and by gender

	All Students		Males (ref.)		Females	
	%	SE	%	SE	%	SE
I concentrate on the parts of the text that are easy to understand.	24.4	(0.6)	22.4	(0.9)	**26.3**	(0.9)
I quickly read through the text twice.	22.9	(0.7)	23.2	(1.0)	22.5	(0.9)
After reading the text, I discuss its content with other people.	28.1	(0.6)	24.4	(1.0)	**31.7**	(0.8)
I underline important parts of the text.	53.0	(0.7)	43.6	(1.0)	**62.2**	(1.0)
I summarise the text in my own words.	49.3	(0.8)	44.1	(1.0)	**54.4**	(1.2)
I read the text aloud to another person.	20.1	(0.6)	15.0	(0.7)	**25.0**	(0.8)

Note: 'Very useful' is defined here as 5/6 on a 6-point Likert-type scale, where 1 is not useful at all. Significant gender differences are in **bold** in the 'females' column.

An index of understanding and remembering was constructed by the OECD drawing on students' ratings of strategy usefulness. The mean score for Ireland was 0.05, which is slightly but significantly above the OECD average of -0.01, indicating somewhat stronger recognition of more effective strategies by students in Ireland. Students in United Kingdom has a score of 0.19, while students in the United States had a score of -0.05 indicating, respectively, higher and lower average awareness of effective strategies (see E-Appendix Table A6.6).

In 2009, 'underlining important parts in the text' (65.4%) and 'summarising the text in my own words' (62.6%) were more strongly endorsed in Ireland than in 2018 (53.0% and 49.3% respectively). While the strategy to 'read quickly through the text twice' was less strongly endorsed in both cycles, 2018 saw a large increase in the percentage of students favouring this strategy, 22.9% in 2018 compared to 14.0% in 2009 (see E-Appendix Table A6.7).

Summarising Information

Students were asked to evaluate the extent to which they found various strategies useful for summarising a piece of informational, fact-based text (Table 6.5). Higher-order strategies such as 'I read through the text, underlining the most important sentences. Then I write them in my own words as a summary' (57.3%) and 'I carefully check whether the most important facts in the text are represented in the summary' (58.7%) were more strongly endorsed than lower-order strategies, such as 'I try to copy out accurately as many sentences as possible' (13.0%) and 'before writing the summary, I read the text as many times as possible' (28.7%).

Females were more likely than males to endorse higher-level summarisation processes (e.g., carefully checking whether the most important facts in a text are represented in the summary). However, more females than males also endorsed what may be considered to be a lower order strategy – reading the text as many times as possible before writing a summary.

Table 6.5: Percentages of students in Ireland indicating that they find various strategies for summarising a text 'very useful', all students and by gender

	All Students		Males (ref.)		Females	
	%	SE	%	SE	%	SE
I write a summary. Then I check that each paragraph is covered in the summary, because the content of each paragraph should be included.	26.2	(0.7)	25.1	(1.0)	27.2	(1.1)
I try to copy out accurately as many sentences as possible.	13.0	(0.5)	12.8	(0.6)	13.3	(0.7)
Before writing the summary, I read the text as many times as possible.	28.7	(0.7)	23.9	(0.8)	**33.4**	(1.1)
I carefully check whether the most important facts in the text are represented in the summary.	58.7	(0.8)	50.7	(1.1)	**66.6**	(1.0)
I read through the text, underlining the most important sentences. Then I write them in my own words as a summary.	57.3	(0.7)	47.4	(0.9)	**67.0**	(1.1)

Note: 'Very useful' is defined here as 5 or 6 on a 6-point Likert-type scale, where 1 is not useful at all. Significant gender differences are in **bold** in the 'females' column

A composite index of summarising strategies was constructed by the OECD with a mean score of 0.0 and a standard deviation of 1. The mean score for Ireland was 0.10, which is significantly above the OECD average (0.00), while students in Korea had a score of -0.20, indicating lower average awareness of effective summarising strategies (see E-Appendix Table A6.6).

Compared to 2009, Irish students in 2018 are less likely to endorse the higher-level strategies, with significant gender differences present for the same three strategies (see E-Appendix Table A6.8). In 2009, 'I read through the text, underlining the most important sentences. Then I write them in my own words as a summary' (72.5%) and 'I carefully check whether the most important facts in the text are represented in the summary' (68.9%) were more strongly endorsed than in 2018 (57.3% and 58.7% respectively). The lower order strategies of 'trying to copy out accurately as many sentences as possible' and 'before writing the summary, I read the text as many times as possible' were less strongly endorsed in both 2009 and 2018. Differences between males and females in 2009 were similar to those observed in 2018, with females in Ireland more strongly endorsing the higher order strategies than males (see E-Appendix Table A6.8).

Assessing Credibility of Sources

A new metacognition scenario introduced in PISA 2018 focused on an important process of online reading – the quality and the credibility of sources. Students were asked to evaluate the appropriateness of various strategies for assessing the credibility of an email. Strategies such as 'Check the sender's email address' and 'Check the website of the mobile phone operator to see whether the smartphone offer is mentioned' were more strongly endorsed than strategies such as 'Click on the link to fill out the form as soon as possible' and 'Answer the email and ask for more

information about the smartphone' (Table 6.6). Females were significantly more likely than males to endorse 'Check the sender's email address' (62.9% of females compared to 53.2% of males), 'Check the website of the mobile phone operator to see whether the smartphone offer is mentioned' (59.2% of females compared to 52.9% of males) and 'Delete the email without clicking on the link' (35.8% of females compared to 31.5% of males).

Table 6.6: Percentages of students in Ireland indicating that they find various strategies for assessing the credibility of an email 'very appropriate', by all students and by gender

	All Students		Males (ref.)		Females	
	%	SE	%	SE	%	SE
Answer the email and ask for more information about the smartphone	21.7	(0.6)	21.0	(0.9)	22.4	(0.9)
Check the sender's email address	58.1	(0.8)	53.2	(1.2)	**62.9**	(0.9)
Click on the link to fill out the form as soon as possible	10.6	(0.4)	10.0	(0.6)	11.2	(0.4)
Delete the email without clicking on the link	33.7	(0.8)	31.5	(1.0)	**35.8**	(0.9)
Check the website of the mobile phone operator to see whether the smartphone offer is mentioned	56.1	(0.8)	52.9	(1.1)	**59.2**	(1.1)

Note: 'Very appropriate' is defined here as 5 or 6 on a 6-point Likert-type scale, where 1 is not appropriate at all. Significant gender differences are in **bold** in the 'females' column.

A composite index of assessing credibility of information strategies was constructed by the OECD with a mean score of 0.00 and a standard deviation of 1. The mean score for Ireland was 0.21, which is significantly above the OECD average (0.01). The United Kingdom and Finland also scored relatively high on the index (0.29 and 0.19, respectively), while students in Korea scored below the OECD average (-0.30) (See E-Appendix Table A6.6).

6.3 Use of Digital Technology

The section examines students' familiarity with digital technology and its relationship to overall achievement scores. It also examine students' use of digital technology during class time. This is followed by the principals' reports on the use of digital technology in enhancing teaching and learning in the school.

6.3.1 Students' familiarity with, and use of, digital technology

The nationally-developed Test-taking Behaviour Questionnaire focussed on the student experience of taking the PISA test. Table 6.7 presents the percentages of students who had taken a computer-based test at least once prior to the PISA 2018 assessment and their mean achievement scores for reading, science and mathematics. The findings underline Irish students' relatively low familiarity with computer-based assessment, with only 46.5% of students having taken a test on computer prior to PISA 2018. In PISA 2015, slightly fewer students reported having taken a test on computer in the year of the PISA assessment (42.8%). However, the difference between 2015 and 2018 is not significant.

Table 6.7: Mean scores of students in Ireland on reading, science and mathematics by computer-based test experience prior to participating in PISA, 2015-2018

		Reading		Science		Mathematics	
	%	Mean	SE	Mean	SE	Mean	SE
2015							
Yes, at least once	42.8	526.2	(3.1)	**510.0**	(3.1)	**510.0**	(2.9)
No, never (ref)	57.2	519.7	(2.8)	499.8	(2.6)	501.2	(2.3)
2018							
Yes, at least once	46.5	521.7	(3.22)	500.0	(3.0)	502.5	(3.0)
No, never (ref)	53.5	517.2	(2.46)	494.9	(2.5)	499.1	(2.2)

Significantly different mean scores are in **bold** (in comparison to the reference group).

In 2018, the average reading score of those who had taken a test on computer before was 521.7, which was higher but not significantly different to the average reading score (517.2) of students who had never sat a computer-based test prior to the PISA 2018 assessment. This pattern is the same for science and mathematics, with higher, but not significantly different mean scores for students who had previously taken a test on computer compared with those who had not. Examining students' familiarity with computer-based assessment in PISA 2015, there are significant differences in both the overall mean science and mathematics scores between students who had and had not taken a test on computer prior to the PISA assessment. Students who had taken a test on computer prior to PISA 2015 had a mean mathematics score of 510.0 compared to 501.2 for students who had no computer-based testing experience. The corresponding scores for science in PISA 2015 were 510.0 and 499.8 respectively.

The ICT Familiarity questionnaire presented students with a list of subjects and they were asked to indicate how much time they spend in a typical school week using digital devices during school class time in those subjects. Table 6.8 presents the percentage of time spent using digital devices during class time for four subjects. In Ireland, among students studying science, 36.6% reported that they spent at least some time using digital devices during their science class, compared to 51.5% of students on average across OECD[42] countries.

Approximately one-third of the students studying English[43] reported that they spent at least some time using digital devices during their English class compared with 48.1% on average across OECD countries. In relation to mathematics class, 30.0% of students in Ireland reported the use of digital devices compared to 41.2% for students on average across the OECD. Looking at the relationship between achievement and the frequency of digital device use reported by students in English, mathematics and science classes, students in Ireland who reported using digital devices more than 30 minutes a week achieved significantly higher overall mean scores on PISA reading and PISA science than students using digital devices for 1-30 minutes, and those who did not use them at all. Students with more than 30 minutes use per week in mathematics classes had a slightly higher mean score on PISA mathematics, but this did not different significantly from the mean scores of those using devices for 1-30 minutes, and those not using them at all (See E-Appendix, Table A6.9).

42 53 countries/economies, including Ireland, administered the ICT Familiarity questionnaire

43 Some students sat the PISA assessment in Irish (76); for students who opted to sit the test in Irish, reading literacy is presented in English, while mathematics and science are presented in Irish.

Table 6.8: Percentage of time spent by students using digital devices during classroom lessons in a typical school week, in Ireland and on average across OECD countries

Time spent using digital devices **during classroom lessons** in a typical school week:	Students who take					
	English class*		Mathematics class		Science class	
	%	SE	%	SE	%	SE
Ireland						
No time	66.8	(1.3)	70.0	(1.4)	63.4	(1.5)
1-30 minutes a week	19.7	(0.8)	15.7	(0.7)	21.0	(0.8)
More than 30 minutes a week	13.5	(0.9)	14.3	(1.0)	15.6	(1.0)
OECD	**Test language class**		**Mathematics class**		**Science class**	
No time	51.9	(0.2)	58.8	(0.2)	48.5	(0.2)
1-30 minutes a week	23.6	(0.1)	20.9	(0.1)	24.4	(0.1)
More than 30 minutes a week	24.5	(0.2)	20.3	(0.2)	27.1	(0.2)

*For the international variable English and Irish classes were mapped onto one variable (use of digital devices in test language classes)

A composite index was created by the OECD that combined students' reports of time spent using digital devices during school classes (with a mean OECD score of 0.00 and a standard deviation of 1). The mean score for Ireland was -0.37, which is significantly and substantially below the OECD average, indicating lower use of ICT for subjects during class-time compared to the average for OECD countries (see E-Appendix Table A6.10). The OECD also created a composite index based on students' reports of time spent using digital devices for subjects outside of school classes (this could be at home or in school). The mean score for Ireland was -0.30, which again was significantly below the OECD average, indicating lower use of ICT for subjects outside of class-time in Ireland compared to countries on average across the OECD.

The ICT Familiarity questionnaire presented a further set of questions with the same list of subjects to the students asking them to indicate who used digital devices in the last month. Table 6.9 presents the percentages of students studying English, mathematics and science indicating whether students or teachers used the digital devices during class time. Considering overall use of devices, students reported greater use of devices in English class (80.5%) by students and/or teachers. Slightly lower use of digital devices was reported in mathematics (72.4%) and science (76.0%) classes.

In general, across all the three subjects, it was mainly the teacher who used the digital devices for teaching. The percentages of students who reported that digital devices were used but only by the teacher, ranged from 48.3% of students studying science to 52.5% of students studying English. Across all subject areas, approximately one in five students reported that both the teacher and student used digital devices during classes, with students in English class reporting the highest joint use at 23.0%, compared to 19.3% representing the lowest reported joint use of digital devices in mathematics classes.

Table 6.9: Percentage of students reporting ways in which digital devices were used for teaching and learning during class by subject area, in Ireland and on average across OECD countries

*Within the last month, has a digital device been used for **learning or teaching during class***	Students who take					
	English Class		Mathematics Class		Science Class	
	%	SE	%	SE	%	SE
Ireland						
Yes, both the **teacher and students** used it	23.0	(1.3)	19.3	(1.4)	22.1	(1.4)
Yes, but only **students** used it	5.0	(0.4)	4.7	(0.3)	5.6	(0.4)
Yes, but only the **teacher** used it	52.5	(1.3)	48.4	(1.4)	48.3	(1.5)
Not used	19.5	(0.7)	27.6	(1.0)	24.0	(0.9)
OECD						
Yes, both the **teacher and students** used it	37.4	(0.2)	28.9	(0.2)	33.4	(0.2)
Yes, but only **students** used it	11.5	(0.1)	10.9	(0.1)	11.5	(0.1)
Yes, but only the **teacher** used it	24.6	(0.2)	24.6	(0.2)	30.1	(0.2)
Not used	26.5	(0.2)	35.5	(0.2)	25.1	(0.2)

Table 6.9 also presents a comparison of digital device usage for teaching or learning during class in Ireland and across OECD countries/economies. Comparing device use on average across the OECD to use in Ireland, there was a higher reported rate of device-free classes on average across the OECD. Teacher-only use was the most frequently reported type of digital device use in Ireland; students in Ireland reported double the rate of teacher-only use during English classes, compared to the average across OECD countries (52.5% in Ireland compared to 24.6% on average across the OECD). On the other hand, use of digital devices for learning or teaching during English classes by both teachers *and* students was the most frequently-reported type of use on average across the OECD countries (37.4%) compared to Ireland (23.0%).

Examining the relationship between digital device use for teaching and learning during class and student performance in reading, mathematics and science in Ireland, there were statistically significant differences between no use and the categories of teacher-only and student-only use (see E-Appendix Table A6.11). There was no significant difference reported between joint use (teacher and student) and no use for student performance on PISA 2018 reading, mathematics and science. Student-only use was related to lower performance on all three domains in 2018; for example, on reading literacy, students reporting student-only use of digital devices in English class achieved a mean score of 470.9, compared to 504.5 for not used. In Ireland, the highest mean score on reading literacy (539.2) was associated with teacher-only use of digital devices.

A national question[44] was added to the ICT familiarity questionnaire on time spent using digital devices on a normal school day. Table 6.10 presents the frequencies, reported by students. Over one-third of students did not play computer games on a normal school day, while almost half of all students (49.3%) reported spending up to three hours per day playing computer games.

Almost one-quarter of students in Ireland (23.3%) reported that they did not use digital devices for homework completion on a normal day. A different pattern of use was reported for interacting on

44 As a national question, there is no international comparison available.

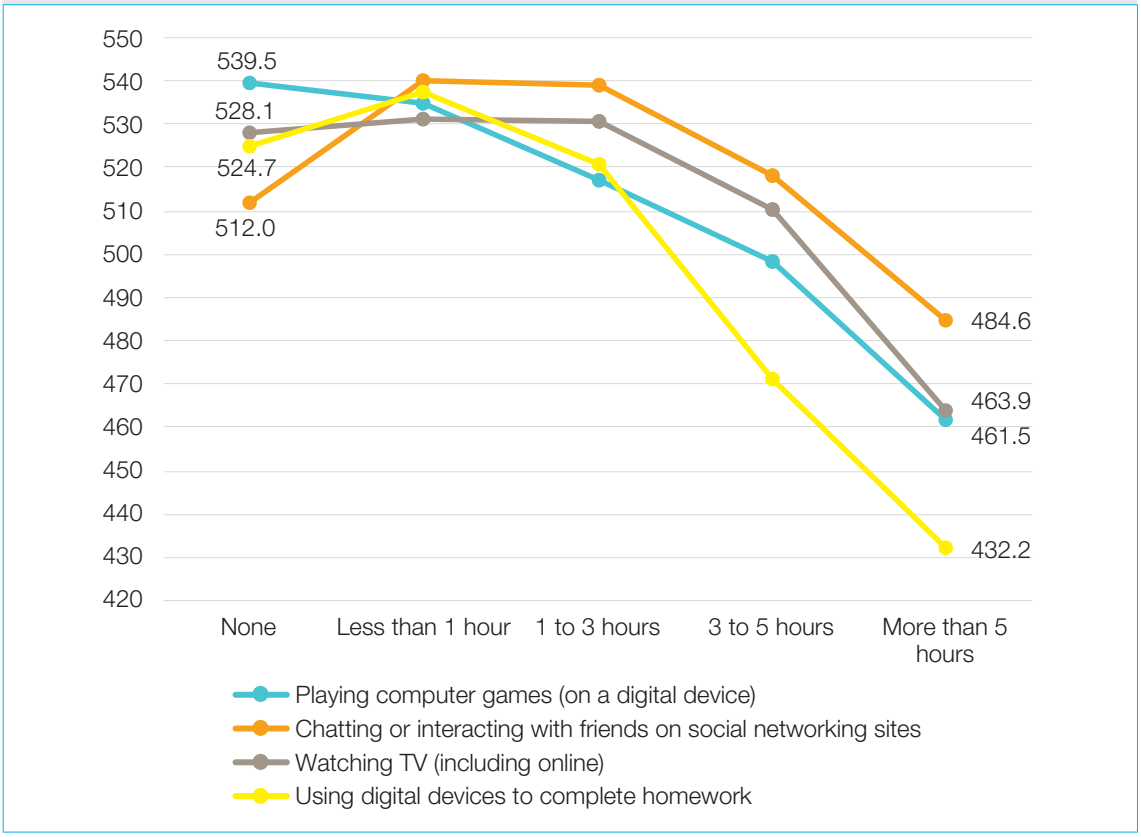
social media and for watching TV, with about 4 in 10 students reporting one to three hours spent on social media and a similar proportion reporting that they watched TV, on a normal school day. More than one in eight students reported very high social media interaction of more than 5 hours on a normal school day (16.3%). Frequency of TV watching was at a more moderate level, with fewer students (5.4%) reporting more than 5 hours of time spent watching TV on a normal school day.

Table 6.10: Frequency of time spent using digital devices on a normal school day (selected activities)

On average, how much time do you spend on the following activities...	None		Less than 1 hour		1 to 3 hours		3 to 5 hours		More than 5 hours	
	%	SE	%	SE	%	SE	%	SE	%	SE
Playing computer games (on a digital device)	35.9	(0.7)	25.1	(0.7)	24.2	(0.7)	9.0	(0.5)	5.8	(0.4)
Chatting or interacting with friends on social networking sites	4.6	(0.4)	19.2	(0.7)	38.5	(0.9)	21.5	(0.6)	16.3	(0.7)
Watching TV (including online)	9.9	(0.4)	32.6	(0.8)	41.0	(0.8)	11.1	(0.5)	5.4	(0.4)
Using digital devices to complete homework	23.3	(0.9)	47.1	(0.9)	22.5	(0.8)	4.5	(0.4)	2.6	(0.2)

Figure 6.4 presents the amount of time spent on various activities, as reported by students, by overall performance on reading literacy. Patterns of time spent using digital devices by students in Ireland indicate that moderate or lower levels of use are related to higher student performance on PISA reading literacy.

Figure 6.4: Time spent using digital devices on a normal school day by reading achievement (selected activities)



See E-Appendix Table A6.12.

Students who don't play computer games or play them for less than an hour a day achieved significantly higher scores on reading literacy than students with higher levels of usage - 539.5 and 535.0 score points respectively, compared to 517.3 for 1 to 3 hours of use, 498.6 for 3 to 5 hours of use, and 461.5 for more than 5 hours of use on a normal school day. Students who spent more than three hours watching TV (including online) had significantly lower reading performance that students who watched less television, or none at all. For interacting with friends on social media, students with moderate levels of activity (up to 3 hours of use) had significantly higher performance on reading, compared to no use or to the highest levels of social media activity.

6.3.2 Enhancing teaching and learning through technology – principals' perspective

School principals were asked to report to what extent they agreed or disagreed with 11 statements about their school's capacity to enhance learning and teaching using digital technology. Digital technology was defined as including a range of different digital devices, such as desktop computers, laptops, notebooks, tablets, and interactive whiteboards (IWBs). For analysis purposes, the statements presented to the principals have been grouped into three broad categories: digital devices; other digital resources; and teacher technological skills and time. In this section, principals' responses of 'agree' and 'strongly agree' are combined into one category, 'agree'.

Digital Devices

Table 6.11[45] shows the four statements presented to principals regarding the availability of devices. Only 56.5% of the students attended a school where the principal reported that the number of digital devices connected to the Internet was sufficient to support the school's capacity to enhance teaching and learning, and even fewer were in schools in which the principal agreed that the number of digital devices for instruction was sufficient (45.3%). Approximately three-quarters of students attended a school where the principal agreed that the school's Internet bandwidth or speed was sufficient and a slightly lower percentage (73.2%) were in schools where the principal agreed that digital devices were sufficiently powerful in terms of computing capacity.

Table 6.11 also compares digital device capacity in schools in Ireland with the average across OECD countries. A higher percentage of students in Ireland compared to the OECD average attend a school where the principal reported that they have sufficiently powerful devices (73.2%, compared to 68.5%) and sufficiently fast Internet broadband (75.9%, compared to 67.5% across OECD countries). Approximately 56% of students in Ireland attended a school where the where the principal reported a sufficient number of devices connected to the Internet; however this is below the average across OECD countries (67.2%). Similarly, 45.3% percent of students in Ireland attend a school where the principal reported a sufficient number of digital devices for instruction, which is well below the average across OECD countries (59.0%).

45 All the data in the tables presented in section 6.3.2 have been weighted by the student weight.

Table 6.11: Percentage of students' whose principals 'agree' on the school's capacity to enhance learning and teaching with digital devices and technology, in Ireland and on average across OECD countries

Schools capacity to enhance learning and teaching using digital technology?	Ireland		OECD	
	%	SE	%	SE
Digital devices				
The number of digital devices connected to the Internet is sufficient	56.5	(3.9)	67.2	(0.5)
The school's Internet bandwidth or speed is sufficient	75.9	(3.8)	67.5	(0.5)
The number of digital devices for instruction is sufficient	45.3	(4.1)	59.0	(0.5)
Digital devices are sufficiently powerful in terms of computing capacity	73.2	(3.7)	68.5	(0.5)

Other Digital Resources

Table 6.12 presents percentages of the students attending schools whose principal teacher agreed with statements about the school's capacity to enhance learning and teaching with digital resources. Just over 70% of students in Ireland attended a school where the principal agreed that 'adequate software is available', while 47.4% attended a school where the principal agreed that 'effective professional resources for teachers to learn how to use digital technology are available' and a similar percentage agreed that an 'effective online learning support platform is available' (45.4%) (Table 6.12).

In comparison to Ireland, a similar percentage of students attended schools across the OECD on average (71.3%) where the principal agreed that adequate software is available. However, in relation to the availability of an online learning support platform and professional resources on how to use and integrate digital technology, higher percentages of students attended schools where principals reported access is adequate across OECD countries on average, 54.1% and 64.7% respectively, compared to 45.4% and 47.4% in Ireland.

Table 6.12: Percentage of students' principals reporting they 'agree' on the school's capacity to enhance learning and teaching with reference to resources, in Ireland and on average across the OECD

School's capacity to enhance learning and teaching using digital technology?	Ireland		OECD	
	%	SE	%	SE
Resources				
Adequate software is available	71.9	(3.9)	71.3	(0.5)
Effective professional resources for teachers to learn how to use digital technology are available	47.4	(4.1)	64.7	(0.5)
An effective online learning support platform is available	45.4	(4.0)	54.1	(0.5)

Teacher skills and time related to digital technology

Table 6.13 presents the percentages of students attending schools whose principal teacher agreed with the school's capacity to enhance learning and teaching with reference to teacher and staff skills

and time. About half of the students attended a school where the principal agreed that 'teachers [had] sufficient time to prepare classes which integrate digital technology' and a similar percentage attended schools where the principal agreed that 'teachers [had] the necessary technical and pedagogical skills to integrate digital technology in instruction' (49.3%). However, as few as one in five students in Ireland attended a school where the principal agreed that 'the school has sufficient qualified technical assistant staff' (20.7%).

In comparison to Ireland, higher percentages of students attended schools across OECD countries on average where the principal agreed that teachers have the necessary technical and pedagogical skills to integrate technology into their teaching (64.6%) and that the school has sufficiently qualified technical assistant staff (54.1%) (Table 6.13). In relation to the amount of time teachers have to prepare for classes in which technology is integrated, 51.1% of students attended a school in Ireland where the principal agreed that sufficient time was available, while the average across OECD countries was higher at 60.9%.

Table 6.13: Percentage of students' principals reporting they 'agree' on the school's capacity to enhance learning and teaching with reference to staff/teacher skills and time, in Ireland and on average across the OECD

Schools capacity to enhance learning and teaching using digital technology?	Ireland		OECD	
	%	SE	%	SE
Teacher skills and time				
Teachers have the necessary technical and pedagogical skills to integrate digital technology in instruction	49.3	(4.4)	64.6	(0.6)
Teachers have sufficient time to prepare classes which integrate digital technology	51.1	(4.3)	60.9	(0.5)
Teachers are provided with incentives to integrate digital technology in their teaching	36.2	(4.2)	56.7	(0.5)
The school has sufficient qualified technical assistant staff	20.7	(3.1)	54.1	(0.5)

6.4 Student Well-being

PISA 2018 defines subjective well-being as a multidimensional construct that reflects the extent to which individuals believe (cognitive element) and feel (affective element) that their lives are desirable, fulfilling and rewarding. The first part of this section presents an overview of the theoretical framework of the assessment of student well-being in PISA 2018. The second part examines students' life satisfaction and its relationship to overall achievement scores. The third part examines student emotions and their relationship to Internet use.

6.4.1 PISA well-being framework

The PISA 2018 Well-being framework (OECD, 2019a) grounds objective and subjective indicators of student well-being in the literature, and sets out the rationale for linking educational achievement and well-being. There are three dimensions identified as the context for student well-being: self; school environment; and out-of-school environment. These dimensions are mapped against two types of indicators, objective and subjective. A range of well-being measures were included in the well-being questionnaire in PISA 2018, attempting to capture these dimensions, across both objective and subjective indicators.

Overall life satisfaction is a subjective measure with the caveat that an overall rating may not capture specific dimensions or aspects of one's life. Other indicators include: objective and subjective indicators of health, body image, psychological functioning (eudaimonic well-being or "flourishing"), affect/emotional well-being, material living conditions, and wellbeing inside and outside of school and leisure time. Several composite indicators are available from the questionnaire, including indices of the overall quality of life, overall subjective well-being, and work/school-life balance, created by aggregating the well-being questions related to schoolwork and to leisure time.

In the next section, student responses to a national question on sources of pressure, exam stress and test anxiety are presented, along with two topics included in the well-being questionnaire, life satisfaction and student affect/emotional well-being.

6.4.2 Test anxiety, exam stress and sources of pressure

In PISA 2018, the Educational Research Centre, along with the Department of Children and Youth Affairs (DCYA) and the Centre for Effective Services (CES), devised a national question on test anxiety, exam stress and sources of pressure. Sixteen statements on test anxiety, exam stress and sources of pressure were presented to students participating in PISA 2018 at the end of the student questionnaire. In previous cycles of PISA, an international question on schoolwork-related anxiety was included, but this was not administered internationally in 2018.

Three sources of pressure were presented to students: "I put pressure on myself to do well in exams and tests"; "I feel under pressure from my parents to do well in exams and tests"; and "I feel under pressure from my teachers to do well in exams and tests". Table 6.14 presents the student-reported sources of pressure to do well in exams and tests. Overall, less pressure was reported coming from parents compared to pressure from the students themselves and from their teachers. Approximately 17% of students reported never feeling pressure from their parents to do well on exams and tests, compared to fewer than one in ten students reporting that they never put pressure on themselves (8.9%) and that their teachers never put pressure on them (9.3%). Students appear to put the most pressure on themselves, with 62.3% of students reporting that they often or always put pressure on themselves to do well in exams, compared to 59.5% reporting that they often or always feel under pressure from teachers, and 52.2% of students reporting that they often or always feel under pressure from parents.

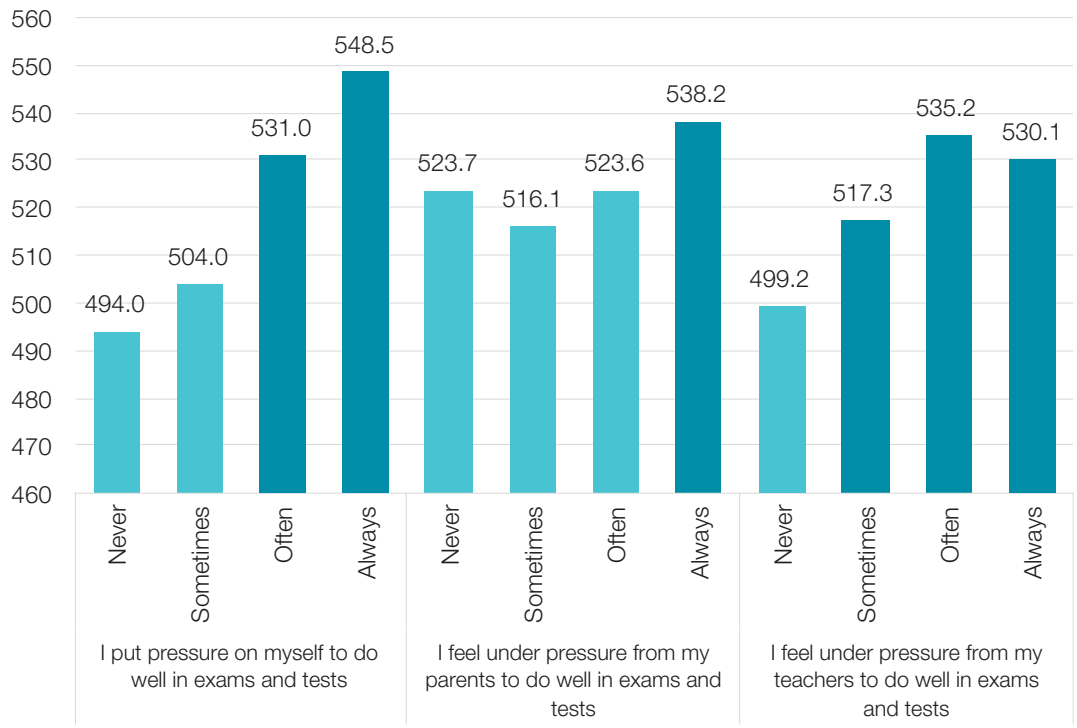
Table 6.14: Percentages of students in Ireland reporting various sources of pressure on them to do well on exams and tests

Thinking about exams and tests you do in school, how often do you have these thoughts or feelings?	Never		Sometimes		Often		Always	
	%	SE	%	SE	%	SE	%	SE
I put pressure on myself to do well on exams and tests	8.9	(0.4)	28.8	(0.7)	35.2	(0.7)	27.1	(0.7)
I feel under pressure from my parents to do well on exams and tests	17.4	(0.7)	30.4	(0.7)	28.2	(0.7)	24.0	(0.7)
I feel under pressure from my teachers to do well on exams and tests	9.3	(0.5)	31.1	(0.8)	36.9	(0.7)	22.6	(0.7)

An analysis of the relationship between achievement in reading literacy and students' perceptions of the source of exam pressure is presented in Figure 6.5 (see E-Appendix Table A6.13). Students who reported that they often or always put themselves under pressure scored significantly higher on

reading literacy (531.0 and 548.5 respectively), compared to students who reported that they never put pressure on themselves to do well (494.0). This pattern is the same for the overall scores for both science and mathematics (see E-Appendix Table A6.13). Students who reported that they always feel under pressure from their parents score significantly higher on reading literacy (538.2), compared to students who reported never feeling under pressure from their parents (523.7). Students who reported never feeling under pressure from their teachers achieved a significantly lower mean score in reading literacy (499.2) compared to students reporting sometimes feeling pressure (517.3), often feeling pressure (535.2) and always feeling pressure (530.1). Similar performance patterns are apparent for science and mathematics (see E-Appendix Table A6.13).

Figure 6.5: Students' mean scores on reading literacy and sources of pressure to do well in exams and tests, in Ireland



See E-Appendix Table A6.13. (Significant differences shown by **darker** bars. Reference group in each case is those answering 'never'.)

Table 6.15 presents the percentages of students reporting the frequency with which they experience exam stress and test anxiety. Worrying about failing an exam or feeling nervous and stressed about exams is prevalent, with 51.6% of students reporting that they often or always worry about what would happen if they fail an exam or test, and 43.1% of students reporting that they often or always feel nervous and stressed when thinking about or doing exams and tests. Students often compare themselves to others, with 44.8% of students reporting that they often or always feel like they will never do as well as other students in exams and tests. Slightly over a quarter of students reported feeling physically unwell often or always when thinking about or doing exams and tests.

Table 6.15: Percentages of students reporting the frequency with which they experienced various forms of exam stress and test anxiety, in Ireland

Thinking about exams and tests you do in school, how often do you have these thoughts or feelings?	Never		Sometimes		Often		Always	
	%	SE	%	SE	%	SE	%	SE
I worry about what would happen if I fail an exam or test	17.7	(0.68)	30.7	(0.74)	26.0	(0.69)	25.6	(0.64)
I feel like I will never do as well as other students in exams and tests	21.1	(0.67)	34.1	(0.76)	24.8	(0.69)	20.0	(0.62)
I feel physically unwell thinking about or doing exams and tests	40.2	(0.84)	32.9	(0.67)	16.2	(0.71)	10.7	(0.50)
I feel nervous and stressed when thinking about or doing exams and tests	18.9	(0.58)	38.1	(0.77)	24.2	(0.62)	18.9	(0.62)

Relationships between achievement in reading literacy and students' reports of exam stress and anxiety are presented in Figure 6.6. Students who reported always feeling worried about what would happen if they failed a test or exam had significantly higher average performance on reading literacy (540.3), compared to students who reported never feeling worried (520.3). Differences between mean scores on the reference category (never feeling worried) and other response categories are not significantly different for mathematics or science (see E-Appendix Table A6.14).

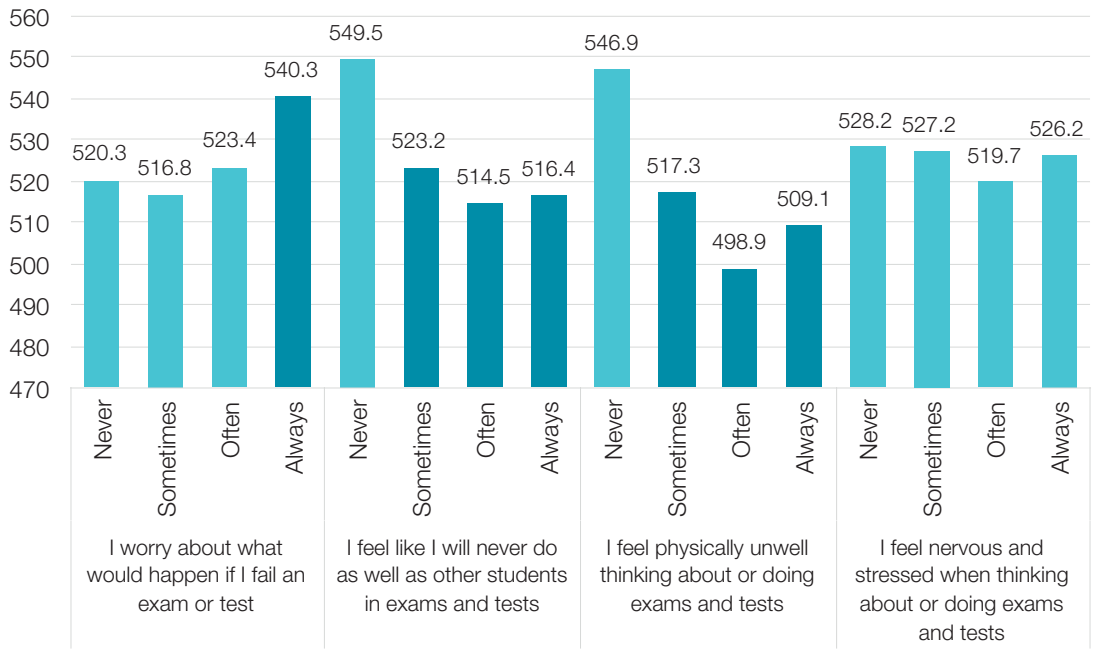
In relation to students feeling that they will never do as well as other students in tests, there is a statistically significant difference between the mean scores of students who never have these stresses or concerns and those that have these worries, sometimes, often and always. Students who never feel they will do as well as other students had a mean score of 549.5, which is significantly higher than those who sometimes, often or always had such feelings (523.2, 514.5, and 516.4 respectively).

Students who never feel physically unwell thinking about or doing exams and tests achieved significantly higher mean scores than students who feel this way sometimes, often or always, for each of reading literacy, mathematics and science, with mean scores of 546.9, 522.4, and 524.4 respectively (see E-Appendix A6.14).

For mathematics and science, the students who had these concerns and worries 'always' achieved the lowest performance on average for reading literacy (480.7 and 477.9 for feeling unwell physically thinking about tests, and 487.3 and 484.9 for feeling like they never do as well as other students in exams and tests).

There were no significant differences for students who feel nervous or stressed when thinking about or doing exams or tests for reading literacy. However, students who reported feeling stressed often or always had significantly lower mathematics and science scores (501.3 and 494.1 for mathematics, and 497.5 and 494.9 for science) than students who never had these feelings (513.3 and 511.8 respectively for mathematics and science) (see E-Appendix A6.14).

Figure 6.6: Mean reading literacy scores of students reporting the frequency with which they experienced various forms of exam stress and test anxiety, in Ireland



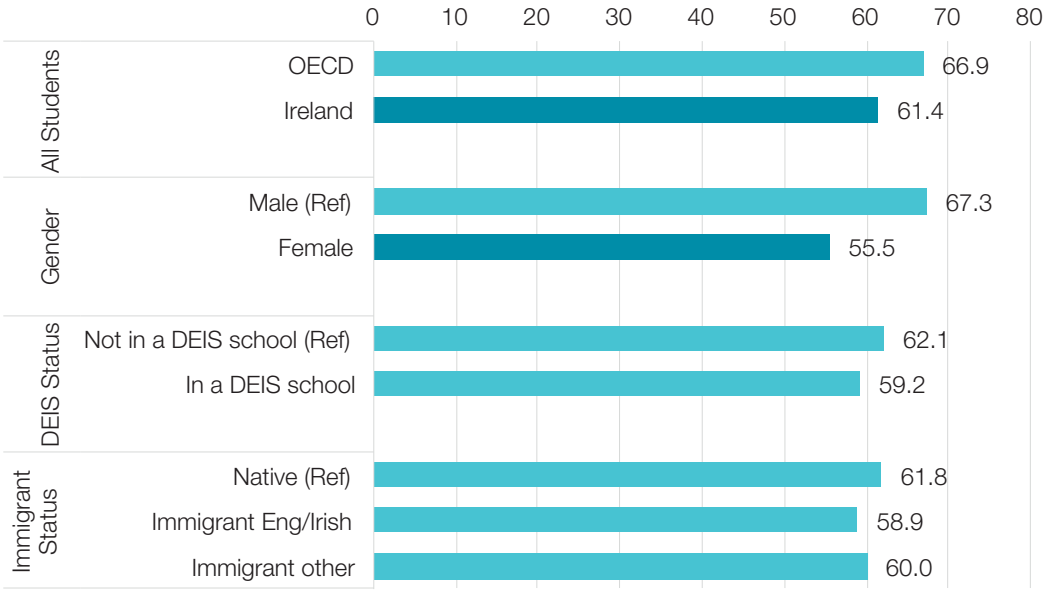
See E-Appendix Table A6.14 (Significant differences shown by **darker** bars. Reference group in each case is those answering 'never'.)

6.4.3 Students' life satisfaction

PISA 2018 defines life satisfaction as an overall evaluation that an individual makes about his or her perceived quality of life, according to his or her chosen criteria. Hence, in PISA, the criteria for life satisfaction are based on students' self-evaluations, as in other studies of student well-being (e.g., Health Behaviour in School-aged Children (HBSC), Children's World). PISA 2018 asked students to rate their life satisfaction on a scale from 0 (worst possible life) to 10 (best possible life). Based on students' responses on the life-satisfaction scale, 15-years-olds were classified into four different groups: 0-4 "not satisfied"; 5-6 "somewhat satisfied"; 7-8 "moderately satisfied" and 9-10 "very satisfied". A combined group who supplied a rating of 7-10 were categorised as being 'satisfied with life'.

Figure 6.7 presents the percentages of students who are satisfied with life, in Ireland and on average across OECD countries. Sixty-one percent of students in Ireland reported that they were satisfied with life, which is significantly lower than the overall average across OECD countries (66.9%). Females in Ireland were significantly less satisfied with life compared to males (55.5% and 67.3% respectively). There were no significant differences between students in DEIS and Non-DEIS schools, between native students and immigrant speakers of English or Irish, or between native and immigrant speakers of other languages (see Appendix Table A6.15).

Figure 6.7: Percentage of students who are satisfied with life, by gender, DEIS Status, Immigrant Status, in Ireland and on average across the OECD



Note: Satisfied with life (score 7-10 on satisfaction scale). See E-Appendix table A6.15. Significant differences shown by **darker** bars.

Table 6.16 shows students categorised by levels of life satisfaction and their overall mean scores in reading. Students in Ireland who reported that they were 'very satisfied' had a mean reading score of 505.2, which, interestingly, was significantly lower than the mean score of students who reported that they were not satisfied with life (522.8).

There are clear gender differences in Ireland in relation to life satisfaction and reading performance which are also presented in Table 6.16. Females scored significantly higher than males at all levels of life satisfaction. Examining gender differences within life satisfaction, male students who reported that they were very satisfied with life scored significantly lower than males who were not satisfied with life (493.2 and 511.9 respectively). In contrast, there are no significant differences in mean reading scores for females who reported that they were very satisfied with life and those who were not satisfied with life (521.5 and 530.7 respectively).

Table 6.16: Student satisfaction with life and mean scores in reading in Ireland, by all students and by gender

	Reading							
	All Students		Males		Females		Males-Females	
	Mean	SE	Mean	SE	Mean	SE	Diff	SED
Not satisfied (ref)	522.8	(3.8)	511.9	(5.4)	530.7	(4.3)	**-18.8**	(6.9)
Somewhat satisfied	523.4	(3.2)	512.2	(5.5)	531.8	(3.5)	**-19.6**	(6.5)
Moderately satisfied	527.2	(2.8)	516.9	(4.2)	538.4	(3.2)	**-21.5**	(5.3)
Very satisfied	**505.2**	(3.2)	**493.2**	(3.5)	521.5	(4.4)	**-28.3**	(5.6)

Significant differences in **bold**.

On average, students in Ireland who reported that they were moderately satisfied with life scored significantly higher on overall mathematics than students who reported that they were not satisfied with life (509.9 and 493.8) (see E-Appendix Table A6.16). There were no significant differences in overall science mean scores for students who were not satisfied with life and those who were somewhat, moderately or very satisfied with life.

6.4.4 Students' emotions and Internet use

PISA 2018 asked students to report how frequently ('never'; 'rarely'; 'sometimes'; 'always') they feel happy, lively, proud, joyful, cheerful (positive affects) and scared, miserable, afraid and sad (negative affects) in normal circumstances. This is considered the affective element of the subjective well-being of 15-year-old students (the cognitive element of subjective well-being was examined in the previous section).

Just over 45% of students in Ireland reported feeling happy all of the time ('always'). A smaller percentage reported always feeling lively (35.8%) while only 15.2% of the students reported that they 'always' felt proud. A higher percentage of students on average across OECD countries reported that they 'always' felt proud (19.0%). In contrast to Ireland, there were more students on average across OECD countries who reported that they 'always' felt cheerful and joyful. Approximately 41% of student on average across OECD countries reported that they 'always' felt cheerful and a similar percentage reported they 'always' felt joyful (compared with 32.0% and 27.3% respectively in Ireland, see E-Appendix Table A6.17).

In contrast to the positive emotions reported by students, only 5% of students in Ireland reported that they 'always' feel sad and fewer than 3% reported 'always' feeling afraid, compared to 6.5% and 10.3% (respectively) of students on average across the OECD.

In the countries and economies that distributed the ICT questionnaire, PISA 2018 asked students how much time they spend using the Internet during the typical weekday and weekend day outside of school. These two questions were combined to calculate the amount of time students spend connected to the Internet during a typical week. Five categories of Internet users were then created based on this indicator: "low Internet user" (0-9 hours per week); "moderate Internet user" (10-19 hours per week); "average Internet user" (20-29 hours per week); "high Internet user" (30-39 hours per week); and "heavy Internet user" (more than 40 hours per week).

Comparing students' usual feelings against the time they spend using the Internet, students in Ireland who were low Internet users were more likely to report positive feelings than heavy Internet users. Low Internet users were also less likely to report negative feelings than heavy Internet users. In particular, 79.3% of students who were low Internet users were more likely to report feeling proud ('sometimes' or 'always') compared to heavy Internet users (69.2%) and more students who were low Internet users reported feeling joyful sometimes or always (89.7%) compared to heavy Internet users (82.9%) (see E-Appendix Table A6.18). Similarly, students who were low Internet users were less likely to report feeling miserable (29.2%) compared to heavy Internet users (41.1%) and were less likely to report feeling scared (27.5%) compared to 37.7% of heavy Internet users (see E-Appendix Table A6.19).

6.5 Summary

This chapter provided an overview of the PISA questionnaire framework and the international and national questionnaires administered to students in Ireland as part of PISA 2018. Selected key findings from the PISA 2018 questionnaires were presented related to three themes: engagement and strategies for reading, use of digital technology and student well-being.

Engagement in reading

In Ireland, 47.7% of students reported that they did not read for enjoyment at all, with significantly more males (56.1%) than females (39.4%) reporting this. Students who did not read at all for enjoyment had a mean reading score (484.1) that was significantly lower than that of students who read for up to 30 minutes day (539.4). Furthermore, students who reported reading more frequently achieved significantly higher overall reading scores (552.5 and 571.0 respectively for reading 30-60 minutes and more than 1 hour per day) than students who read for up to 30 minutes a day (539.4). Average reading achievement was almost 90 score points lower for students who did not read compared with students who read for more than 1 hour a day.

Since the first cycle of PISA, there has been a substantial and significant increase in the percentage of students in Ireland who do not read for enjoyment, from 33.4% (2000) to 41.9% (2009) to 47.7% in 2018. In addition, there has been a significant decrease in the percentage of students in Ireland reading for more than 1 hour per day in 2018 compared to 2009 (13.2% and 15.8% respectively). Those who read more often in paper format also had a considerably higher mean score on PISA reading literacy than those who read more often on digital devices (561.4 and 511.3 respectively). However, students who read in any format had a significantly higher reading score than students who reported never or rarely reading. In line with the overall gender difference in reading, the mean reading score of females who did not read for enjoyment (491.8) is significantly higher than the mean score of non-reading males (478.7).

The mean score for Ireland on the composite index for enjoyment of reading was -0.07, indicating a lower level of enjoyment compared to the OECD average, though not to a significant extent. On average across OECD countries, female students reported greater enjoyment of reading than females in Ireland (0.24 compared to 0.19); the difference is statistically significant.

Reading and Learning Strategies

In 2018, the most strongly endorsed strategies among students in Ireland when understanding and remembering a text were 'underlining important parts in the text' (53.0%) and 'summarising the text in my own words' (49.3%). However, these strategies more strongly endorsed in 2009 than in 2018. For summarising texts, higher-order strategies such as 'I read through the text, underlining the most important sentences. Then I write them in my own words as a summary' and 'I carefully check whether the most important facts in the text are represented in the summary' were more strongly endorsed than lower-order strategies, but again, to a somewhat lesser extent than in 2009. There was a significant increase reported by students in 2018 for the strategy 'read quickly through the text twice'; 22.9% of students favoured this strategy compared with 14.0% in 2009.

A new metacognition scenario introduced in PISA 2018 focused on assessing the quality and credibility of sources, a key skill for students learning in a digital world. Students were asked to evaluate the appropriateness of various strategies for assessing the credibility of an email. Students in Ireland more strongly endorsed appropriate strategies for assessing quality and credibility of

sources, than on average across OECD countries. Strategies such as 'checking the sender's email address' were more strongly endorsed compared with strategies such as 'clicking on the link to fill out the form as soon as possible'.

Students' familiarity with, and use of, digital technology

About half of participating students in Ireland reported familiarity with computer-based assessment, with 46.5% of students having taken a test on computer prior to PISA. This was slightly, but not significantly, higher than the percentage of students who reported experience with computer-based assessment in 2015 (42.8%).

On the index of subject-related digital technology use in class by students, students in Ireland had a mean score (-0.37), which was significantly and substantially below the average across OECD countries (0.00). The mean score for student reports of time spent using digital devices for subjects outside class was -0.30, significantly below the OECD average of (0.01). This indicates an under-usage of digital technology among students in Ireland.

Exploring how digital devices are used in classes, students in Ireland reported that across selected subjects (English, science, and mathematics), it was mainly the teacher who used the digital devices in the classroom. The rate of use by teachers only in Ireland during English classes (52.2% of students) was over twice that reported by students on average across OECD countries (24.6%). On the other hand, use of digital devices by both teachers and students was higher on average across OECD countries (37.4%) than in Ireland (23.1%) during English classes.

Enhancing Teaching and Learning through digital technology

About half of students (56.5%) attended a school in Ireland where the principal reported that the number of digital devices connected to the Internet was sufficient for enhancement of teaching and learning, and this was below the average for OECD countries (67.2%). Just 45.3% of students in Ireland attended schools where the principal reported that there was a sufficient number of devices for instruction, compared with an OECD average of 59.0%. On the other hand, higher percentages of students in Ireland attended a school where the principal reported that digital devices were sufficiently powerful in terms of computing capacity (73.2%), and there was sufficiently fast Internet broadband (75.9%), compared to the corresponding OECD averages (68.5% and 67.5% respectively). Just under half of students in Ireland (47.4%) attended a school where the principal agreed that 'effective professional resources for teachers to learn how to use digital technology are available', while the corresponding OECD average was 64.7%. One in five students in Ireland attended a school where the principal agreed that 'the school has sufficient qualified technical assistant staff', compared with an OECD average of 54.1%. In relation to the amount of time teachers have to prepare for classes in which technology is integrated, 51.1% of students attended a school in Ireland where the principal agreed that sufficient time was available, while the average across OECD countries was higher at 60.9%.

Test anxiety and exam stress

In Ireland, students who reported that they often or always put themselves under pressure to do well on exams and tests scored significantly higher on reading literacy (531.0 and 548.5 respectively), compared to students who reported that they never put pressure on themselves to do well (494.0). Students who reported never feeling under pressure from their teachers to do well also scored

significantly lower in reading literacy compared to students who reported sometimes feeling pressure (517.3), often feeling pressure (535.2) or always feeling pressure (530.1).

Students often compare themselves to others, with 44.8% of students in Ireland reporting that they often or always feel like they will never do as well as other students in exams and tests. Over half of students (51.6%) reported that they often or always worry about what would happen if they fail an exam or test, while 43.1% reported that they often or always feel nervous and stressed when thinking about or doing exams and tests. Students in Ireland who reported 'often' worrying about what would happen if they failed a test or exam had a higher overall mean score on reading literacy than students who never or sometimes worried about this. Students who reported that they often or always feel physically unwell thinking about exams performed less well on average on reading literacy (498.9 and 509.1 respectively), compared to students who never feel physically sick thinking about tests (546.9).

Students' life satisfaction

Sixty-one percent of students in Ireland reported that they were satisfied with life, which is significantly lower than the overall average across OECD countries (66.9%). On average, female students were less likely to be satisfied with their life (55.5%) compared to male students (67.3%); the gender difference is statistically significant. Examining the relationship between life satisfaction and student performance, students in Ireland who reported that they were 'very satisfied' had a mean reading score of 505.2, which was significantly lower than the mean score of students who reported that they were not satisfied with life (522.8).

Students' emotion and Internet use

Approximately 45.3% of students in Ireland reported feeling happy all of the time ('always') in normal circumstances, compared to 41.0% of students on average across OECD countries, while fewer students in Ireland felt cheerful, joyful or proud than students on average across OECD countries. Students in Ireland who are low Internet users were more likely to report positive feelings in general (e.g., happy or lively) and less likely to report negative feelings (e.g., sad or afraid) than heavy Internet users.

Chapter 7
Conclusions and a Look Ahead

This chapter sets out the conclusions from PISA 2018 and looks ahead to PISA 2021.

7.1 Conclusions

The conclusions cover six themes – overall performance in PISA 2018, performance of low-achievers, performance of high-achievers, gender differences in student performance, the use of digital technology in education, and aspects of student well-being in Ireland. For a detailed summary of the outcomes of PISA 2018 in Ireland, please refer to the Executive Summary.

7.1.1 Overall performance and trends in PISA

Ireland's performance in reading literacy, science and mathematics was relatively stable between 2015 and 2018, with small but not statistically significant changes in each domain. On average across OECD countries between 2015 and 2018, mean scores on reading literacy and mathematics increased by small non-significant amounts, while there was a small non-significant decline in science.

This section highlights overall student performance on PISA 2018 in Ireland, while specific breakdowns of performance, including variation in performance and gender differences, are discussed in subsequent sections.

7.1.1.1 Performance on reading literacy

In preparation for the 2018 assessment, the PISA reading literacy framework underwent considerable revision, to better reflect how reading has evolved in recent years, mainly because of new technologies. A new element, fluency, was added to the framework and to the assessment for 2018.

Ireland's mean score of 518.1 on the reading scale in PISA 2018 is significantly higher than the OECD average[46] of 487.1. Ireland ranked 4th out of 36 OECD countries (or between 1st and 5th if a 95% confidence interval is applied) and 8th out of all 77 participating countries/economies for whom valid data were available (between 5th and 9th if a 95% confidence interval is applied).

Student performance on PISA reading literacy in Ireland is characterised by an above average percentage of high performers (12.1%), and a small and below average percentage of low performers (11.8%); there are significantly fewer low performers and significantly more high performers in Ireland than on average across OECD countries.

Not unexpectedly, given Ireland's strong overall performance, the mean score on each process and source subscale score for reading literacy in Ireland is significantly above the corresponding

46 The OECD average for reading literacy in 2018 is based on 36 countries, while for mathematics and science, the average is based on 37 countries. Reporting on PISA 2018 reading literacy data for Spain is deferred until sub-optimal response patterns are investigated. For trend comparisons in reading literacy 2009-2018, the OECD average is based on 35 countries; mean performance for Austria was not reported in 2009.

OECD average. In Ireland, the mean score on Locating Information was 33.5 score points above the OECD average; it was 23.6 score points above the OECD average for Understanding; and it exceeded the OECD average by 30.0 points for Evaluating and Reflecting. Students in Ireland also scored significantly above the OECD average on both Single and Multiple Text subscales, with a difference of 27.5 points for Single Texts and a difference of 26.5 points for Multiple Texts.

Comparing student performance in reading literacy in Ireland to 2009 (when reading was also the major assessment domain), the overall mean score was 22.4 points higher in 2018. Student performance in reading literacy in Ireland returned to the pre-2009 level in 2012, and has remained relatively stable in 2015 and 2018. Comparisons between 2009 and 2018 should be made cautiously, as issues with the statistical model used to scale the PISA 2009 data and low engagement amongst students in Ireland may have resulted in an underestimate of Ireland's reading literacy score. Ireland was amongst a group of countries that experienced a small and non-significant drop in reading performance since 2015 (2.7 score points), but the decrease was marginally lower than that experienced on average across OECD countries (3.0 points).

The relative stability in overall mean scores, notwithstanding the revised assessment framework (to better reflect how reading has evolved in recent years) and new test content, highlights the consistently strong performance of students in Ireland on PISA reading literacy. This steady performance includes the incorporation of digital navigation and other interactive reading skills and competencies, both in traditional and newer texts.

The new English specification was introduced in 2014, and thus all participating students in PISA 2018 in Ireland studied under it (see Chapter 2). The new specification includes clearer links across elements and strands and also references the use of multi-modal texts and associated skills. Students in Ireland in 2018 reported strong awareness of reading strategies. In particular, students in Ireland are significantly above the OECD average (0.00) at 0.21 on an OECD-developed metacognition index, where students are asked to evaluate the appropriateness of various strategies for assessing the credibility of an email.

7.1.1.2 Performance on science

Science was a minor assessment domain in PISA 2018. While the science frameworks for both 2015 (when science was a major assessment domain) and 2018 were broadly similar, some differences were noted, including a greater emphasis on procedural knowledge (from 32.6% of items in 2015 to 40.9% in 2018). This was linked to the observation that, while the number of items requiring students to perform and interpret the outcomes of interactive experiments had remained the same between 2015 and 2018 (24 in both years), the actual number of science items had decreased (from 184 to 115), meaning that items based on interactive experiments comprised a greater proportion of the item pool in 2018.

Coinciding with the introduction of computer-based testing in 2015, the overall trend in science performance in Ireland over the period 2012 to 2018 shows a significant decline (25.9 points). The corresponding change on average across OECD countries was a significant drop of 9.6 score points (OECD 2019d, Table I.B1.12). As Shiel et al. (2016) noted, the percent correct scores for science in PISA 2015 on new and trend items differed. While the percent correct score for trend science items was relatively stable and above the OECD average, the percent correct score for new interactive items fell below that of the average across OECD countries. However, as noted by Jerrim (2016), in an analysis of PISA 2012 released mathematics test items, differences in performance across modes are unlikely to be solely due to the interactive nature of certain computer-test questions. Yet,

in a third of countries included in the analysis, mean paper and mean computer PISA scores were found to differ by at least 10 points (0.1 standard deviations) – a magnitude the OECD describe as substantial (*ibid*).

The mean science score of students in Ireland on PISA 2018 was 496.1. This is significantly above the OECD average of 488.7. Ireland ranked 17th among 37 OECD countries (or between 13th and 21st if a 95% confidence interval is applied), and 22nd among 78 participating countries/ economies with valid data (or between 18th and 26th if a 95% confidence interval is applied).

Student performance on PISA science in Ireland is characterised by an average percentage of high performers (5.8%), and a significantly lower percentage of low performing students (17.0%) than on average across OECD countries. The overall trend in science performance over the period 2012 to 2018 is recorded as significantly declining (25.9 points), but, as noted, the drop of 6.5 points between 2015 and 2018 is not statistically significant.

The new science specification was introduced in 2016, with the first round of students sitting that subject as part of the Junior Cycle Profile of Achievement (JCPA) in 2019. Therefore, only a very small proportion of students participating in PISA 2018 studied under the new specification for science. A key change to the new specification is the inclusion of the nature of science strand, along with the introduction of Earth and Space as a discrete content area. The nature of science is a core unifying strand; it cuts across all other strands, facilitating scientific enquiry across the contextual strands, and 'makes the science classroom a dynamic and interactive space, in which students are active participants in their development' (NCCA, 2015: 11). This strand, in conjunction with core domains of scientific knowledge, may be a key area for students in the future, given the integration of computer-based assessment, including the use of interactive simulations of experiments and questions that ask students to reflect on the process of scientific enquiry. The interaction between core scientific content knowledge and cross-cutting skills and competencies (including student-led practical experiments and use of digital apps and software) may need to be examined in tandem, to better understand and address the overall decline in science performance in recent cycles of PISA. The *STEM Education Policy Statement 2017-2026* (DES, 2017b) highlights several areas where the Department and relevant stakeholders can enhance and build capacity in line with identified needs to provide a high-quality STEM education experience.

7.1.1.3 Performance on mathematics

Mathematics was a minor assessment domain in PISA 2018. Unlike reading literacy and science, no items specifically designed for computer-based assessment were included, though this is due to change in 2021, when PISA mathematics will be the major assessment domain. All PISA mathematics items administered in 2018 were drawn from the paper-based assessment in 2012.

The overall mean mathematics score of students in Ireland in 2018 was 499.6. This is significantly higher than OECD average score of 489.3. Ireland ranked 16th among 37 OECD countries (or between 12th and 21st if a 95% confidence interval is applied), and 21st among 78 participating countries/ economies with valid data (or between 17th and 26th if a 95% confidence interval is applied).

Student performance on PISA mathematics in Ireland is characterised by a below average level of high achievers (8.2%), and a significantly lower percentage of low-performing students (15.7%) than on average across OECD countries. The overall trend in mathematics performance between 2012 and 2018 is stable, with a non-significant change in mean scores.

The new specification for mathematics was introduced to First Year students in 2018; therefore, almost all PISA 2018-eligible students studied under the old specification, often referred to as Project Maths[47]. Shiel and Kelleher (2017) concluded that the Project Maths curriculum had a small positive impact on student performance in mathematics, as measured by PISA 2015 and TIMSS 2015. Looking ahead to further computer-based assessments in international studies like PISA and eTIMSS, and the introduction of new interactive items in PISA 2021 mathematics, the role of digital technology in developing and assessing students' mathematical knowledge in interactive ways may need to be considered, in line with the *Digital Strategy for Schools 2015-2020* (DES, 2015a), *Digital Learning Framework* (DES, 2017a), and the *STEM Education Policy Statement 2017-2026* (DES, 2017b). Furthermore, ways to embed the use of digital technology, considering a whole-school approach and the use of specific applications, are important considerations for the development of mathematics. By 2021, all students in Ireland will have studied under the new mathematics specification, and thus, the development of mathematical proficiency in students will be underpinned by core skills from the Junior Cycle Framework, such as reasoning and problem-solving, alongside new approaches to assessment. However, the PISA mathematics framework will also have changed in 2021; hence, it may not be possible to draw strong conclusions about the impact of the new specifications.

Stronger performance in PISA mathematics may have been expected in PISA 2018, given the strong National Assessments results in 2014 (see Chapter 2). However, there may be several factors at play here, including two key issues: first, the National Assessment instruments are curriculum-based, while PISA is not, focusing instead on real-life skills and competencies; and second, PISA has transitioned to computer-based assessment since 2015 and this may not be familiar to all students (53.5% of students had not taken a test on computer prior to PISA 2018). While PISA mathematics in 2018 did not include new item formats that utilised the full capabilities of computer-based assessment, the test included digital tools such as equation toolbars, and students had the option to use their own calculator, use a roughwork sheet, and/or use the built-in computer tool.

While students in Ireland performed well on optional digital assessments in reading literacy in PISA 2009 and 2012, the performance of students in Ireland on digital mathematics in 2012 did not differ from the OECD average, while on print mathematics, students in Ireland were significantly above the average across OECD countries (Perkins et al, 2013). This may, in part, explain student performance in mathematics in Ireland in PISA 2018, and may also be relevant in looking ahead to PISA 2021.

7.1.2 Low performers in PISA

This and the next section consider the variation in performance in PISA 2018, examining the range of achievement and focusing on the proportions of low- and high-performing students in Ireland, across each of the three domains. Low-performing students are considered in this subsection, and high-achieving students in the next one.

The outcomes of the PISA 2018 assessment highlight the relatively low percentages of low-achieving students across the three domains of reading literacy, mathematics and science in Ireland, compared to the corresponding OECD averages and to comparator countries.

In reading literacy, 11.8% of students in Ireland performed below Proficiency Level 2, compared to 22.7% on average across OECD countries. Such students can understand the literal meaning of

47 The old curriculum for mathematics, often referred to as Project Maths, was implemented on a phased basis in post-primary schools, between 2008 and 2015.

sentences or simple statements, but have insufficient reading skills to deal with future needs in real-life or further education. Ireland has the 2nd lowest percentage of low performers in reading literacy in the OECD, just behind Estonia (11.1%). This is also close to the target of 10% to be achieved by 2025 as set out in the *Action Plan for Education 2016-2019* (DES, 2016). Only one entity, B-S-J-Z (China), had a percentage of low performers in PISA 2018 below 10%, with 5.2% of students performing below Level 2. The revised Literacy and Numeracy Strategy targets (DES, 2017c) set the benchmark of 8.5% of students performing below Level 2 in PISA, to which no OECD country came close in 2018.

In Ireland, 17% of students performed below Level 2 on the science proficiency scale, compared to 22.0% on average across OECD countries. These students can recognise basic scientific phenomena or simple patterns in data, but lack the scientific skills and knowledge they may require in their future lives. There was a non-significant increase from 15.3% to 17% in the proportion of students performing below Level 2, between 2015 and 2018. Ireland has the 8th lowest percentage of low performers among OECD countries; Estonia has the lowest percentage of students performing below Proficiency Level 2 (8.8%). The percentage of low performers in Ireland in 2018 is in excess of the target of 10% set out in the *Action Plan for Education 2016-2019*, to be achieved by 2025.

In mathematics, 15.7% of students in Ireland performed below Level 2 on mathematics, indicating that they lacked the mathematical knowledge and skills required for future education and work. This was significantly below the OECD average of 24.0%. While Ireland had more lower-achieving students than countries with significantly higher average scores in mathematics, it had similar proportions to countries with mean scores that are not significantly different. Ireland has the 7th lowest percentage of low performers among OECD countries for mathematics, despite an overall ranking of 16th. Estonia has the lowest percentage of students performing below Proficiency Level 2 in mathematics (10.2%) across the OECD. The percentage of low-performing students on mathematics in Ireland in 2018 is in excess of the target of 10% set out in the *Action Plan for Education 2016-2019* (to be achieved by 2025), and of the 10.5% set out in the revised targets of the *Literacy and Numeracy Strategy, 2011-2020*.

Across the three domains, Ireland has below average proportions of low-performing students. However, there are more low-achieving students in science and mathematics relative to reading literacy, highlighting room for improvement in these areas. It may be the case, as in PISA 2012 science, that should the overall mean score increase significantly in future PISA cycles, the proportion of low-achievers will decrease, as more students move up the proficiency scale.

7.1.3 High performers in PISA

Almost one in eight students in Ireland (12.1%) performed at the highest proficiency levels in reading (Levels 5-6 combined), and hence can be considered higher-achieving readers. On average across OECD countries, 8.7% performed at Levels 5-6, indicating that Ireland has more higher-achieving readers. Ireland has the 10th highest percentage of high performers across OECD countries, with Canada as the country with the highest proportion of high-achieving students at 15%. The percentage of students in Ireland achieving at the highest levels in reading literacy in 2018 is within 1% of the target of 13% to be achieved by 2025, set out in the *Action Plan for Education 2016-2019*, and meets the revised target of 12% set out in the *Literacy and Numeracy Strategy, 2011-2020*. While the differences in the percentages of students in Ireland performing at Levels 5 and 6 in reading literacy are not statistically significant between 2012 and 2018 or between 2015 and 2018, these small increases highlight the consistency in the performance of high-achieving students in Ireland

on reading literacy. It is also noted that all PISA students in 2018 studied under the new English specification (NCCA, 2018a).

In 2018, the proportions of students in Ireland and on average across OECD countries who performed at Levels 5-6 in PISA science were similar (5.8% and 6.8% respectively), even though Ireland's mean score is significantly higher than the OECD average. Among comparison countries, only Northern Ireland (5.4%) has fewer students performing at Levels 5-6 than Ireland. Ireland is 21st among OECD countries for high performers in science; Japan is the country with the highest proportion of students considered as high-achieving at 13.1%. The percentage of students in Ireland achieving at the highest levels in science in 2018 is lower than the 2025 target of 13% set out in the *Action Plan for Education 2016-2019*. There was a non-significant drop in the proportion of students in Ireland performing at Levels 5-6, from 7.1% in 2015 to 5.8% in 2018. However, compared to PISA 2012, there has been a significant decline of 4.9% in the percentage of high-performers in science. Over this period, the science assessment in PISA was updated and revised to include new items, including interactive items. Only a small proportion of students in PISA 2018 studied under the new science specification (NCCA, 2015), with the new nature of science strand and new assessment arrangements; PISA 2021 will be the first cycle where all participating students will have studied under the new specification.

In Ireland, 8.2% of students performed at Levels 5-6 in PISA mathematics, which is not significantly different from the OECD average of 10.9%. A number of countries with overall mean scores not significantly different from Ireland's had proportionately more students at Levels 5-6, including Sweden (12.6%) and the UK (12.9%). In Northern Ireland, 8.3% of students performed at Levels 5-6. Ireland is 30th in terms of the percentage of high-performers amongst OECD countries for mathematics. Across the OECD, Korea has the highest percentage of students performing at the highest levels in mathematics at 21.4%. The percentage of students in Ireland achieving at the highest levels in mathematics in 2018 is 2.7% lower than the *Action Plan for Education 2016-2019* target of the OECD average, which was 10.9% in 2018. This differs from the other targets and may fluctuate slightly from cycle to cycle. There has been a significant decline (2.4%) in the percentage of students in Ireland performing at the highest level in PISA mathematics, between 2012 and 2018. While the *STEM Education Policy Statement 2017-2026* (DES, 2017b) noted encouraging trends in the performance of students in Ireland on PISA mathematics, there is clearly room for improvement. In particular, it is important to consider the declines in the proportions of high-achievers in mathematics and science in Ireland, and how these may be addressed.

In relation to the targets from the *Action Plan for Education 2016-2019* and the *National Literacy and Numeracy Strategy, 2011-2020* (see Chapter 2), consideration may need to be given to the relevance of these looking forward. As the Action Plan targets were set before the transition to computer-based assessment in PISA 2015, and bearing in mind the significant revisions to the framework and test content for domains every third cycle, caveats are relevant for the targets. It may also be prudent to consider the relative proximity of the results of students in Ireland to each target, taking into account estimates of measurement error. Therefore, future targets could incorporate ranges of percentages for student performance on PISA below Proficiency Level 2 and at or above Proficiency Level 5 (e.g., 10-14%), along with reference to the OECD average. However, the OECD average may fluctuate over time with new and sometimes low-performing countries acceding every few years. Given the relative strength of student performance in Ireland, with low percentages of lower-achieving students, a renewed focus on the underperforming high achievers in mathematics and science may provide a useful lens through which to review student performance (e.g., Pitsia et al., 2019).

7.1.4 Gender differences

The patterns of gender differences in Ireland in PISA 2018 are not dissimilar to earlier rounds of PISA, but differ from PISA 2015. The gender gap in favour of females in reading literacy in Ireland (23.2 points) is statistically significant; however, it is among the lowest on average for OECD countries in PISA 2018, and greater than the gender difference in PISA 2015 (12.0 score points). For mathematics and science, there are no significant differences between the average scores of female and male students in 2018. This differs from 2015 in Ireland when male students significantly outperformed females in both mathematics and science (by 16.1 and 10.5 score points respectively).

Female students in Ireland significantly outperformed male students on PISA 2018 overall reading. The difference, 23.2 score points in favour of females, was among the lowest across comparison countries, and at a similar level to Singapore, the United States, Korea and the United Kingdom. On average across OECD countries, the gender difference in favour of female students was 29.7 points. On the overall reading proficiency scale, 8.5% of females, and 15.1% of males performed below Level 2. Hence, there are significantly more lower-achieving males than females in Ireland, a finding that also emerged on average across OECD countries where 27.7% of males, and 17.5% of females performed below Level 2. In Ireland, significantly more females (13.8%) than males (10.3%) performed at Levels 5-6. The corresponding OECD average estimates were 10.4% and 7.1% respectively.

Gender differences in science performance across countries tend to be small and non-significant. In Ireland, male students achieved a mean score of 495.4, while females achieved a mean score of 496.9. The difference, 1.5 score points in favour of females, is not statistically significant. On average across OECD countries, male students had a mean score of 487.5, while females had a mean score of 489.8. The difference in favour of females, 2.3 score points, is statistically significant. In Ireland, more male students (18.1%) performed below Level 2 in science, compared with females (16.0%), while on average across OECD countries, 23.2% of males and 20.8% of females performed below Level 2. While the difference in Ireland is not significant, the OECD average difference is. More male students than female students in Ireland also achieved Levels 5-6 (6.8% and 4.9% respectively), though the difference is not significant. On average across OECD countries, significantly more males (7.3%) than females (6.2%) achieved Levels 5-6.

Gender differences in mathematics performance across countries tend to be small and non-significant. In Ireland, male students achieved a mean score of 502.6. Although higher than the mean score of females (496.7), the difference (5.9 score points) is not statistically significant. On average across OECD countries, the difference in favour of male students (5.2 points) was marginally smaller than in Ireland, but reached statistical significance. In Ireland, similar proportions of male and female students (15.7% in both cases) performed below Proficiency Level 2 in mathematics, while the corresponding OECD average percentages were higher, at 23.9% for males and 24.0% for females. Significantly more male students in Ireland (9.9%) compared with females (6.6%) performed at Levels 5-6, and the corresponding OECD averages, also significantly different from one another, were 12.3% and 9.5% respectively.

It is unclear why the gender gap in reading literacy in 2018 has increased since 2015, and why there are no longer significant differences in favour of male students in mathematics and science. However, across domains, the gender differences in 2018 are broadly similar to earlier cycles of PISA, prior to the introduction of computer-based assessment. Efforts are required to understand why these changes have occurred, with consideration given to student engagement and test-taking behaviour in PISA, student engagement and interest in reading (and in other subjects), familiarity with the use of digital devices in teaching, learning and assessment, sampling fluctuations from cycle to cycle, and whether these differences may reflect real changes over time.

7.1.5 Digital technology in education

Recent years have seen an increased number of strategies and reports on the integration and embedding of digital technology in the Irish education system (see Chapter 2). The findings from PISA 2018 in relation to digital technology for teaching and learning are consistent with findings from the evaluation of the *Digital Learning Framework* (Cosgrove et al., 2018a, 2018b, 2019), highlighting areas for further support.

In PISA 2018, the range of indicators related to digital technology access and use in the Student and School Questionnaires was limited. These relate to students' familiarity with computer-based assessment, use of digital technology in selected subjects, how digital devices were used in classes (who used them), and principals' views on the adequacy of digital technology infrastructure, teacher skills/time and technical support and maintenance.

In PISA 2018, over half of students in Ireland (53.5%) reported they had never taken a test on computer before, down from 57.2% in PISA 2015. However, there was no significant relationship between student performance in reading literacy, mathematics and science and prior experience of taking a test of computer. This differs from 2015, when significant differences were observed in science and mathematics in favour of students with computer-based assessment experience.

In relation to time spent by students using digital devices inside and outside of school for selected school subjects, students in Ireland were significantly and substantially below the OECD averages, indicating underuse of digital technology. Students in Ireland were also more likely to report that only the teacher used digital devices during instruction in selected subjects, compared with the average across OECD countries. In contrast, the highest reported usage by students across OECD countries was for teacher and student usage combined.

Ireland lags behind the average across OECD countries on indicators of computer resources in school and principals' reports of the adequacy of digital technology infrastructure, teacher skills and technical support. Two key findings emerged: compared to the average across OECD countries, students in Ireland attended schools where principals reported lower levels of CPD resources available for integrating digital technology into the classroom; and teachers were less likely to have the technical and pedagogical skills, and sufficient time to prepare integrated content for teaching. These findings underline the relevance of the *Digital Strategy for Schools* (DES, 2015a) and the *Digital Learning Framework* (DES, 2017a) and indicate a need to continue to monitor and enhance resources and make time available for CPD and preparation for instruction.

Furthermore, in comparison to the average across OECD countries, fewer students in Ireland attended schools where the principal reported that adequate levels of technical support were available. One in five students attended schools where the principal reported an adequate level of sufficiently qualified technical support staff for the maintenance of digital infrastructure, compared to one in two students in schools on average across OECD countries. In reporting on the findings of the Digital Learning Framework trial, Cosgrove et al. (2019) noted that further work is needed to identify cost-effective, efficient models and solutions to providing equitable technical support to schools. Technical support had previously been identified as a key challenge in the 2013 ICT Census of Schools (Cosgrove et al., 2014).

Notwithstanding these findings, there are relative strengths in the resourcing of post-primary schools in Ireland with digital devices and technology. For example, a greater percentage of students in Ireland than on average across OECD countries attended schools where the principal reported that the school's Internet bandwidth or speed was sufficient, and that devices had sufficient computing capacity. The availability of other resources reported in Ireland were close to OECD average levels,

e.g., the number of devices available for instruction and access to adequate software. However, the development of teacher skills and CPD resources, along with efficient models of technical support across schools, are more complex to roll-out than the provision of adequate levels of devices and software.

Reflecting on findings from Cosgrove et al. (2019), principals' priorities focus on implementing a Digital Learning Plan, developing a whole-school approach to embedding digital technology and developing teachers' skills in specific applications or software. Consideration may need to be given to whether strategies related to the use of digital technology in specific subjects may need to be re-examined in the context of the results of PISA 2015 and 2018 (since the transition to computer-based assessment), particularly in relation to STEM subjects, mathematics and science. The question of the broader use of digital technologies in assessment, including state examinations, is also relevant in this regard.

Further thematic analyses will be undertaken by the Educational Research Centre on digital technology in PISA 2018 in 2020-2021.

7.1.6 Aspects of student well-being in Ireland

Well-being has been identified as a key area of emphasis in the revised Junior Cycle, with the importance of student well-being highlighted as a key issue in a holistic sense for young people, but also in relation to their performance at school. PISA 2018 provides useful data on student wellbeing in Ireland, along with other studies (My World, HBSC etc.), that may contribute to a better understanding of how best to support young people as they navigate their educational careers. Exploring the factors that contribute to life satisfaction, and investigating the relationship between exam stress, sources of pressure and student performance are important in considering student educational experiences and outcomes.

Students in Ireland reported a lower level of life satisfaction (61.4%) compared to the average across OECD countries (66.9%). On average, female students in Ireland were less likely to be satisfied with their life (55.5%) compared to male students (67.3%); the gender difference is statistically significant. Approximately 45.3% of students in Ireland reported feeling happy all of the time ('always') in normal circumstances, compared to 41.0% of students on average across OECD countries, while fewer students in Ireland felt cheerful, joyful or proud than students on average across OECD countries. Other studies (My World 2, HBSC) have explored gender and age differences in levels of life satisfaction in teenagers, with males and younger students more likely than females and older teenagers to report levels of higher life satisfaction (Dooley et al., 2019; Költű et al., 2020).

A certain level of exam stress may be considered part of a students' educational experience. In Ireland, in response to a national question in PISA 2018, students were often found to compare themselves to others, with 44.8% of students in Ireland reporting that they often or always feel like they will never do as well as other students in exams and tests. Over half of students (51.6%) reported that they often or always worry about what would happen if they fail an exam or test, while 43.1% reported that they often or always feel nervous and stressed when thinking about or doing exams and tests. Students in Ireland who reported 'often' worrying about what would happen if they failed a test or exam had a higher overall mean score on reading literacy than students who never or sometimes worried about this. Students who reported that they often or always felt physically unwell thinking about exams performed less well on average on reading literacy (498.9 and 509.1 respectively) compared to students who never feel physically sick thinking about tests (546.9). In contrast, there was little difference in the mean scores in reading literacy of students who

reported never, sometimes, often or always feeling stressed about tests, highlighting the complexity of identifying optimal or tolerable levels of stress. The *My World 2* (Dooley et al., 2019) identified increased risk factors for adolescent well-being between the two phases of the study (e.g., increased rates of anxiety and depression), along with decreasing trends in other risk factors (e.g., fewer adolescents reported being bullied, or drinking alcohol).

Students in Ireland who reported that they often or always put themselves under pressure to do well on exams and tests scored significantly higher on reading literacy (531.0 and 548.5 respectively), compared to students who reported that they never put pressure on themselves to do well (493.3). Students who reported never feeling under pressure from their teachers to do well also scored significantly lower in reading literacy compared to students who reported sometimes feeling pressure (517.3), often feeling pressure (535.2) or always feeling pressure (530.1). The amount of pressure that students perceive from teachers or from themselves may be related to their educational aspirations, or their previous performance on the tests, and it may be useful to explore whether students perceive the pressure to be negative or positive in relation to their performance and their mental health.

The ERC is undertaking research to develop an evaluation of Teachers' Professional Learning (TPL) activities 2019-2021. The overarching aim is to provide a template for evaluating TPL activities in key areas, which will be applied to student wellbeing. The study will involve qualitative and quantitative feedback from teachers, students and stakeholders. The interrelationships between students, teachers and the school environment in supporting student well-being and educational outcomes will require further research.

7.2 Looking ahead to PISA 2021

The next cycle of PISA, PISA 2021, is underway, with the Field Trial due to take place in March and April 2020, and the Main Study in 2021. Mathematical literacy will be the main domain, with science and reading literacy as minor domains. PISA 2021 will be the third cycle in which the tests and the Student Questionnaire are fully administered on computer in Ireland, and the first time that the main mathematics assessment will be tailored for computer-based assessment, incorporating interactive items. Furthermore, incorporating adaptive testing into the mathematics assessment design is planned in 2021. Therefore, PISA 2021 will include new interactive items designed for computer-based assessment for each of the three domains of mathematics, reading literacy and science. Adaptive testing will be integrated for reading literacy and mathematics in 2021, with science following in PISA 2024, the next time that science is the main assessment domain.

In a similar vein to science in 2015 and reading literacy in 2018, new tasks in 2021 aim to position PISA mathematics in a rapidly changing world driven by new technologies and students' ability to deal with unexpected tasks relevant to the world and society in which they live. Mathematical reasoning, a long-term part of the PISA framework, is a core component of the 2021 mathematics framework. Technology is also relevant, exploring the need for students to understand those computational thinking concepts that are part of mathematical literacy, and recognising the reality of computer-based assessment for students in the 21st Century.

A change to the integrated design is planned for PISA 2021, with two 1-hour blocks forming the two-hour assessment. Students will only be tested on two domains, one being mathematics as the main domain of assessment. In previous cycles, four 30-minute blocks constituted the assessment, with various combinations of domains administered to students. The updated approach is aligned with the integration of a more adaptive design as PISA incorporates technological advances.

Ireland is planning to administer the core Student and School Questionnaires, along with the optional (and very short) ICT Familiarity Questionnaire, and the Well-being Questionnaire in 2021. Ireland was one of nine countries to administer the new Well-being questionnaire in PISA 2018. In 2021, parents will also be asked to complete a paper-based questionnaire, as in PISA 2015 and 2018, providing useful contextual information on the home and family backgrounds of students participating in PISA. A nationally-developed questionnaire will also be administered to teachers of mathematics.

Creative Thinking is the optional innovative domain developed by the OECD to be administered as part of PISA 2021, integrated into the two hour test window; however, due to PISA's design, not all students will be assessed on Creative Thinking cognitive items. A questionnaire will complement the cognitive assessment, with questions on creativity, and creative attitudes and behaviours. The assessment of Creative Thinking seeks to assess students' knowledge and competency across four domains of written expression, social problem-solving, scientific problem-solving, and visual expression. The scoring of the innovative domain brings new challenges, as coders must evaluate students' responses under three themes: variety of ideas, originality, and ability to evaluate and improve ideas. Ireland will not take part in the cognitive assessment of Creative Thinking in PISA 2021, but will administer the questionnaire component in the PISA 2021 Field Trial; this may provide useful information on the attitudes of Irish students around creativity and creative thinking, as well as allowing comparison with other countries.

References

Banks, J., McCoy, S., & Smyth, E. (2018). *Senior Cycle Review: Analysis of discussions in schools on the purpose of senior cycle education in Ireland.* Working Paper No. 607, Dublin: ESRI.

Central Statistics Office (CSO). (2013). *PIAAC 2012 Survey Results for Ireland.* Dublin: Author.

Clerkin, A., Perkins, R., & Cunningham, R. (2016). *TIMSS 2015 in Ireland: Mathematics and science in primary and post-primary schools.* Dublin: Educational Research Centre.

Conway, P., & Sloane, F. (2005). *International trends in post-primary mathematics education: Perspectives on learning, teaching and assessment.* Dublin: NCCA.

Cosgrove, J., Moran, E., Feerick, E., & Duggan, A. (2019). *Digital Learning Framework national evaluation: Starting off. Baseline report.* Dublin: Educational Research Centre.

Cosgrove, J., Ní Chobhthaigh, S., Shiel, G., & Leahy, M. (2018a). *Digital Learning Framework trial evaluation: Baseline report.* Dublin: Educational Research Centre.

Cosgrove, J., Duggan, A., Shiel, G., & Leahy, M. (2018b). *Digital Learning Framework trial evaluation: Final report.* Dublin: Educational Research Centre.

Cosgrove, J., Butler, D., Leahy, M., Shiel, G., Kavanagh, L., & Creaven, A-M. (2014a). *The 2013 ICT Census in Schools - Main Report.* Dublin: Department of Education and Skills.

Cosgrove, J., & Cartwright, F. (2014b). Changes in achievement on PISA: The case of Ireland and implications for international assessment practice. *Large-Scale Assessments in Education, 2, 2.*

Department of Education and Skills (DES). (2019a). *Cumasú – Empowering through learning: Statement of Strategy 2019-2021.* Dublin: Author.

DES. (2019b). *Wellbeing Policy Statement and Framework for Practice, 2018-2023.* Dublin: Author.

DES. (2017a). *Digital Learning Framework for post-primary schools.* Dublin: Author.

DES. (2017b). *STEM Education Policy Statement.* Dublin: Author.

DES. (2017c). *Literacy and Numeracy for Learning and Life 2011-2020: New targets 2017-2020.* Dublin: Author.

DES. (2016). *Action Plan for Education 2016-2019.* Dublin: Author.

DES. (2015a). *Digital Strategy for Schools – Enhancing Teaching, Learning And Assessment.* Dublin: Author.

DES. (2015b). *Framework for Junior Cycle.* Dublin: Author.

DES. (2011). *Literacy and Numeracy for Learning and Life: The National Strategy to Improve Literacy and Numeracy among Children and Young People*. Dublin: Author.

DES. (2008). *Investing effectively in information and communications technology in schools, 2008-2013*. Dublin: Author.

DES. (2005). *DEIS, Delivering Equality of Opportunity in Schools: An Action Plan for Educational Inclusion*. Dublin: Author.

Department of Children and Youth Affairs. (2014). *Better Outcomes, Brighter Futures: The National Policy Framework for Children and Young People, 2014-2020.* Dublin: Author.

Department of Education and Skills & National Council for Curriculum and Assessment. (2017). *Guidelines for Wellbeing in Junior Cycle.* Dublin: Author.

Dooley, B., O'Connor, C., Fitzgerald, A., & O'Reilly, A. (2019). *My World Survey 2: The National Study of Mental Health in Ireland.* Jigsaw & UCD School of Psychology: Dublin.

Eivers, E., Gilleece, L., & Delaney, E. (2017). *Reading achievement in PIRLS 2016: Initial report for Ireland.* Dublin: Educational Research Centre.

European Commission. (2012). *Report of the thematic working group on assessment of key competencies: Literature review, glossary and examples*. Brussels: Author.

Griffin, P., McGaw, B., & Care, E. (2012). *Assessment and teaching of 21st century skills*. Dordrecht: Springer.

Jeffes, J., Jones, E., Cunningham, R., Dawson, A., Cooper, L., Straw, S., et al. (2012). *Research into the impact of Project Maths on student achievement, learning and motivation: First interim report for the Department of Education and Skills and the National Council for Curriculum and Assessment.* Slough: NFER.

Jeffes, J., Jones, E., Wilson, M., Lamont, E., Straw, S., Wheater, R., et al. (2013). *Research into the impact of Project Maths on student achievement, learning and motivation: Final report*. Slough: NFER.

Jerrim, J. (2016). PISA 2012: how do results for the paper and computer tests compare? *Assessment in Education: Principles, Policy & Practice*, 23:4, 495-518.

Kirwin, L. (2015). Mathematics curriculum in Ireland. The influence of PISA on the development of Project Maths. *International Electronic Journal of Elementary Education, 8*(2), 317-332.

Költű, A., Gavin, A., Molcho, M., Kelly, C., Walker, L. and NicGabhann, S. (2020). *The Irish Health Behaviour in School-aged Children (HBSC) Study 2018.* Galway: Health Promotion Research Centre, NUI Galway.

Merriman, B., Shiel, G., Cosgrove, J., & Perkins, R. (2014). *Project Maths and PISA 2012: Performance in initial project maths schools and in non-initial schools on PISA 2012 mathematics and problem-solving and on Junior Certificate mathematics*. Dublin: Educational Research Centre.

National Council for Curriculum and Assessment (NCCA). (2018a). *Junior Cycle Specification – English.* Dublin: Author.

NCCA. (2019). *Interim report of review of Senior Cycle education*. Dublin: Author.

NCCA. (2018a). *Junior Cycle English.* Dublin: Author.

NCCA. (2018b). *Report of the review of the early enactment of Junior Cycle English.* Dublin: Author.

NCCA. (2017a). *Junior Cycle mathematics*. Dublin: Author.

NCCA. (2017b). *Junior Cycle well-being guidelines*. Dublin: Author.

NCCA. (2015). *Junior Cycle science.* Dublin: Author.

NCCA. (2003). Junior Certificate science syllabus. Ordinary level and higher level. Dublin: Stationery Office.

Organisation for Economic Cooperation and Development (OECD). (2020, in press). *PISA 2018 Technical Report.* Paris: OECD Publishing. Accessed at: https://www.oecd.org/pisa/data/pisa2018technicalreport/

OECD. (2019a). *PISA 2018 assessment and analytical framework*. Paris: OECD Publishing.

OECD. (2019b). *PISA 2018 main survey item pool – Cognitive assessment.* Paris: OECD Publishing.

OECD. (2019c). *PISA 2018 released field trial and main aurvey new reading items*. Paris: OECD Publishing.

OECD. (2019d). *PISA 2018 Results Volume 1: What students know and can do*. Paris: OECD Publishing.

OECD. (2019e). *PISA 2018 Results Volume 2: Where all students can succeed.* Paris: OECD Publishing.

OECD. (2019f). *PISA 2018 Results Volume 3: What school life means for students' lives.* Paris: OECD Publishing.

OECD. (2019g). *Education at a Glance 2019: OECD Indicators*. Paris: OECD Publishing.

OECD. (2018). PISA 2021 mathematics framework. Draft. Paris: Author. Accessed at: https://pisa.e-wd.org/files/PISA%202021%20Mathematics%20Framework%20Draft.pdf

OECD. (2017a). *PISA 2015 Results – Volume III: Students' well-being.* Paris: OECD Publishing.

OECD. (2017b). *PISA 2015 Technical Report.* Paris: OECD Publishing.

OECD. (2016a). *PISA 2015 assessment and analytic framework: Science, reading, mathematics, financial literacy, and collaborative problem solving*. Paris: OECD Publishing.

OECD. (2016b). *Skills Matter – Further Results from the Survey of Adult Skills.* Paris: OECD Publishing.

OECD. (2016c). *Classification and scaling information of PISA 2015 Main Survey Items.* Paris: OECD Publishing.

OECD. (2013). *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem-solving and financial literacy*. Paris: OECD Publishing.

Perkins, R., Shiel, G., Merriman, B., Cosgrove, J., & Moran, G. (2013). *Learning for life: The achievements of 15-year-olds in Ireland on mathematics, reading literacy and science in PISA 2012.* Dublin: Educational Research Centre.

Perkins, R., Cosgrove, J., Moran, G., & Shiel, G. (2012). *PISA 2009: Results for Ireland and changes since 2000*. Dublin: Educational Research Centre.

Pitsia, V., O'Leary, M., Shiel, G., & Lysaght, Z. (2019). *What do international large-scale assessments tell us about high achievement in mathematics and science, with specific reference to Ireland and some comparison countries?* Paper presented at AEA-Europe 2019.

Sachse, K.A., Mahler, N., & Pohl, S. (2019). When nonresponse mechanisms change: Effects on trends and group comparisons in international large-scale assessments. *Educational and Psychological Measurement, 79 (4).*

SEC (State Examinations Commission). (2017). *Junior Cycle Examination 2017 – English, Chief Examiner's Report.* Dublin: Author.

Shiel, G., & Kelleher, C. (2017). *An evaluation of the impact of Project Maths on the performance of students in Junior Cycle mathematics*. Dublin: Educational Research Centre.

Shiel, G., Kelleher, C., McKeown, C., & Denner, S. (2016). *Future Ready? The performance of 15-year-olds in Ireland on science, reading and mathematics in PISA 2015.* Dublin: Educational Research Centre.

Shiel, G., & Kavanagh, L. (2014). *The 2014 National Assessments of English Reading and Mathematics. Vol. 1: Performance.* Dublin: Educational Research Centre.

Werlich, E. (1976). *A text grammar of English.* Heidelberg: Quelle and Meyer.

Westat. (2019). *PISA 2018: Weighting summary report for Ireland.* Maryland: Author.

Appendix A:
Membership of the PISA 2018 National Advisory Committee

In Ireland, PISA is administered on behalf of the Department of Education and Skills (DES) by the Educational Research Centre. The DES and the ERC are supported in their work by a National Advisory Committee. Members of the PISA 2018 National Advisory Committee are:

Orlaith O'Connor (Department of Education and Skills, Chair, from September 2019)

Suzanne Dillon (Department of Education and Skills, Chair, to August 2019)

Declan Cahalane (Department of Education and Skills, to April 2019)

Conor Galvin (University College Dublin)

Odilla Finlayson (Dublin City University)

Deirdre Henchy (State Examinations Commission, from April 2016)

Philip Matthews (Trinity College Dublin)

Brendan MacMahon (National University of Ireland Galway, from May 2016)

Kevin McClean (Department of Education and Skills, from April 2019)

Thomas McCloughlin (Dublin City University)

Hugh McManus (State Examinations Commission, to April 2016)

Frances Moss (Department of Education and Skills, from September 2019)

Brian Murphy (University College Cork)

Evelyn O'Connor (National Council for Curriculum and Assessment, from May 2016)

Liz O'Neill (Department of Education and Skills, to April 2016)

Maurice O'Reilly (Dublin City University)

Ruth Richards (Department of Education and Skills, to April 2019)

Barry Slattery (National Council for Curriculum and Assessment)

Peter Archer (ERC, PISA Governing Board representative, to September 2018)

Caroline McKeown (ERC, National Project Manager 2018, PISA Governing Board representative September 2018 – August 2019)

Gerry Shiel (ERC)

Sylvia Denner (ERC)

Sarah McAteer (ERC)

Lynsey O'Keeffe (ERC)

Rachel Perkins (ERC, PISA Governing Board representative, from September 2019)

Brenda Donohue (ERC, National Project Manager 2021).

Educational Research Centre, Dublin 9
http://www.erc.ie

ISBN 978-0-900440-81-6