Learning for Life:

The Achievements of 15-year-olds in Ireland on Mathematics, Reading Literacy and Science in PISA 2012

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Preface

The Programme for International Student Assessment (PISA) is an international assessment of the skills and knowledge of 15-year-old students in mathematics, reading and science. It is sponsored by the Organisation for Economic Co-operation and Development (OECD). PISA takes place in three yearly cycles (beginning in 2000). PISA 2012 is the fifth cycle of the study. In each cycle, one of the subject areas, or domains, becomes the major focus of the assessment with the other domains assessed as 'minor domains'. Mathematics is the main domain in 2012 and was also the main domain in 2003, allowing for a detailed comparison of results between these two cycles. Results for reading and science are compared to the cycles when they were assessed as major domains - 2000 and 2009 in the case of reading, and 2006 for science. Where data are available, comparisons are made across all cycles for each domain.

As part of PISA 2012, students in Ireland also participated in computer-based assessments of mathematics and digital reading (along with students from 31 other countries), and a computer-based assessment of problem solving (with students in 43 other countries). The results for computer-based mathematics and digital reading are presented in this report, while the results for problem solving will be published by the OECD in spring 2014. A national report presenting the problem-solving results for Ireland will also be published at the same time as the international report.

In Ireland, PISA 2012 was managed by the Educational Research Centre (ERC) on behalf of the Department of Education and Skills (DES). Just over 5,000 students in 182 schools in Ireland completed the assessment in March 2012. In all, around 510 000 students in 65 countries/ economies participated in PISA 2012.

The OECD (2013a) has published a framework for PISA 2012 and the initial results of PISA 2012 in four volumes (OECD, 2013b-e), while a technical report that describes the design, methods and procedures underlying PISA will be published shortly (OECD, in press). The ERC has already published two reports based on a survey of mathematics teachers in schools that participated in PISA 2012: *Teaching and Learning in Project Maths: Insights from Teachers who Participated in PISA 2012* (Cosgrove, Perkins, Shiel, Fish and McGuinness, 2012) and *Mathematics in Transition Year: Insights from Teachers from PISA 2012* (Moran, Perkins, Cosgrove & Shiel, 2013).

This report is divided into eight chapters which are preceded by an executive summary. Chapter 1 presents an overview of the design, content and procedures associated with PISA. Chapter 2 provides the research and policy context for PISA 2012, including a review of the performance of students in Ireland in previous cycles of PISA. Chapter 3 describes the achievements of students in Ireland on the PISA 2012 assessments of print and computer-based mathematics. Results are presented for the overall print and computer-based mathematics scales, as well as the seven print mathematics subscales. Chapter 4 describes the performance of students in Ireland on the print and digital assessments of reading, and the assessment of science. Chapter 5 provides a description of school and student characteristics and their associations with mathematics achievement, while Chapter 6 explores students' attitudes towards and engagement with school and mathematics. Chapter 7 describes trends in achievement, student and school characteristics, and students' attitudes towards and engagement with mathematics and school. Consideration is also given to some factors which may be related to changes in achievement since previous cycles. Conclusions are presented in Chapter 8.

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Finally, we especially thank all students and schools who participated in PISA 2012, during both the field trial in spring 2011 and the main study in 2012. In particular, we thank the students for completing the tests and questionnaires, and the school-coordinators for arranging the assessments. Without their help, PISA in Ireland would not have been possible.

Acronyms and Abbreviations

BRR	Balanced Repeated Replication
CSO	Central Statistics Office
DES	Department of Education and Skills
DEIS	Delivering Equality of opportunity In Schools
ERC	Educational Research Centre
ESCS	Economic, Social and Cultural Status
HLM	Hierarchical Linear and nonlinear Modelling
IALS	International Adult Literacy Survey
ICCS	International Civics and Citizenship Study
ICT	Information and Communication Technology
IRL	Ireland
IRT	Item Response Theory
ISCO	International Standard Classification of Occupations
ISCED	International Standard Classification of Education
ISEI	International Socio-Economic Index
NCCA	National Council for Curriculum and Assessment
NS	Not Significant
OECD	Organisation for Economic Co-operation and Development
PIAAC	Programme for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
PM	Project Maths
SD	Standard Deviation
SE	Standard Error
SED	Standard Error of the Difference
SEN	Special Educational Needs
SES	Socio-economic Status
SSP	School Support Programme
TALIS	Teaching and Learning International Survey
TIMSS	Trends in International Mathematics and Science Study
UAE	United Arab Emirates

Executive Summary

In 2012, the Programme for International Student Assessment (PISA) was administered in 65 countries/economics, including all 34 member states of the Organisation for Economic Co-operation and Development (OECD). In Ireland, 5015 15-year-olds in 182 schools took part. In all countries/economies, students sat print-based tests of mathematics, reading literacy and science and completed background questionnaires. In subsets of countries, including Ireland, subsamples of students also completed computer-based tests of mathematics, reading literacy and problem solving. In all countries, principal teachers completed school background questionnaires.

For the first time since 2003, mathematics was a major assessment domain in PISA 2012. Hence, there is strong emphasis on mathematics in reporting outcomes, and many of the analyses in this report include mathematics performance. However, some reference is also made to the minor domains of reading literacy (a major domain in 2009) and science (a major in domain in 2006). In line with OECD reporting practices, performance on computer-based problem solving in PISA 2012 will not be reported on until spring 2014.

Print Mathematics Performance

In 2012, Ireland's mean performance on print mathematics is 501.5, which is significantly above the average across OECD countries (494.0). Ireland is ranked 13th out of 34 OECD countries and 20th out of all participating countries. Ireland's performance does not differ significantly from that of Australia (504.2), New Zealand (499.7), France (495.0) and the United Kingdom (493.9). Students in Ireland perform significantly better than their counterparts in Northern Ireland (486.9). Ireland's mean print mathematics score in 2012 is significantly higher than in 2009 (487.1), but does not differ from the mean scores obtained in 2003 (502.8) and 2006 (501.5).

In line with its status as a major assessment domain, performance on PISA 2012 print mathematics is also reported with reference to four mathematics content area subscales (Change & Relationships, Space & Shape, Quantity and Uncertainty & Data). Ireland has mean scores that are above the corresponding OECD averages in Uncertainty & Data (Ireland: 508.7; OECD average: 493.1), Quantity (505.2, 495.1) and Change & Relationships (501.1, 492.6). However, performance is below the corresponding OECD average in Space & Shape (477.8, 489.6). There has been little change in the mean scores of students in Ireland across the four mathematical content areas since 2003, with the exception of the Uncertainty & Data subscale. Although students in Ireland perform best on Uncertainty & Data in both 2003 and 2012, performance is significantly lower on this subscale in 2012 than in 2003 (517.2).

Three new mathematical process subscales are described for print mathematics in PISA 2012: Formulating, Employing, and Interpreting. The mean scores of students in Ireland on the Interpreting and Employing subscales (506.8 and 502.3, respectively), are significantly above the corresponding OECD average scores (497.0 and 493.4, respectively), while students in Ireland do not differ significantly from the average of students across OECD countries in terms of performance on the Formulating subscale (492.4 for Ireland and 491.6 for the OECD average).

The score of students in Ireland at the 10th percentile (i.e. lower-performing students) on the overall print mathematics scale in PISA 2012 is 391.0, which is significantly above the corresponding OECD average (375.0), while the score of higher-achieving students (i.e. those at the 90th percentile) (609.8) is not significantly different from the corresponding OECD average (613.6). There is considerable variation in the performance of lower- and higher-achieving students in Ireland across the process and content area subscales, ranging from 356.5 for the Space & Shape subscale to 395.0 for the Uncertainty & Data subscale for lower-achieving students, and from 598.4 for the Space & Shape subscale to 623.5 for the Quantity subscale for higher-achieving students. There has been little change in the scores of Irish students at the 10th percentile on the overall print mathematics and the content area subscales between 2003 and 2012. On the other hand, the score of students at the 90th percentile on the Uncertainty & Data subscale has dropped significantly since 2003 (from 632.5 to 619.4). The performance of higher-achieving students on the other subscales and on the overall print mathematics scale has not changed significantly since 2003 in Ireland.

Ireland has considerably fewer students performing below Level 2 on the overall print mathematics scale compared to the OECD average (16.9% and 23.0%, respectively), while the proportion of students performing at or above Level 5 in Ireland is about the same as the corresponding OECD average (10.7% and 12.6%, respectively). There is some variation in the proportion of students performing below Level 2 across the process and content area subscale in Ireland in 2012 (ranging from 15.8% on Uncertainty & Data to 26.7% on Space & Shape). On the other hand, the proportion of students performing at or above Level 5 in Ireland ranges from 8.3% on Space & Shape to 13.7% on Quantity. With the exception of 2009, which saw an increase in the proportion of students performing below Level 2 and a decrease in the proportion of students performing at Level 5 or above, there has been little variation in the proportions of students performing at these benchmarks since 2003.

Male students in Ireland significantly outperform females on print mathematics in 2012 (509.0 and 493.7, respectively). The mean print mathematics scores of males and females in Ireland have not changed significantly between 2003 and 2012 but both are significantly higher than in 2009. The gender difference in Ireland is also similar in 2003 and 2012 (14.8 points and 15.3 points, respectively). There has been a slight variation in the mean scores of male and female students in Ireland across the content area subscales in 2003 and 2012, although none of these differences is significant. There has also been little change in the proportion of lower- and higher-achieving males and females in Ireland across the two cycles.

Computer-based Mathematics Performance

Students in Ireland have a mean computer-based mathematics score of 493.1 in PISA 2012, which does not differ significantly from the corresponding OECD average score (497.1). Ireland's score is ranked 15th among the 23 OECD countries and 20th among all 32 participating countries. Students in Ireland perform significantly less well on the computer-based assessment of mathematics than on the print mathematics assessment. However, there is considerable variation in the performance of countries across the print and computer-based assessments, with 15 countries obtaining higher print mathematics than computer-based mathematics scores and 17 countries achieving lower scores.

The score of students at the 10th percentile on the computer-based mathematics scale in Ireland does not differ from the OECD average (387.9 and 382.0, respectively), while the performance of students at the 90th percentile in Ireland is significantly below the corresponding OECD average (593.6 and 609.1, respectively). The percentage of students scoring below Level 2 on computer-based mathematics in Ireland (17.9%) is similar to the corresponding percentage for print mathematics (16.9%) but is slightly below the OECD average for computer-based mathematics (20.0%). On the other hand, there is a somewhat higher proportion of students at Level 5 or above on print mathematics (10.7%) than on computer-based mathematics (7.0%) in Ireland and the proportion of students scoring at Level 5 or above on the computer-based mathematics scale is lower in Ireland than on average across OECD countries (11.3%).

In Ireland, male students have a score of 502.2 on computer-based mathematics, which is significantly higher than the score for female students (483.6). Male students in Ireland do not differ from the OECD average score for males (503.3); however, female students in Ireland perform significantly less well than do females on average across OECD counterparts (490.8). The size of the gender difference in Ireland is slightly larger for computer-based mathematics (18.6 points) than for print mathematics (15.3 points). A somewhat higher percentage of female students than male students perform below Level 2 on the computer-based mathematics scale in Ireland (20.1% versus 15.7%), while over twice as many male as female students obtain computer-based mathematics scores at Level 5 or above (9.7% compared to 4.3%).

Print Reading Performance

In 2012, the mean print reading score of students in Ireland is 523.2, which is significantly above the OECD average score of 496.5. Ireland is ranked 4th out of 34 OECD countries and 7th out of all 65 participating countries. The mean print reading score for Ireland has increased significantly since 2009 (from 495.6) but is not significantly different to the mean score in 2000 (526.7), the two cycles when print reading was assessed as a major domain.

Students scoring at the 10th and 90th percentiles on the print reading scale in Ireland in 2012 (410.2 and 631.5, respectively) have significantly higher scores than the corresponding averages across OECD countries (371.7 and 613.5, respectively). The score of students in Ireland at the 10th percentile on print reading is higher in 2012 than in 2000 (401.3), while the performance of higher-achieving students is lower (641.1 in 2000), although neither difference is significant.

In Ireland, 9.6% of students perform below Level 2 on print reading, compared to 18% across OECD countries. The proportion of students at or above Level 5 on the print reading scale is somewhat higher in Ireland compared to the OECD average (11.4% and 8.5%, respectively). The proportions of students below Level 2 and at or above Level 5 on print reading in Ireland are lower in 2012 than in 2000 (by 1.4% for those below Level 2 and by 2.8% for those at Level 5 or above).

Female students significantly outperform male students in Ireland on the print reading scale in 2012 (537.7 and 509.2, respectively). While male and female students in Ireland have significantly higher mean print reading scores than the respective OECD average scores, the difference is somewhat larger for males (+31.4 points compared to +22.3 points). The mean print reading scores of male and female students in Ireland have not changed significantly since 2000 (541.5 for females and 512.8 for males). The gender difference, in favour of females, is also about the same in 2012 (28.5 points) as it was in 2000 (28.7 points). The proportion of lower-achieving male students in Ireland in 2012 (13.0%) is about the same as in 2000 (13.5%), while the proportion of lower-achieving female students decreased slightly, from 8.3% in 2000 to 6.1% in 2012. On the other hand, the proportions of higher-achieving males and females in reading have decreased since 2000, by 2.7 percentage points for males and 3.0 percentage points for females.

Digital Reading Performance

The mean score of students in Ireland on digital reading is 520.1, which is significantly above average digital reading score across OECD countries (496.9) and the mean score for Ireland in 2009 (508.9). In 2012, Ireland's performance is ranked 5th among the 23 OECD countries and 9th among all 32 participating countries. There is no significant difference between the mean digital reading and print reading scores for students in Ireland in 2012, while students in Ireland perform significantly higher on the assessment of digital reading than on the print reading assessment in 2009.

The scores of students in Ireland at the 10th and 90th percentiles on the digital reading assessment in 2012 (411.6 and 621.6, respectively) are significantly higher than the corresponding OECD average scores (372.8 and 611.4, respectively). The scores of students at both the 10th and 90th percentiles increased since 2009 (from 397.7 to 411.6 for lower-performing students and from 616.2 to 621.6 for higher-performing students). There is little difference between the mean scores of students at the 10th percentile on the digital and print reading assessments, while students at the 90th percentile perform less well on digital reading than on print reading.

The proportion of students in Ireland performing at Level 2 or below on the digital reading assessment in Ireland (9.4%) is considerably lower than the average across OECD countries (17.6%), while the proportion of students at or above Level 5 (9.0%) is similar to the OECD average (8.0%). The proportion of students below Level 2 in Ireland is lower in 2012 than in 2009 (12.1%), while the proportion scoring at or above Level 5 is higher (7.8%). In Ireland, the proportions of students below Level 2 on the digital and print reading assessments are similar, while the proportion of students at Level 5 or above is slightly lower for digital reading than for print reading.

Female students significantly outperform males on the digital reading assessment in Ireland (533.0 compared to 507.7). Both male and female students in Ireland have significantly higher mean digital reading scores than the corresponding OECD average scores (484.0 for males and 510.0 for females). Also, both male and female students in Ireland achieve higher mean scores on print than on digital reading, although the differences are small (4.7 points for females and 1.5 points for males). The digital reading performance of male and female students in Ireland also increased significantly between 2009 and 2012 (from 493.6 to 507.7 for males and from 524.6 to 533.0 for females) and the gender difference decreased from 31.1 points in 2009 to 25.3 points in 2012. The proportions of males and females scoring at Level 5 or above have increased slightly since 2009, by 1.2% for males and 1.3% for females. On the other hand, the percentage of males scoring below Level 2 on digital reading decreased from 16.6% to 12.2% between 2009 and 2012, while the proportion of females scoring below Level 2 remained stable (7.4% in 2009 and 6.5% in 2012).

Science Performance

Ireland's mean science score in 2012 is 522.0, which is significantly above the corresponding OECD average (501.2). Ireland's score is ranked 9th among 34 OECD countries and 15th among all 64 participating countries. The mean science score of students in Ireland has increased significantly since 2006 (508.3) and is also significantly higher than in 2009 (508.0).

At both the 10th and 90th percentiles, students in Ireland achieved mean science scores that are significantly higher than on average across OECD countries (403.9 compared to 379.9 at the 10th percentile, and 636.6 compared to 618.8 at the 90th percentile) in 2012. The performance of students at the 10th percentile has increased significantly since 2009 (+18.6 points), as has the performance of students at the 90th percentile (+6.3 points).

In Ireland, 11% of students are performing below Level 2 on the science scale, which is considerably lower than the corresponding OECD average (17.8%), while the proportion of students at or above Level 5 in Ireland is slightly above the corresponding OECD average (10.8% and 8.4%, respectively). The percentage students below Level 2 in science in Ireland decreased from 15.5% to 11.1% between 2006 and 2012, while the proportion of higher-achieving students increased from 9.4% to 10.8%.

There is no significant difference between male and female students in Ireland in terms of science performance in 2012 (523.9 and 520.0, respectively). The mean science scores of both male and female students in Ireland are significantly higher than the corresponding OECD average scores (501.8 for males and 500.5 for females). The mean science scores of both male and female students in Ireland also increased significantly between 2006 and 2012, although the increase was greater among male students (+15.8 points) than among females (+11.5 points). The gender difference has changed slightly from 0.4 points in favour of females in 2006 to 3.9 points in favour of males in 2012.

In 2012, the proportions of male and female students performing below Level 2 on the science scale are similar in Ireland (11.6 and 10.5, respectively), while slightly more male than female students have science scores at or above Level 5 (11.7% and 9.7, respectively). The proportions of male and female students performing below Level 2 have decreased considerably since 2006 (-5.0 percentage points for males and -3.9 percentage points for females), while the proportions at or above Level 5 have increased slightly (+1.4 percentage points for males and +1.2 percentage points for females).

Student and School Characteristics Associated with Achievement

In addition to contextual information gathered through questionnaires completed by students and principals, some information from national sources (such as the DES post-primary database) was drawn on to better understand student performance, especially in mathematics, which was assessed as the major domain in 2012. Comparisons are made with 2003, when mathematics was last assessed as a major domain. Demographic characteristics that have been found to be related to mathematics achievement in 2012 include student Economic, Social and Cultural Status (ESCS), which is positively associated with achievement in all domains. In Ireland, a one unit (i.e. standard deviation) increase in ESCS is associated with an increase of 38 points in print mathematics achievement, which is similar to the average across OECD countries (39 points). Families in Ireland have a significantly higher mean ESCS score compared to the average across OECD countries (0.13 compared to 0.00). Student mean ESCS in Ireland has increased significantly since 2003 (from -0.26 to 0.13).

In Ireland, students in one-parent families perform significantly less well than students in other family types (485.0 compared to 509.9 for print mathematics). There has been a decrease in the percentage of students from one-parent families since 2003 (from 15.4% to 11%) and the achievement gap between these two groups has narrowed somewhat between 2003 and 2012 (from 32.7 points to 24.9 points). In 2012, one-parent families have significantly lower ESCS (-0.20 in Ireland and -0.21 across OECD countries) than other family types (0.21 in Ireland and 0.06 across OECD countries).

In 2012, the percentage of immigrant students in Ireland (9.6%) is about the same as the OECD average (10.5%), and has increased significantly since 2003 (3.4%). Of the 9.6% of students in Ireland classified as immigrants in 2012, just over half speak Irish or English at home (5.1%) and the rest speak other languages (4.5%). In general, there are no significant differences in achievement scores between native students and immigrant students who speak English/Irish or immigrant student who speak other languages, with the exception of print reading where other language-speaking immigrants achieve a mean score (505.8) that is significantly lower than the scores for the other two groups (526.5 for native students and 529.3 for immigrant students who speak English/Irish). In Ireland in 2012, English/Irish-speaking immigrants have significantly higher average ESCS (0.33) than either native (0.12) or other language-speaking immigrants (0.05). The level of ESCS among immigrant students has changed relative to native students, i.e. immigrant students had a significantly higher average ESCS score than native students in 2003, while in 2012, there is no significant difference between the two groups of students in terms of their average ESCS.

Differences in achievement are also noted across grade levels. In 2012, the majority of PISA students in Ireland are in Third Year (60.5%), with a further quarter in Transition Year (24.3%) and smaller numbers in Fifth Year (13.3%) and First and Second years (1.9%). Transition Year students have significantly higher scores on all the achievement domains compared to Third Years (e.g., +27.9 points for print mathematics), while First and Second Years have significantly lower scores (-49.9 points for print mathematics), and Fifth Years do not differ significantly (+6.8 points for print mathematics). Student mean ESCS also varies according to grade level: Second and Fifth Years have lower average ESCS (-0.21 and -0.11 respectively) than Third Years (0.13), while Transition Year students have the highest average level (0.27).

Other aspects of students' backgrounds which are found to be associated with achievement in 2012 include the amount of time spent in paid work, preschool attendance, early school-leaving risk, and skipping school. Students who reported engaging in paid work during term time for more than 8 hours per week have significantly lower mean scores in all achievement domains compared with those who did not engage in paid work (by 28.6 points for print mathematics). Students in Ireland who never attended preschool perform significantly less well than students who had attended for a year or less and those who attended for more than a year, on all domains, with the exception of computer-based mathematics. The difference between those who have never attended and those who attended for a year or less was almost 15 points for print mathematics. However, this relationship appears to be related to ESCS as students from higher ESCS families are more likely to have had at least one year of pre-school education.

The 6.5% of students in Ireland who indicated that they did not intend to complete the Leaving Certificate or were unsure also achieve significantly lower scores on all five achievement domains (the difference was about 63 points for print mathematics). These students also have a lower average ESCS (-0.32) than the other students (0.17). The percentage of students who indicated that they intend to leave school before completing the Leaving Certificate declined from 20.5% in 2003 to 6.5% in 2012. Students who did not skip any days in the two weeks prior to the PISA assessment in their school significantly outperform those who skipped school for one or two days, and those who skipped school for three or more days, on all domains (the difference between those who had not skipped school and those who had skipped 3 or more days was almost 75 points for print mathematics)

School characteristics are also associated with some differences in achievement. Students attending fee-paying schools have higher average scores than those at non-fee-paying school, by about 57 points for print mathematics, and also have significantly higher levels of ESCS (0.88 compared to 0.06). Students attending schools in the School Support Programme (SSP) under DEIS perform significantly less well than their counterparts in other schools on all domains, and the difference is almost 60 points for print mathematics. In Ireland, students in boys' secondary schools obtain the highest print mathematics, computer-based mathematics and science scores (520.7, 512.7 and 537.2, respectively), while students in girls' secondary schools have the highest mean scores for reading (544.1 for print reading and 535.6 for digital reading).

Students in Ireland report significantly higher levels of teacher support in mathematics classes (0.08), higher levels of mathematics teacher classroom management (0.15) and more positive disciplinary climate in mathematics classes (0.13) when compared to the average across OECD countries (0.00 for all indices). Students in Ireland also report attending schools that offer significantly lower levels of mathematics extracurricular activities (1.81[1]) and where teachers engage in significantly lower levels of formative assessment (-0.07) and student-orientated practices (-0.58) compared to the OECD averages (2.36 for mathematics extracurricular activities and 0.00 for the formative assessment and student orientation indices). School principals in Ireland report significantly higher levels of teacher morale (0.49) compared to the OECD average (0.00).

Student Attitudes Towards and Engagement with School and Mathematics

PISA also assesses aspects of students' behaviour, motivation and confidence and the associations between these variables and students' mathematics performance.

Compared to the average across OECD countries, students in Ireland have significantly more positive attitudes towards school (in terms of learning activities or the perceived effects of working hard at school [0.20] and learning outcomes or the extent to which school is perceived to be useful [0.11]), higher levels of intrinsic (0.06) and instrumental motivation in mathematics (0.13), higher levels of perseverance in learning in general (0.14) and higher levels of subjective norms in mathematics (0.13), with the latter indicating that their views about mathematics and the mathematical ability of their parents and friends influence how they thought about mathematics (the OECD average for each index is 0.00). Students in Ireland also have significantly higher levels of anxiety about mathematics (0.11) than the OECD average (0.00). The mean scores for students in Ireland on mathematics self-efficacy (0.01), mathematics self-concept (-0.04) and sense of belonging to school (-0.03) are not significantly different from the OECD average scores (0.00). The mean scores of students in Ireland are significantly lower than the OECD averages on the self-responsibility for failure in mathematics (-0.10), mathematics behaviours (-0.43) and mathematics intentions indices (-0.12), indicating that students in Ireland are less likely to attribute mathematics failure to themselves, to engage in activities related to mathematics such as chess or mathematics clubs with any great frequency, and to intend to study mathematics courses in college or pursue a career in mathematics.

[1] The mathematics extracurricular activities index is scaled slightly differently from other indices. The OECD average for this scale is 2.36 rather than 0.00.

In Ireland, male students have significantly higher levels of instrumental (but not intrinsic) motivation, perseverance, self-efficacy, self-concept, openness to problem solving and maths intentions than females. Female students, on the other hand, have significantly higher levels of anxiety about mathematics and self-responsibility for failure in mathematics

Between 2003 and 2012, students' sense of belonging to school decreased significantly (from 0.09 to -0.03) in Ireland. Irish students' intrinsic and instrumental motivation for mathematics and their mathematical self-efficacy increased significantly since 2003 (+0.14 points for intrinsic motivation, +0.08 points for instrumental motivation and +0.12 points for mathematical self-concept), while there has also been a significant increase in students anxiety about mathematics (+0.09 points), especially among female students (+0.13 points compared to +0.05 points for males).

Trends in Achievement

A number of factors can be considered to have contributed to the increase in student performance in Ireland between 2009 and 2012, including the implementation of PISA 2012 in Ireland, changes in the demographics of the school-going population, changes in curriculum, changes in the level of effort that students invested in the tests, and changes in the way PISA estimates trends for reading.

With regard to the implementation of PISA in Ireland, there have been a number of changes since 2009. Firstly, members of the Inspectorate of the Department of Education and Skills (DES) and staff from the national centre administered the assessment in 2009 instead of teachers. Secondly, there was no prize draw used to incentivise student participation in 2012. Thirdly, the population of schools was not split as in 2009 as no other large scale international studies were conducted in post-primary schools at the time of PISA 2012. While Ireland met the technical standards set out and verified by the OECD and its contractors for both cycles, it is possible that other factors, such as survey fatigue could have had an indirect negative effect on performance in PISA 2009.

There has also been a number of changes in the school-going population in Ireland since 2009, including increases in the number of immigrant students (in particular an increase in the number of students speaking a language other than English or Irish from 3.5% to 4.5%) and students with Special Educational Needs participating in PISA (from 3.5% to 4.7%) and a decrease in the percentage of students selected to participate in PISA who had already left the education system decreased, from 1.5% to 0.5%[2]. Despite these changes in the school-going population in Ireland, the mean scores for reading, mathematics and science are significantly higher in 2012 than in 2009.

The introduction of social, environmental and scientific education in the revised primary curriculum in 1999 (Government of Ireland, 1999) and changes in the junior cycle science syllabus (Department of Education and Science, 2003) may have contributed to the significant increase in science achievement observed in Ireland in 2012, compared with earlier cycles, though the effects may have begun to have an impact in 2009, since, unlike reading literacy and mathematics, the performance of students in Ireland in 2009 did not decline significantly, compared with earlier cycles.

While there are fewer very low performing schools in the 2012 sample compared to the 2009 sample (three in 2012, compared to seven in 2009), the range of average school scores has increased

[2] The percentage of students with Special Educational Needs participating in PISA has increased from 2.0% 2003 to 4.7% in 2012. The percentage of students selected to participate in PISA who had already left the education system decreased, from 1.7% in 2003 to 0.5% in 2012.

in Ireland between the two cycles. In 2009, the difference between the lowest- and highest-performing schools for reading was 286.6 points, while in 2012 it was 298.3 points.

Also, a decline in the percentage of students skipping items between 2009 and 2012 is likely to have contributed to the increase in mean scores for print reading, mathematics and science. This suggests that students invested relatively more effort in the assessment in 2012 than in 2009.

Finally, there has been changes in the way in which PISA scores are scales. These include an increase in the number of common reading items (from 26 to 44) used to create links with reading achievement in previous cycles of PISA, which has allowed for a more stable analysis of reading trends. This means that changes in achievement scores across cycles are less likely to be overestimated.

1. Overview of PISA 2012

The Programme for International Student Assessment (PISA) is a project of the Organisation for Economic Co-operation and Development (OECD) that aims to measure how well students, at age 15[3], are prepared to meet the challenges they may encounter in future life, including education (OECD, 2013a). At age 15, students in most OECD countries are approaching the end of compulsory education. While PISA is informed by the content of national curricula, the focus of the assessment is on students' ability to apply knowledge and skills effectively in unfamiliar, real-life situations.

PISA takes place every three years and assesses students in the three domains of reading, mathematics and science[4]. As well as the traditional print-based assessment of these domains, countries in PISA 2012 were given the option of participating in an additional computer-based assessment of reading and mathematics.[5] Each cycle of PISA focuses on one 'major domain', to which the majority of testing time is devoted. The 'minor domains' provide a less detailed profile of achievement. Mathematics was the major domain for the second time in PISA 2012 (see Table 1.1). Therefore, it provided the first opportunity for a detailed examination of changes over time in mathematics outcomes. In addition to reading and science, problem solving was assessed as a minor domain in PISA 2012, the second time it has been assessed as a minor domain since 2003.

While problem solving was assessed in both PISA 2003 and 2012, comparisons between the two cycles are not recommended. This is because the PISA 2012 assessment of problem solving was delivered on a computer platform (by comparison to the print version administered in PISA 2003), which allowed the inclusion of items that require students to interact with the problem situation, and involved the gathering of data on the nature of these interactions. Also, while cross-disciplinary problems were included in the PISA 2003 assessment, problems requiring disciplinary knowledge were avoided in PISA 2012, as the focus was on the underlying cognitive processes necessary for problem solving. Further information on the content and results of the PISA 2012 assessment of problem solving will be published in a separate national report in spring 2014, at which time the results of the assessment will also be released by the OECD.

Table 1.1. Assessment domains across PISA cycles (2000-2012)

Year	Major domain	Minor domain
2000	Reading	Mathematics, Science
2003	Mathematics	Reading, Science, Problem Solving
2006	Science	Mathematics, Reading
2009	Reading	Mathematics, Science
2012	Mathematics	Reading, Science, Problem Solving

About 500,000 students in 65 countries/economies[6] (listed in Table 1.2) participated in the main strand of PISA 2012, i.e. the print-based tests of reading, mathematics and science. While the computer-based assessment of problem solving was a core domain in PISA 2012, due to technical

[3] The PISA population in a country is defined as all students enrolled in educational programmes aged between 15 years and 3 months to 16 years and 2 months (OECD, 2013b).
[4] Throughout this report, the terms reading, mathematics and science are used as shorthand for reading literacy, mathematical literacy, and scientific literacy.
[5] Science is the only domain in PISA 2012 that does not have a computer-based component.
[6] Not all participating entities are countries (e.g. the Shanghai region of China).

difficulties, not all countries participated. Of the 44 countries that did, 32 countries including Ireland also participated in a computer-based assessment of reading and mathematics (see asterisks in Table 1.2). An assessment of financial literacy (an optional add-on to PISA 2012) was not administered in Ireland.

This chapter is organised in three main sections. The first describes the content of the assessments of mathematics, reading and science, including changes from previous cycles; the second considers the content of questionnaires that were administered to participating students, mathematics teachers and school principals in order to generate contextual information; and the third describes the implementation of PISA 2012 in Ireland. The chapter concludes with an explanation of how students' assessment data were used to construct the PISA achievement scores, and with a guide to interpreting analyses presented in the report.

Table 1.2. Countries/economies participating in PISA 2012

OECD Countries		Partner Countries/Economies	
Australia**	Japan**	Albania	Macao-China**
Austria**	Korea, Republic of**	Argentina	Malaysia*
Belgium**	Luxembourg	Brazil**	Montenegro*
Canada**	Mexico	Bulgaria*	Peru
Chile**	Netherlands*	China (Shanghai)**	Qatar
Czech Republic*	New Zealand	Chinese Taipei**	Romania
Denmark**	Norway**	Colombia**	Russian Federation**
Estonia**	Poland**	Costa Rica	Serbia, Republic of*
Finland*	Portugal**	Croatia*	Singapore**
France**	Slovak Republic**	Cyprus*	Thailand
Germany**	Slovenia**	Hong Kong-China**	Tunisia
Greece	Spain**	Indonesia	United Arab Emirates**
Hungary**	Sweden**	Jordan	Uruguay*
Iceland	Switzerland	Kazakhstan	Vietnam
Ireland**	Turkey*	Latvia	
Israel**	United Kingdom*	Liechtenstein	
Italy**	United States**	Lithuania	

* = participated in the computer-based assessment of problem solving
** = participated in the computer-based assessments of problem solving and reading and mathematics.

1.1. Content of the Assessment

The PISA tests are composed of assessment units consisting of stimulus material (text and often other information such as tables, charts, 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 constructed-response type item formats. Multiple-choice items are either simple multiple-choice, requiring students to select an answer from a number of alternatives, 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. Constructed-response items are designed to generate a written response from students, and require either a brief answer (short constructed-response), an answer based on a very limited range of possible responses (closed constructed-response) or a more extended answer (open constructed-response). Examples of different types of test item are presented in Appendix B.

The theoretical basis of each domain is articulated in a set of assessment frameworks, which also serve to guide test development. Though the frameworks for each domain differ, they are similarly structured in that each domain is described in terms of the type of *content or knowledge* it encompasses, the *processes* required of students, and the *situations/contexts* in which assessment items are situated. The following sections summarise the frameworks for mathematics, reading and science.

1.2. Framework for Mathematics

The mathematics framework is based on that of PISA 2003, while introducing revisions that seek to improve on and update the earlier framework. Major revisions to the framework include the use of the mathematical competencies as a primary reporting dimension, and the introduction of an optional computer-based assessment of mathematics. The computer-based assessment is discussed later in this section.

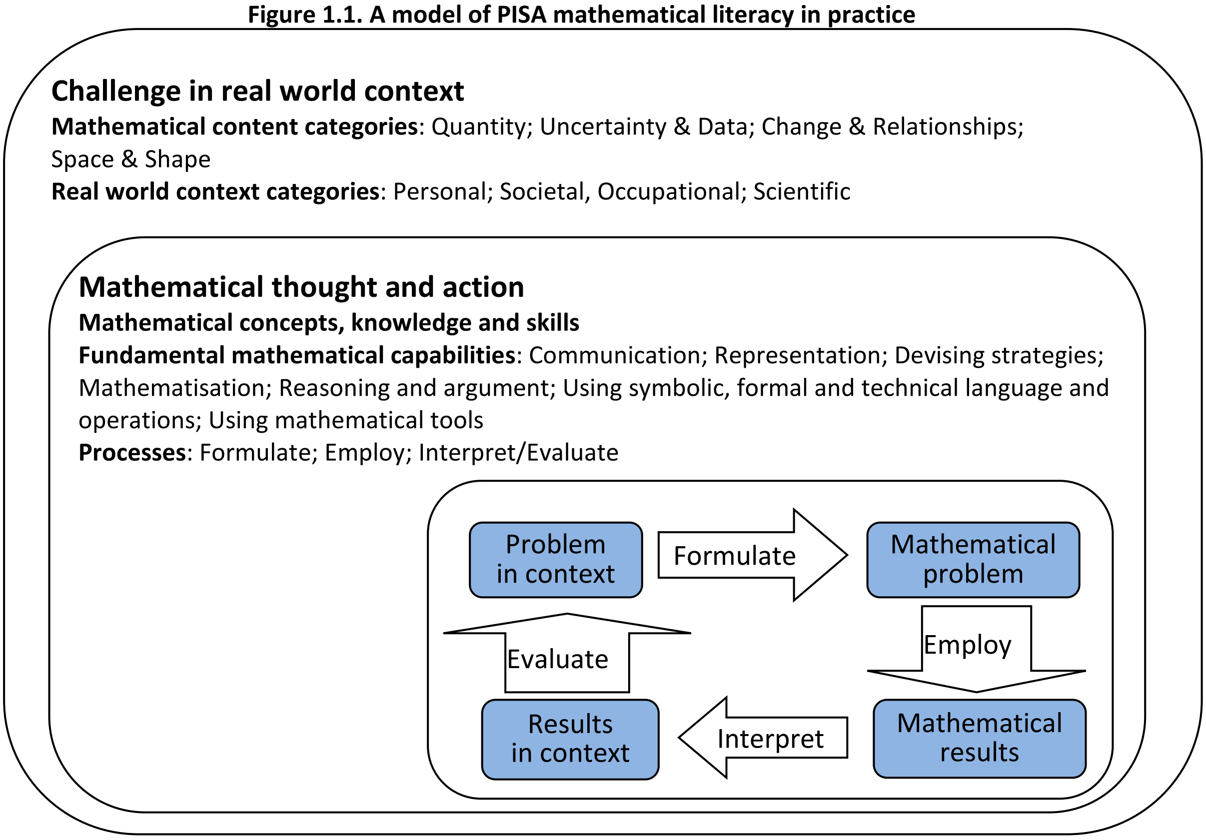
The PISA 2012 mathematics framework defines mathematical literacy as:

> *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 judgments and decisions needed by constructive, engaged and reflective citizens* (OECD, 2013b, p.25).

The PISA 2012 definition of mathematical literacy builds on that of PISA 2003 by making reference to the variety of contexts in which mathematical problems are situated; by emphasising a view of students as active problem solvers; by explicitly stating the mathematical processes required (*formulating, employing and interpreting*); and by including reference to the use of mathematical tools. The definition is also intended to incorporate the notion of *mathematical modelling*, which has been a central feature of previous PISA mathematics frameworks, where it was referred to as mathematising.

The different elements of this definition of mathematical literacy and their interrelations are summarised in Figure 1.1. The outer-most box shows that mathematical literacy occurs in the context of a real-life challenge or problem, characterised in the framework in terms of the mathematical content that underlies the challenge and the area of life (real world context) in which it arises. In engaging with the challenge, individuals apply mathematical thought and action, operationalised in three ways in the framework: mathematical *concepts, knowledge, and skills*; fundamental mathematical *capabilities*; and *processes*. The inner-most box of Figure 1.1 portrays the mathematical modelling cycle described in the PISA framework, which is an idealised and simplified representation of the stages of mathematical work involved in solving mathematical problems in context. The cycle starts with a problem situated in a meaningful context. The problem-solver formulates the problem according to mathematical concepts, so as to render it amenable to formal mathematical treatment. The problem-solver then employs mathematical strategies to obtain mathematical results. The mathematical results must then be interpreted and evaluated in terms of the original contextual problem. Depending on the nature of the mathematical problem to be solved, it may not be necessary to engage in all stages of the modelling cycle, and many PISA items involve only parts of the cycle.

Figure 1.1. A model of PISA mathematical literacy in practice



Adapted from Figure 1.1, OECD 2013a, p.26

For the purposes of assessment, the PISA 2012 definition of mathematical literacy is conceptualised in terms of three interrelated aspects which work together to ensure broad coverage of the domain:

- the mathematical *content* assessed;
- the mathematical *processes* that describe what students do to connect the context of the problem with mathematics in solving the problem, and the capabilities that underlie those processes; and
- the *contexts* in which mathematical problems are located.

1.2.1. Mathematical Content Knowledge

The PISA mathematics framework adopts an experience-based approach to the categorisation of mathematical content knowledge. This approach places the focus on the capacities required to engage with underlying mathematical phenomena, rather than on listing content strands and topics that reflect the historically-established branches of mathematics, as is generally seen in school curricula. The PISA framework specifies four content categories[7]:

- *Change & Relationships*;
- *Space & Shape*;
- *Quantity*; and
- *Uncertainty & Data*.

It is argued that these categories "meet the requirements of historical development, coverage of the domain of mathematics and the underlying phenomena which motivate its development, and

[7] The content categories were referred to as "overarching ideas" in the framework for PISA 2003.

reflection of the major strands of school curricula" (OECD, 2013a, p.33). The different content areas are not intended to be mutually exclusive.

Change & Relationships

Tasks in this subdomain require students to understand types of change and to recognise when they occur in order to use suitable mathematical models to describe and predict change. In mathematical terms, this means modelling the change and relationships with appropriate functions and equations, as well as creating, interpreting, and translating among symbolic and graphical representations of relationships. Literacy in this content area requires an understanding of aspects of functions and algebra (such as algebraic expressions, equations and inequalities, tables and graphical representations), statistical representations of data and descriptions of relationships, geometric phenomena (e.g. the relationships among lengths of the sides of triangles) and the basics of number.

Space & Shape

Items in this subdomain span a range of activities, such as 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. Geometry is central to Space & Shape, which also draws on aspects of other content areas such as spatial visualisation, measurement, number and algebra. The manipulation and interpretation of shapes in settings such as dynamic geometry software and Global Position System (GPS) tools are included in the domain.

Quantity

The PISA framework suggests that Quantity "may be the most pervasive and essential mathematical aspect of engaging with, and functioning in, our world" (OECD, 2013a, p.34). Literacy in this subdomain entails the application of knowledge of number and number operations in a wide variety of settings, and is a prerequisite for engagement with the other content areas. It incorporates quantification of the world (e.g. understanding measurements, counts, indicators, relative size, and numerical trends and patterns) and quantitative reasoning (e.g. number sense, multiple representations of numbers, elegance in computation, mental calculation, estimation, and assessment of reasonableness of results). This content area lends itself strongly to the application of tools such as calculators and spreadsheets.

Uncertainty & Data

This content area includes knowledge of variation in processes, uncertainty and error in measurement, and chance. It also includes forming, interpreting and evaluating conclusions drawn in circumstances where there is uncertainty. The presentation and interpretation of data is central to this category. An understanding of probability and statistics allows for the description, modelling and interpretation of phenomena involving uncertainty, and for making inferences. Literacy in this area also demands an understanding of number and of aspects of algebra, such as graphs and symbolic representation.

1.2.2. Mathematical Processes and the Underlying Mathematical Capabilities

The PISA 2012 framework articulates three mathematical processes[8] that correspond to the different stages of the mathematical modelling cycle:

- *formulating* situations mathematically;
- *employing* mathematical concepts, facts, procedures, and reasoning; and
- *interpreting*, applying and evaluating mathematical outcomes.

The framework also identifies seven mathematical abilities that underpin the 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 the abilities can be displayed at different levels of competence, which form the basis of the descriptions of proficiency levels used to report mathematics performance.

Formulating Situations Mathematically

This process involves recognising an opportunity to use mathematics in a real-world context, and translating the problem into formal mathematical language.

Employing Mathematical Concepts, Facts, Procedures and Reasoning

This process refers to those elements of mathematical work that take place within the mathematical world. It involves the application of mathematical concepts, facts, procedures and reasoning to mathematically-formulated problems, to obtain mathematical results.

Interpreting, Applying and Evaluating Mathematical Outcomes

Items assessing this mathematical process focus on the student's ability to reflect on mathematical solutions, results or conclusions and interpret them in the context of real-life problems. This involves translating mathematical solutions back in to the original problem context and evaluating whether the solution makes sense.

1.2.3. Mathematical Contexts

The ability to engage with mathematical problems in a variety of contexts is central to how PISA defines mathematical literacy. 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 an individual's world in which the problems are placed. PISA defines four context categories in terms of which test items are classified: personal, occupational, societal, and scientific. The selection of contexts for assessment items is guided by a consideration of their relevance to the lives and interests of students. The major purpose of the context categories is to ensure that the selection of assessment items reflects a broad range of settings.

1.2.4. Attitudes Towards Mathematics

The PISA 2012 survey includes items that measure students' attitudes towards mathematics, as part of the student questionnaire. Such measures are included on the grounds that positive attitudes to mathematics make students more likely to use the mathematics they know in their future lives, and

[8] These processes replace the three "competency clusters" (Reproduction, Connections, and Reflection) of previous cycles of PISA.

that attitudes may help to explain differences in achievement (OECD, 2013a). Some of these measures were also administered in PISA 2003, making comparisons possible. Two broad areas were measured: students' interest in mathematics and their willingness to engage in it. Interest in mathematics incorporates both present and future activity, with questions addressing students' interest in mathematics at school, whether they see it as useful in real life, as well as their intentions to study mathematics in the future and to participate in mathematics-oriented careers. Willingness to engage in mathematics includes questions related to the emotions of enjoyment, confidence and (lack of) mathematics anxiety, self-concept and self-efficacy.

The student questionnaire also includes items that measure opportunity to learn, which are specifically concerned with students' experience with applied mathematics problems of various types, familiarity with mathematics concepts by name, and prior experience in class or on tests with PISA style items.

1.2.5. Computer-based Assessment of Mathematics

A computer-based assessment of mathematics was included for the first time in PISA 2012, due to the increasing interdependency of mathematical and ICT literacy in the workplace, as well as the opportunities the digital medium affords to design test items that are more interactive, authentic, and engaging (OECD, 2013a). The computer-based assessment of mathematics is underpinned by the same framework as the print assessment. A challenge inherent in computer-based assessment is differentiating between the mathematical demands of an item and those demands that relate to the test environment, such as ICT skills and item format. In an attempt to address this, each item is described according to three aspects:

The mathematical competencies being tested, i.e. the aspects of mathematical literacy that are present in all environments, not just computer environments. These are tested in every computer-based mathematics item.

Competencies that cover aspects of mathematics and ICT, i.e. competencies that require demonstrating mathematical literacy through using ICT. These are assessed in some items only, in an effort to isolate the effects of this type of item format on performance. Some examples include:

- making a chart from data, including from a table of values using simple 'wizards';
- producing graphs of functions and using the graphs to answer questions about the functions;
- sorting information and planning efficient sorting strategies;
- using hand-held or on-screen calculators;
- using virtual instruments such as an on-screen ruler or protractor; and
- transforming images using a dialog box or mouse to rotate, reflect or translate the image.

ICT skills, i.e. the basic skills necessary to work with a computer, are also involved. These include basic knowledge of hardware (e.g. keyboard and mouse) and of conventions (e.g. arrows to move forward and specific buttons to execute commands). Items were designed with the intention of keeping the need for such skills to a minimal level.

1.2.6. PISA 2012 Mathematics Test Characteristics

The characteristics of the PISA 2012 mathematics tests are derived from the main elements of the framework as outlined above. Test items can be classified according to the mathematical process and content assessed, and the context in which they are set (Table 1.3). About half of items in both the print and computer-based assessments belong to the process *employing mathematical concepts, facts, procedures, and reasoning.* The remainder of the items are split approximately evenly between the two processes that involve *formulating situations mathematically* and *interpreting, applying, and evaluating mathematical outcomes*. Both print and digital assessment items are distributed approximately evenly across the content and context categories. Sample mathematics items are presented in Appendix B.

The print mathematics test consists of 110 items, while the computer-based test contains 41 items[9]. Of the print mathematics items, approximately 41% are multiple-choice or complex multiple-choice, 30% require a short written response, and 28% require a longer written response (open constructed-response). Approximately 29% of computer-based mathematics items are classified as multiple-choice or complex multiple-choice, 61% as short constructed-response, and 10% as open constructed-response.

For the first time in PISA 2012, performance on the print mathematics test is reported according to process subscales, in addition to an overall print mathematics scale and content subscales. Results of the computer-based test of mathematics are reported on an overall computer-based mathematics scale for the 32 countries that participated in this component of the assessment. Changes in mathematics outcomes since 2003 are reported on the basis of the print mathematics scale. The OECD (2013b) also report results on a composite scale, which is the average of performance on the overall print and computer-based mathematics scales.

Table 1.3. Distribution of 2012 mathematics items by process, content and context: print and computer-based assessments

Process	%	Content	%	Context	%
Print Assessment					
Formulating situations mathematically	29.3	Change & Relationships	26.6	Personal	19.3
Employing mathematical concepts, facts, procedures, and reasoning	45.9	Space & Shape	24.8	Occupational	22.0
Interpreting, applying and evaluating mathematical outcomes	24.8	Quantity	25.7	Societal	33.0
		Uncertainty & Data	22.9	Scientific	25.7
Total	100		100		100
Computer-based Assessment					
Formulating situations mathematically	22.0	Change & Relationships	26.8	Personal	31.7
Employing mathematical concepts, facts, procedures, and reasoning	53.6	Space & Shape	29.2	Occupational	22.0
Interpreting, applying and evaluating mathematical outcomes	24.4	Quantity	22.0	Societal	26.8
		Uncertainty & Data	22.0	Scientific	19.5
Total	100		100		100

Note: Figures may not add exactly to 100% due to rounding.

[9] As PISA uses a rotated test design, each student completes just a portion of the test items.

1.3. Framework for Reading

Reading literacy was assessed as the major domain in the first cycle of PISA (PISA 2000) and the fourth cycle (PISA 2009). Reading is a minor domain in the fifth cycle (PISA 2012) and the assessment framework remains unchanged since PISA 2009. There were two major modifications to the framework in PISA 2009: the incorporation of the reading of digital texts and the elaboration of the constructs of reading engagement and metacognition. An assessment of digital reading was also included in PISA 2012. As reading formed a minor domain, data on reading engagement and metacognition were not collected. PISA 2012 defines reading literacy as:

> *Understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.* (OECD, 2013a, p.61).

This definition stresses the active, purposeful and functional aspects of reading in a range of situations and for various purposes. The 'written texts' referred to include printed and digital texts. The PISA framework articulates three main dimensions upon which the assessment of reading literacy is based:

- text – the type and purpose of the material that is read;
- aspect – the cognitive approach that describes how readers engage with a text; and
- situation – the range of broad contexts or purposes for which reading takes place.

1.3.1. Types of Reading Texts

Text types used in the assessment are classified according to *medium, environment, text format* and *text type*.

Medium is the form in which texts are presented – print (paper) or digital (hypertext). Digital is defined as a text or texts with navigation tools and features that make possible and require non-sequential reading.

Environment applies only to digital texts, which can be located in an *authored* environment (in which the content cannot be modified, e.g. homepages, government information sites) or a *message-based* environment (in which the user can add or change content, e.g. e-mails, blogs, chat rooms).

There are four different types of *text format*: continuous, non-continuous, mixed and multiple. Continuous texts are composed of sentences arranged in paragraphs. Non-continuous texts consist of a number of lists and include graphs and tables. Mixed texts contain elements of both continuous and non-continuous text types, e.g. prose accompanied by a graph or table. Multiple texts are those that have been generated and make sense independently, but have been juxtaposed for assessment purposes.

Six different forms of *text type* are specified in the framework:

- *Description* – refers to properties of objects in space (e.g. information report in prose, catalogue, blog diary, flight schedule);
- *Narration* – refers to properties of objects in time (e.g. novel, comic strip story);
- *Exposition* – provides an explanation of how different elements interrelate (e.g. book review, graph showing population trends, rating of online shopping item);

- *Argumentation* – presents the relationship among concepts or propositions, including persuasive and opinionative texts (e.g. letter to the editor, advertisement, blog in an online forum);
- *Instruction* – provides directions on what to do (e.g. recipe, instructions for operating software, booking system for online flight schedule); and
- *Transaction* – aims to achieve a specific purpose outlined in the text (e.g. requesting that something is done, making a social engagement with a friend).

1.3.2. Reading Aspects or Processes

The mental strategies, approaches or purposes used by readers to engage with texts are referred to in the framework as reading aspects. Five aspects are identified:

- Retrieving information;
- Forming a broad understanding;
- Developing an interpretation;
- Reflecting on and evaluating the content of a text; and
- Reflecting on and evaluating the form of a text.

For reporting purposes, these five aspects are organised into three broad aspect categories:

- *Access and retrieve* (tasks involving retrieving information are assigned to this scale);
- *Integrate and interpret* (tasks involving forming a broad understanding and developing an interpretation contribute to this scale); and
- *Reflect and evaluate* (tasks involving reflecting on and evaluating the content and form of a text contribute to this scale).

The three aspect categories are considered to be interrelated, interdependent and semi-hierarchical (e.g. in order to reflect on and evaluate information, it is first necessary to retrieve it). A fourth aspect category, *complex reading*, is identified for digital texts. A complex reading task in the digital medium requires the individual to process the visible information immediately and extrapolate from and evaluate it. As it requires a variety of skills, it cannot be assigned to any one aspect category.

1.3.3. Reading Situations/Contexts

The reading situations refer to the contexts and purposes of a text. PISA texts are categorised in terms of four types of reading situation/context:

- *Personal* – reading intended to satisfy an individual's personal interests (e.g. personal letters, fiction, emails);
- *Public* – reading that relates to activities and concerns of wider society (e.g. official documents, news websites);
- *Educational* – reading for the purpose of instruction (e.g. printed text books, interactive learning software); and
- *Occupational* – reading that involves the accomplishment of some immediate task (e.g. searching for a job, following workplace directions).

1.3.4. PISA 2012 Reading Test Characteristics

The distribution of items in the print and digital reading assessments according to text structure, situation and aspect are shown in Table 1.4. Most print items are based on continuous text types (59%), while 79% of digital texts are classified as multiple.

Over half of the print items assess integrate and interpret skills, with the remainder equally divided between access and retrieve and reflect and evaluate. In the digital assessment, items are fairly evenly split between integrate and interpret (32%), access and retrieve (26%), and the composite *complex* aspect category (26%), with fewer items in the reflect and evaluate category (16%). The majority of print items are situated in either personal or educational contexts, while 53% of digital items are situated in public contexts. For a description of the similarities and differences between print and digital reading as assessed in PISA, see OECD (2013a, pp.69-71). Sample questions from both the print and digital reading assessments are presented in Appendix B.

The PISA 2012 print reading assessment consists of 44 items, while the digital reading assessment contains 19 items. Reading outcomes are reported on separate scales for print and digital reading[10]. Subscales are not constructed for minor domains.

Table 1.4. Distribution of 2012 reading items by text structure, situation and aspect: print and digital assessments

Text Structure	%	Situation	%	Aspect	%
Print Assessment					
Continuous	59.1	Personal	36.4	Access and retrieve	22.7
Non-continuous	29.5	Educational	31.8	Integrate and interpret	54.5
Mixed	9.1	Occupational	20.4	Reflect and evaluate	22.7
Multiple	2.3	Public	11.4	Complex	0.0
Total	100		100		100
Digital Assessment					
Continuous	5.3	Personal	31.6	Access and retrieve	26.3
Non-continuous	10.5	Educational	15.8	Integrate and interpret	31.6
Mixed	5.3	Occupational	0.0	Reflect and evaluate	15.8
Multiple	78.9	Public	52.6	Complex	26.3
Total	100		100		100

Note: Figures may not add exactly to 100% due to rounding.

1.4. Framework for Science

The science framework used in PISA 2012 remains unchanged since PISA 2006, when science was the major domain. It is the only domain in PISA 2012 that does not have a computer-based assessment component. The framework refers to four aspects of scientific literacy when it defines science as an individual's:

- *Scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues;*
- *Understanding of the characteristic features of science as a form of human knowledge and enquiry;*

[10] Digital reading outcomes are reported for the 32 participating countries.

- *Awareness of how science and technology shape our material, intellectual, and cultural environments;* and
- *Willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.* (OECD, 2013a, p. 100).

The assessment framework is organised in terms of four interrelated dimensions:

- *Context* – recognising life situations that involve science and technology;
- *Knowledge* – understanding the natural world on the basis of scientific knowledge that includes knowledge of the natural world and knowledge about science itself;
- *Competencies* – displaying the ability to identify scientific issues, explain phenomena scientifically, and draw evidence-based conclusions; and
- *Attitudes* – indicating an interest in science, support for scientific enquiry and motivation to act responsibly towards, for example, natural resources and environments.[11]

1.4.1. Science Contexts

Science items are set in contexts deemed to be relevant to students' general lives, rather than being limited to a school setting. The three context categories relate to the self, family and peer groups (*personal*), the community (*social*), and life across the world (*global*).

1.4.2. Science Knowledge

Scientific knowledge refers to both *knowledge of science* and *knowledge about science*. Knowledge of science refers to knowledge of the natural world across the major fields of physics, chemistry, biology, Earth and space science, and technology. The selection of science content to assess was guided by the following criteria: relevance to real-life situations; importance and enduring utility; and appropriateness to the developmental level of 15-year-old students.

Knowledge about science can be divided into scientific enquiry and scientific explanations. Scientific enquiry refers to the process of science (how scientists get data). Scientific explanations refer to the results of scientific enquiry (how scientists use data).

1.4.3. Science Competencies

PISA science assesses three competencies judged to be important for scientific investigation, due to their grounding in logic, reasoning, and critical analysis.

Identifying scientific issues involves recognising questions that can be investigated scientifically, identifying keywords to search for scientific information on a topic, and recognising key features of a scientific investigation. This competency requires both knowledge of and knowledge about science.

Explaining phenomena scientifically includes describing or interpreting phenomena and predicting changes, and may involve recognising or identifying appropriate descriptions, explanations and predictions. It involves applying knowledge of science.

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[11] Since science is a minor domain in PISA 2012, the assessment does not contain science-related attitudinal items.

Using scientific evidence involves accessing scientific information and producing arguments and conclusions based on scientific evidence. Students displaying this competency should be able to present clear and logical connections between evidence and conclusions or decisions. It can involve knowledge of science or knowledge about science.

1.4.4. PISA 2012 Science Test Characteristics

The PISA 2012 science assessment is based on the framework as outlined above. Performance is reported on an overall science scale only, in line with its status as a minor domain in PISA 2012. The test contains 53 items in total, approximately two-thirds (64%) of which are multiple-choice in format; the remaining third require a written answer. Items are split approximately evenly between knowledge of science and knowledge about science, as shown in Table 1.5. Approximately 42% of the questions require the competency explaining phenomena scientifically, 34% require using scientific evidence, and 25% assess identifying scientific issues. Items contexts are distributed across personal, social and global settings in the ratio 1:2:1, approximately. Sample science items from PISA 2012 can be found in Appendix B.

Table 1.5. Distribution of 2012 science items by competence, knowledge and context

Competency	%	Knowledge	%	Context	%
Identifying scientific issues	24.5	Knowledge of science	49.1	Personal	22.6
Explaining phenomena scientifically	41.5	Knowledge about science	50.9	Social	56.6
Using scientific evidence	34.0			Global	20.8
Total	100		100		100

Note: Figures may not add exactly to 100% due to rounding.

1.5. PISA Context Questionnaires

In addition to the assessments of mathematics, reading and science, PISA collects background information from questionnaires. The information is conceptualised at four levels: variables that relate to individual students; to classrooms, to schools; and to the country's educational system as a whole (OECD, 2013a, p.175). The data gathered are used to 'contextualise' the results, by examining relationships between background characteristics and outcomes, particularly performance in mathematics.

As in previous cycles of PISA, background information was collected via the administration of student and school questionnaires. Both these instruments consist of a set of core questions administered internationally, to which countries are given the opportunity to add a small number of questions of national interest. In consultation with the PISA national committee (membership of which is shown in Appendix A), some national additions (described below) were made to the student and school questionnaires in Ireland. Ireland also opted to administer two additional student questionnaire modules offered as part of PISA – one on students' educational careers and the other on ICT familiarity.[12]

Students in Ireland also responded to short questionnaires addressing their test-taking behaviour in both the print and computer-based assessments. These instruments were developed and

[12] Overall, 21 countries administered the educational career questionnaire and 43 administered the ICT familiarity questionnaire.

administered as part of PISA 2012 in Ireland in an attempt to understand the strategies students used to complete the tests. The current report is focused on Ireland's results in the context of the initial international reporting. Detailed analyses of these national instruments will be reported in an additional report *Contextualising Achievement in PISA 2012* which will be published in 2014. An optional international parent questionnaire, administered by 11 countries, was not administered in Ireland.

An international teacher questionnaire is not part of PISA 2012. However, as in previous cycles of PISA, a national teacher questionnaire was developed and administered in Ireland in conjunction with the assessment. The target population was all mathematics teachers in participating schools. For the first time in PISA 2012, a national questionnaire was also administered to mathematics school co-ordinators in Ireland. Data gathered from these instruments have been analysed and published in two separate thematic reports: *Teaching and Learning in Project Maths: Insights From Teachers who Participated in PISA 2012* (Cosgrove et al., 2012), and *Mathematics in Transition Year: Insights of Teachers from PISA 2012* (Moran et al., 2013). Both reports are available at www.erc.ie.

As well as the information collected during the course of the survey, the OECD makes use of PISA-developed indicators (e.g., the yearly OECD publication of *Education at a Glance*) as a source of data on system characteristics.

The following sections describe international and national components of the student and school questionnaires.

1.5.1. Student Questionnaire

A student questionnaire was administered to all students who responded to the print assessment. Questions on a number of core topics were administered in the questionnaires in all participating countries, including student characteristics; family context and home resources; mathematics learning; experience with different kinds of mathematics problems at school; mathematics experiences; classroom and school climate; and problem-solving experiences. Questions in the educational career module, which was administered in 21 countries, covers students' educational histories, their career aspirations and their facility with languages, while the questions on ICT familiarity, which were administered in 43 countries, gather information on students' access to and use of ICTs, and attitudes towards computers.

A number of national additions to the student questionnaire in Ireland were developed by the national centre in consultation with the PISA national committee. These included questions on involvement in paid work, early school-leaving intent, immigration and integration, interaction with parents, and enjoyment of reading.

1.5.2. School Questionnaire

Principals of participating schools were asked to complete a school questionnaire which included questions on the structure and organisation of the school, the student and teacher body, the school's resources, the school's instruction, curriculum and assessment, school climate, and the school's policies and practices. Nationally developed questions which were also administered in the school questionnaire in Ireland included questions on integration of migrant students, opinions on Project Maths, and ability grouping for mathematics. Some further school-level variables needed for national analyses (such as school sector) were obtained from the databases of the Department of Education and Skills.

1.6. Implementation of PISA 2012 in Ireland

This section describes the field trial in 2011 and the main study in 2012 in Ireland. The field trial and main study were implemented by the Educational Research Centre (ERC) on behalf of the Department of Education and Skills (DES), in accordance with PISA's set of technical standards (OECD, in press). Some aspects of PISA's implementation are not considered here, such as the test design for PISA 2012 and the procedures used to compile the international database. For a complete description of all aspects of the implementation of PISA 2012, readers are referred to the *PISA 2012 Technical Report* (OECD, in press).

1.6.1. Development of Test Materials and Questionnaire Items

Participating countries were invited to develop and submit units (texts) and items (questions) for the field trial assessment of mathematics and problem solving (both print and computer-based). Due to their status as minor domains, no new items were developed for reading and science. Newly developed items were reviewed by subject experts in participating countries, based on criteria including perceived relevance to 15-year-old students, possible sensitivity issues (e.g. culture bias), and technical issues (e.g. translation or coding problems, inappropriate level of ICT demand for computer-based items).

Following revisions arising from this process, 62 print mathematics units and 27 computer-based mathematics units were selected for inclusion in the field trial. Based on analyses of the psychometric properties the items displayed in the field trial, a subset were selected for the main study. Core international items for use in the school and student questionnaires were developed through a similar process, described in detail in the *PISA 2012 Technical Report* (OECD, in press).

1.6.2. Field Trial 2011

As part of PISA's quality assurance programme, participating countries were required to successfully carry out a field trial in advance of the main study, to pilot test questionnaire items and to try out operational procedures. In Ireland, 81 schools in total were randomly sampled, 37 to complete print mathematics assessments and computer-based assessments of mathematics and problem solving. An additional 44 schools were selected to complete the computer-based assessments only. The method of selection and sample size were in accordance with the PISA field trial sample guidelines. The assessment was administered in schools in Ireland by retired Department of Education and Skills inspectors and school principals who had undergone training. The computer-based assessments were delivered on a Microsoft Windows platform via USB, using laptops provided by the national centre. Open-ended PISA items were scored by trained coders, using internationally developed scoring rubrics. In Ireland, the print test was completed by 817 students, while 1,068 completed the computer-based tests.

1.6.3. Main Study 2012

The PISA 2012 main study took place in Ireland between March 1st and March 30th.

Population

The PISA target population is 15-year-old students attending post-primary schools (i.e. those who are enrolled in First Year of post-primary school [grade 7] or higher). For PISA 2012, the age definition was operationalised in Ireland as all students born in 1996. The total target population in Ireland was estimated at 57,979 students, based on DES data on the number of students born in 1996 who were enrolled in educational institutions in grade 7 or higher in 2010/11. This includes those enrolled in post-primary and non-aided schools (i.e. commercial schools in which the salaries of teaching staff are not paid by the DES). Students enrolled in Special Educational Needs (SEN) schools were excluded from the population, as SEN-only schools in Ireland are classified as grade 6 (i.e. Sixth class) or below.

The target population excludes approximately 812 students enrolled in educational institutions in grade 6 or below (most of whom would have had Special Educational Needs), along with approximately 505 students who left school (an estimated 0.9% of the total population, based on PISA 2009 data). As in previous cycles of PISA, students enrolled in island schools (estimated at 27 students) were also excluded from the sampling process for logistical reasons. The exclusion of students in special schools and students from island schools leaves an estimated total enrolment of 57,952 students in the national desired population, which is 99.95% of the total target population.

Sample

With the agreement of the international PISA consortium, a decision was made nationally to administer the PISA 2012 assessment in all 23 initial Project Maths schools[13], as results of the mathematics assessment in these schools are of particular national interest. Results of analyses of PISA data in initial Project Maths schools, compared with non-initial schools, will form the main focus of a separate national report, *PISA and Project Maths*, which will be published in 2014. It should be noted that the inclusion of all initial Project Maths schools in the sample for Ireland results in an over-sampling of such schools. The sample weights, however, take account of this over-sampling.

The sampling process took place in two stages: school level and student level. Samples for each country were drawn by the international PISA consortium (OECD, in press). Sampling at the school level involved first categorising schools into 11 distinct groups, or explicit strata, based on relevant school level characteristics. The approach taken to stratifying schools in Ireland differed from that of PISA 2009 in two major respects. Firstly, an explicit stratum was created for initial Project Maths schools, in order to accommodate the administration of the assessment in all 23 of such schools. In addition, an explicit stratum was created for non-aided schools[14] (these had been excluded from the sampling frame in previous cycles of PISA). The remaining schools (i.e. DES funded, non-initial Project Maths schools) were then divided into nine further explicit strata, using the same method employed

[13] Project Maths began in 2008 in 24 post-primary schools, referred to in this report as initial Project Maths schools, and was rolled out across all post-primary schools in the country on a phased basis, beginning in the autumn of 2010. One of the original 24 initial Project Maths schools amalgamated with another school and therefore was not included as an initial Project Maths school in the sample for PISA 2012.

[14] Although non-aided schools were included in the PISA 2012 sample, no such schools actually participated in the assessment.

in PISA 2009. That is, nine groups were derived from all possible combinations of two school-level variables (school size and sector), each containing three levels (small, medium or large[15], and community/comprehensive, secondary or vocational, respectively).

Within each explicit stratum, schools were ordered by two implicit stratification variables: socio-economic status and school sex composition. Schools were categorised according to which quartile they occupied with regard to the school DEIS score[16] for the former and the percentage of students who were female for the latter. As initial Project Maths schools occupied their own explicit stratum, they were implicitly stratified by school size and type, in addition to school socio-economic status (i.e. DEIS score) and gender composition. Non-aided schools were not stratified by the implicit variables, as information on the characteristics of these schools was not available.

The number of schools sampled within each explicit stratum is based on the number of students in that stratum in the population and the number in the expected sample. The probability of a school being selected is proportional to the number of students in the target population in the school. Overall, 188 schools were sampled to participate. Of these, 182 schools[17] took part, including one replacement school. This gives a weighted school-level response rate of 99.3% after replacement.

The next stage of the sampling procedure involved selecting students within schools that had agreed to participate. In schools with 35 or fewer students that met the age criteria, all students were selected; in schools with more than 35 such students, 35 were randomly sampled. From the 35 (or fewer) students selected to complete the print assessment, a subset of up to 18 were randomly selected to participate in the computer-based test.

Of the 6,318 students who were sampled to participate in the print assessment, 70 (1.1%) were ineligible. Of this 1.1%, 14 (0.2% overall) did not meet the age requirement, and 56 (0.9%) were no longer enrolled in the school. There was a within-school exclusion rate of 4.3% (271 students). These students were deemed by school principals to be unable to participate (in accordance with PISA guidelines) due to either limited experience of the language of the assessment, or special educational needs. This left 5,977 students eligible to complete the assessment. In total, 5,016 students sat the print assessment, yielding a weighted response rate of 84.1%. Absenteeism accounted for the majority of cases of non-participation (749 students, or 12.5% of eligible students), with student or parent refusals accounting for the remaining 212 students (3.5%). Response rates in Ireland at both school and student level met international PISA standards (85% and 80%, respectively; OECD, in press). A total of 2,396 students participated in the computer-based assessment, which was 67% of students sampled to participate.[18]

Six participating schools were Irish medium. As in previous cycles of PISA, these schools were provided with both English and Irish versions of all print materials. Students chose on an individual

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[15] Small schools are defined as those with fewer than or equal to 40 15-year-olds, medium as those with between 41 and 80 15-year-olds, and large as those with more than 80 15-year-olds.

[16] A school's DEIS score is based on the assessed level of disadvantage within the school (Weir & Archer, 2005). Non-aided schools were assigned to the least disadvantaged quartile.

[17] This includes all 23 initial Project Maths schools. Although selected, no non-aided schools participated in the PISA 2012 assessment.

[18] In each participating school, a subsample of up to 18 students was selected to participate in the computer-based assessments. Each test administrator was supplied with 15 rather than 18 laptops on which the computer-based assessment was to be carried out due to the likelihood of absences on the test day. Therefore, in some schools where more than 15 of the selected students were present on the day of the assessment a small number were unable to participate in the computer-based assessment.

basis which version of the assessment and questionnaire they would prefer, on the day of testing. Irish medium schools were also offered computer-based materials in either English or Irish. For both print and digital assessments, reading literacy items and texts were not translated into Irish.

The majority (60.5%) of selected students were in Third Year at the time of testing, almost a quarter (24.3%) were in Transition Year, 13.3% were in Sixth Year, and 1.9% were in First or Second Year[19].

Administration of the Assessment

DES inspectors administered the assessment in schools, and computer resources (a set of laptops for each administrator) were supplied by the national centre. Two hours were allowed for completion of the print assessment, and a further 45 minutes for the student questionnaire. The computer-based test took 40 minutes, with a further 20 minutes allocated for preparatory activities, including a 15-minute practice session. The print assessment was administered in the morning, with the computer-based assessment following in the afternoon of the same day.

Both the print and computer-based assessment use a rotated test design, which means that each student responded to just a subset of the entire pool of items. Print items were distributed across 13 test booklets, with items repeated across booklets. Each booklet contained mathematics items, while reading and science items appeared in nine booklets. Similarly, items were distributed across 24 forms for the computer-based assessment, with each domain (problem solving, reading and mathematics) appearing in 12 forms of the test. All reading (both print and digital) and science items were link items from previous cycles of PISA. Of the 110 print mathematics items, 35 were link items from PISA 2003.

In each participating country, a PISA quality monitor was employed by the international consortium to observe a number of test administration sessions. In Ireland, a retired senior school inspector fulfilled this function. Seven assessment sessions were monitored, and the results communicated directly to the international consortium. From this, it was judged that the administration of PISA 2012 in Ireland met the required international standards. Student responses to open-ended items were scored at the ERC by trained coders, using an international coding rubric. Inter-rater reliability was measured by having groups of four coders independently score a subset of test booklets. The outcomes of this exercise indicate a high level of marking reliability in Ireland (OECD, in press).

Constructing the PISA 2012 Achievement Scales

Student achievement was scaled using a one-parameter Item Response Theory (IRT) model (specifically, a mixed coefficient multinomial logit model), which uses estimates of item difficulty to predict the probability that a student will answer a question correctly (assuming items behave the same way across countries). In PISA, the procedure was applied in three steps: national calibrations, international scaling, and student score generation. IRT places item difficulty and student ability on the same metric, meaning that student ability at a specific level can be described in terms of task characteristics of items associated with that level.

As each student completed only part of the assessment item pool, student achievement was imputed using five plausible values. Plausible values are random numbers which are drawn from the distribution of scale scores that could be reasonably assigned to each student. Plausible values contain random error variance components and are not optimal for reporting scores at the level of

[19] These percentages are weighted.

the individual student. However, when combined, plausible values can be used to describe the performance of groups of students. In PISA, five plausible values are assigned to each student for each overall scale (print mathematics, computer-based mathematics, print reading, digital reading, science and problem solving) and for each print mathematics subscale (Formulate, Employ, Interpret, Change & Relationships, Space & Shape, Quantity and Uncertainty & Data).

Plausible values were produced from country-by-country regressions, based on principle components analyses of dummy-coded student questionnaire variables and student gender, grade, and parental occupation status. This scaling process essentially produces student-level achievement estimates which are, in theory, unbiased estimates that can be used to compare the performance of students across countries participating in PISA, as well as to compare the performance of sub-groups of students within and across countries. Full details on the development of achievement scales in PISA 2012 can be found in the *PISA 2012 Technical Report* (OECD, in press).

The comparability of scores across PISA cycles is possible because of the use of link items that are common across assessments. Of the 110 mathematics items that were administered in 2012, 84 are linked to 2003 items, 48 to 2006 items and 35 to 2009 items. For reading, the 44 items used in PISA 2012 are link items (all of them are linked to 2009, while three are linked to 2000, 2003 and 2006). The 53 science items in 2012 are link items to PISA 2009 and PISA 2006. Linking of achievement across cycles is done through equating the properties of items administered in 2012 to the properties that they had when they were administered in a previous cycle as part of the major domain. The equating of the reading scale in 2012 was done in two steps: 1) the link items in 2012 were equated to PISA 2009 and 2) the PISA 2009 reading scale was linked back to the reading scale in 2006 through 26 link items (which were common to the 2009 and 2006 scales but not the 2012 scale).

The equating procedure that allows scores in different PISA assessments to be compared introduces a form of random error that is related to performance changes on link items. There is a lack of agreement on the best method in which to estimate the size of this error (Gebhardt & Adams, 2007) and LaRoche and Cartwright (2010) argue that the linking error that is used in the OECD published trends analyses (OECD, 2010a) is too small; in other words, the OECD risks reporting that a change in achievement is statistically significant if it assumes that the link error is smaller than it actually is. Link error estimates as used by the OECD are documented in the *PISA 2012 Technical Report* (OECD, in press).

Inset 1.1. How to Interpret the Analyses in this Report

OECD average

Throughout this 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. print mathematics performance). The OECD (2013b-e) includes both OECD average and OECD total in its reports. The OECD total is the mean score on an indicator in which each student in the OECD area contributes equally so that countries with larger PISA populations contribute proportionately more than countries with smaller PISA populations. In this report, reference is made to the OECD average but not the OECD total. Where references are made to ‘OECD’ in tables and figures, this always refers to the OECD average. Also in this report, ‘mean’ and ‘average’ are used interchangeably.

Data Sources

For international comparisons, results are generally taken from the OECD reports on PISA 2012 (OECD, 2013b-e). National analyses, especially those reported in Chapters 5 to 7, were conducted by the ERC.

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 we would expect the population estimate to fall 95% of the time, if we were to use many repeated samples. 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. 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 these scores differ significantly from one another, the reader can infer that the difference is *statistically* significant.

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. In PISA 2012 print mathematics literacy, Ireland achieved a mean score of 502 and the standard deviation was 85. Therefore, 68% of students in Ireland are estimated to have obtained an achievement score between 417 and 587 (502±*85*1*), while 95% of students are estimated to have obtained achievement scores between 332 and 672 (502 ± *85**2).

Proficiency levels

In PISA, student performance and the level of difficulty of assessment items are placed on a single scale for each domain assessed. Using this approach 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 2012, six proficiency levels are described for print mathematics and computer-based mathematics; seven proficiency levels are described for print reading, five for digital reading, and six for science. In each domain, Level 2 is considered the basic level of proficiency needed to participate effectively and productively in society and in future learning (OECD, 2013b). 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.

Correlations

Correlation coefficients describe the strength of a relationship between two variables (e.g., the relationship between socio-economic 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 value of 0 indicates that there is no relationship between variables, while the closer a value is to ±1, the stronger the relationship. 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.

Bivariate Versus Multivariate, Multilevel Analyses

Results in Chapters 3 to 7 are largely based on bivariate analyses, in that they examine the relationship between two variables, such as mean achievement scores by gender. These analyses are useful for identifying patterns but do not account for mediating variables. Multi-variate and multi-level analysis 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.

2. The Research and Policy Context for PISA 2012

This chapter reviews the findings for Ireland from previous cycles of PISA (2000 to 2009) and other national and international assessments of student achievement, so as to provide a context in which to consider the outcomes of PISA 2012. Achievement outcomes in mathematics, problem solving, reading and science are described, followed by a review of contextual factors associated with achievement in Ireland. The chapter concludes with an overview of recent developments in the teaching and learning of mathematics and the broader education system in Ireland.

2.1. Achievement Outcomes from Previous Cycles of PISA and Other Assessments

As outlined in Chapter 1, each cycle of PISA assesses the achievement of 15-year-old students in three domains: mathematical literacy, reading literacy and scientific literacy. One domain becomes the main focus (or 'major domain') of the assessment in each cycle, with less focus on the other, 'minor', domains. In PISA 2003, an additional minor domain (cross-curricular problem solving) was also assessed. Problem solving was also assessed as an additional domain in 2012 through a computer-based assessment, with the focus on underlying cognitive processes necessary for problem solving rather than on disciplinary knowledge. Results of the problem-solving assessment will be presented in a subsequent report that will be released by the OECD in summer 2014.

Student performance is reported on an overall scale as well as on subscales for the major domain, while just overall performance is described for each of the minor domains. The overall scale for each domain is constructed when that domain is first a major domain (i.e. the overall reading scale was set in 2000, while the scale for mathematics was set in 2003 and the scale for science in 2006) and is set to have an average of 500 and a standard deviation of 100 across OECD countries. Thus, trend comparisons for each domain are linked back to when that domain was first assessed as a major domain.

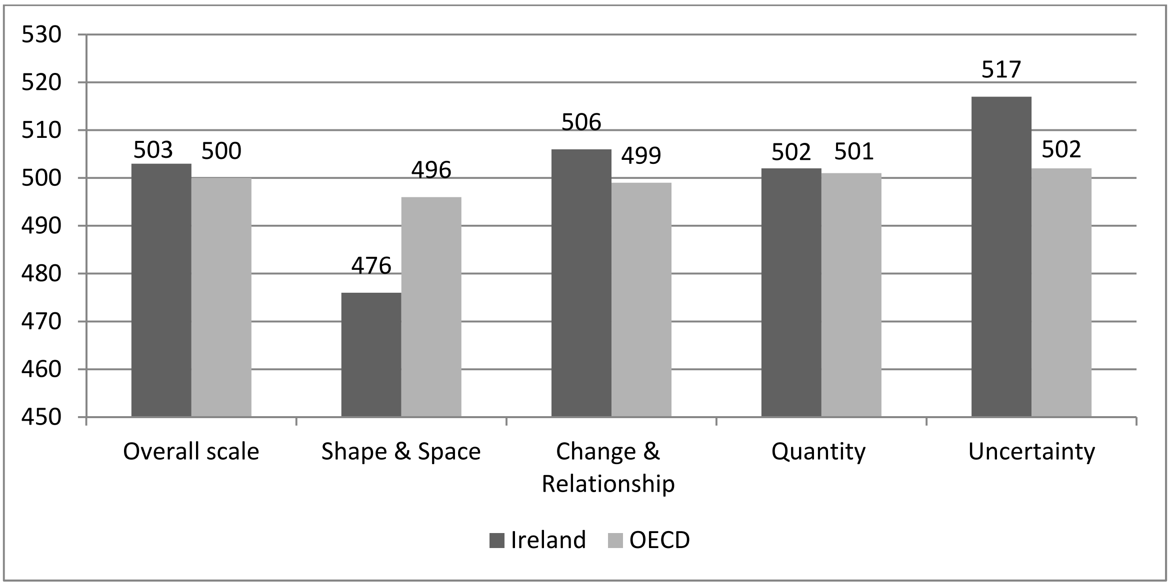
Proficiency levels, which describe skills that students can perform at different levels of achievement, are also reported for each domain. Level 2 is used as a benchmark for poor performance, i.e. students who perform below Level 2 are considered by the OECD not to have demonstrated the baseline skills required for future education and everyday life and are likely to be only able to answer the easiest PISA items correctly. On the other hand, those who perform at or above Level 5 are considered to be top performing students and are likely to be able to correctly answer the most difficult PISA items. The skills that students are likely to be able to demonstrate at each level are described in greater detail in the relevant chapters (Chapter 3 for mathematics and Chapter 4 for reading and science).

2.1.1. Mathematics Achievement in Previous PISA Cycles

In PISA 2003, when mathematics was first assessed as a major domain, students in Ireland achieved a mean score of 503, which was not significantly different from the average score across all OECD countries at the time (500; Figure 2.1) (OECD 2004a). The achievement of Irish students did not differ significantly from the mean scores of students in Austria, Germany, or the Slovak Republic, but was significantly below the highest-performing OECD countries: Finland, Korea, the Netherlands, Japan and Canada.

Student performance was also reported on four mathematics subscales in 2003, which measured the content areas of Space & Shape, Quantity, Change & Relationships, and Uncertainty (Figure 2.1). There was considerable variation between the mean scores of students in Ireland on these four content areas. Students performed least well on the Space & Shape subscale (476, significantly below the OECD average), about average on the Quantity subscale (502, not significantly different from the OECD average), and significantly higher than the OECD average on the Change & Relationships (506) and on the Uncertainty (517) subscales (OECD, 2004a).

Figure 2.1. Mean scores on the overall mathematics scale and content area subscales in Ireland and on average across OECD countries in 2003



Note: 29 OECD countries participated in PISA 2003

Ireland experienced a drop in mathematics achievement of close to 16 points (about one-sixth of an international standard deviation) between 2003 and 2009, with the majority of this decline (just over 14 points) occurring between 2006 and 2009 (OECD, 2010a). This was the second largest drop of all countries that participated in PISA 2003 and 2009 (the largest drop was among students in the Czech Republic, where the decline was 24 points). Other countries/economies which showed statistically significant declines in mathematics performance since 2003 include Northern Ireland[20] (23 points), Sweden (15 points), France (14 points) and Belgium (14 points). However, Ireland was the only country to experience a negative change in its position relative to the OECD average, from being not significantly different from the OECD average in 2003 to being significantly below it in 2009. There was very little change in the average achievement of the 28 OECD countries that participated in both cycles, with just a slight decrease from 500 in 2003 to 499 in 2009.

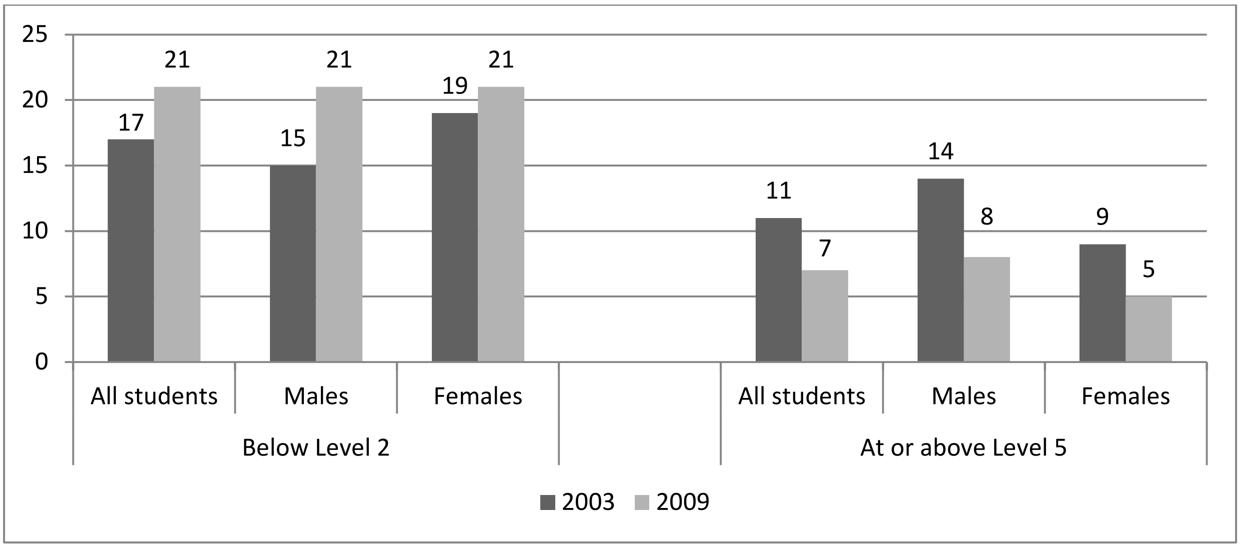
As well as a drop in overall performance, there were also changes in the proportions of higher- and lower-achieving students in Ireland (Figure 2.2). The proportion of higher-achieving students (those at or above Level 5) decreased significantly from 11% in 2003 to 7% in 2009 and was below the corresponding average across OECD countries in both cycles. There was also a significant increase in

[20] Northern Ireland forms part of the sample for the United Kingdom in PISA, though separate results are also reported for Northern Ireland, England, Wales and Scotland.

the proportion of lower-achieving students (those scoring below Level 2) in Ireland from 17% in 2003, which was significantly lower than the corresponding OECD average, to 21% in 2009, which was not significantly different from the corresponding OECD average. A comparison of the performance of students in Ireland at the 10th, 25th, 75th and 90th percentiles, in 2003 and 2009, shows that, while there was a decline in achievement at each benchmark, the decline is slightly greater at the higher benchmarks (OECD, 2010a).

Male students outperformed female students in mathematics in Ireland in both 2003 and 2009 (by 15 points and 8 points, respectively), although the gender difference was only significant in 2003. On average across OECD countries, the gender difference increased only slightly by 0.4 points between 2003 and 2009. In Ireland, the mean scores of both genders dropped significantly between 2003 and 2009, although the decline was greater for male students (19 points) than for females (12 points). Ireland also saw an increase in the proportion of low-achieving males (from 15% to 21%) and females (from 19% to 21%) from 2003 to 2009, with the increase greater among male students (Figure 2.2). On the other hand, the percentage of males performing at or above Level 5 dropped by 6 points between 2003 and 2009 (from 14% to 8%), while the percentage of females at this level dropped by 4 points (from 9% to 5%) (OECD, 2010a).

Figure 2.2. Percentages of students below proficiency level 2 and at or above proficiency level 5 on the overall mathematics scale in Ireland in 2003 and 2009



There were also changes in the mathematics performance of students at different grade (year) levels in Ireland since 2003. PISA is aimed at an age-based cohort of 15-year-old students and as a result the sample in Ireland is spread across four grade levels – Second Year, Third Year, Transition Year and Fifth Year (Perkins, Cosgrove, Moran & Shiel, 2012). Between 2003 and 2009, there was a substantial increase in the proportion of PISA students in Transition Year and a corresponding decrease in the proportion of PISA students in Fifth Year. The socio-economic composition of students at these grade levels also changed. While the levels of Economic, Social and Cultural Status (ESCS; a measure of socio-economic status in PISA) of students in Second, Third and Fifth Years steadily increased since 2003, there was a corresponding decrease in the ESCS of students in Transition Year, although, in 2009, students in Transition Year still had the highest mean ESCS of all grade levels. There was also a steady decline in the proportion of female students, and a corresponding increase in the proportion of male students, in Transition Year in the Irish PISA samples.

Students in Transition Year obtained the highest mean score in mathematics in both 2003 and 2009; however, the largest decline in mathematics between the two cycles occurred at this grade level. While decreases in reading and science were also observed at Transition Year, the largest declines for these domains were among Fifth Year students, suggesting that the decline in mathematics in Transition Year cannot be solely attributed to changes in the socio-economic or gender composition of students at this grade level. A description of teaching and learning of mathematics in Transition Year, based on a survey of mathematics teachers and mathematics school co-ordinators in PISA 2012, can be found in Moran et al. (2013).

2.1.2. Cross-curricular Problem Solving Achievement in PISA 2003

Problem solving was assessed as an additional domain in both PISA 2003 and 2012. While the problem-solving assessment was delivered in the same format (print) as the other domains in 2003, in 2012 the assessment was delivered on computers and thus involved more items that were designed to be interactive.

The mean performance of Ireland on the problem-solving scale in 2003 was 499, which did not differ significantly from the OECD average of 500 (OECD, 2004b). The overall performance of students in Ireland was not significantly different from that of students in Sweden, Austria, Iceland, Hungary, Luxembourg, the Slovak Republic and Norway. Proficiency levels were also described for the problem-solving scale, although just four intervals were defined: Levels 3, 2, 1 and below Level 1. The proportions of students in Ireland scoring at the highest- (Level 3) and lowest- (below Level 1) proficiency levels were considerably lower than the corresponding OECD averages, indicating a narrower spread of achievement in Ireland. Just over twelve percent of students in Ireland achieved a score at Level 3, compared to 18% on average across OECD countries, while 13% of students in Ireland and 17% of students across the OECD scored below Level 1.

There was no significant difference between male and female students in Ireland on the overall problem-solving scale, with males outperforming females by just half a point. Similarly, there was very little difference between the proportion of male and female students in Ireland at Level 3 (about 12% for both genders) or below Level 1 (about 13% for both genders). On average across OECD countries, females outperformed males by two points; however this difference was not significant (OECD, 2004b).

Problem solving in 2003 was considered to be independent from students' mathematical knowledge, although, it has been acknowledged that there is some overlap in terms of the problem-solving processes used. In fact, a strong positive correlation (r=.90) was found been between performance on the problem-solving and mathematics assessments. Strong correlations were also observed between performance on reading and problem-solving (r=.87) and between science and problem solving (r=.85) (OECD, 2004b).

2.1.3. Reading Achievement in Previous PISA Cycles

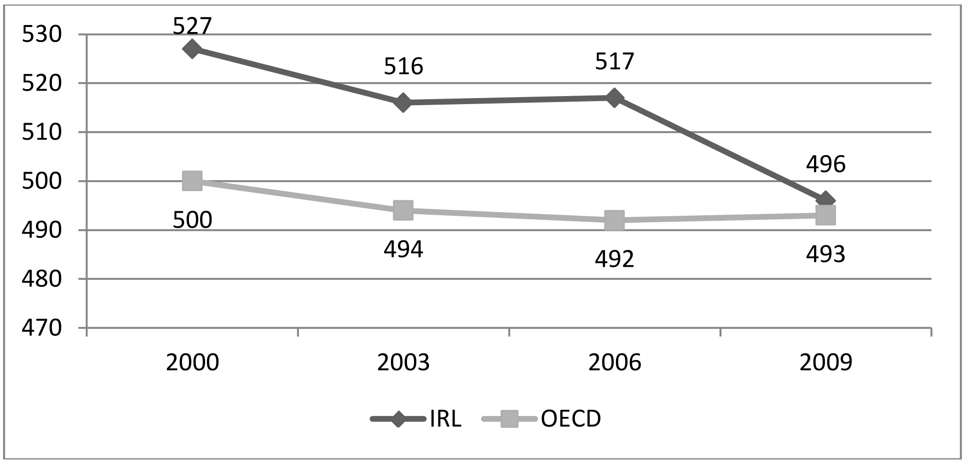
Reading was assessed as a major domain in both 2000 and 2009, thus allowing more detailed analysis of changes in reading achievement between these two cycles, although comparisons can only be made for 38 countries that have data available for both cycles, including 26 OECD countries. Furthermore, the assessment of digital reading was introduced as a new assessment domain in PISA 2009. Nineteen countries, of which 16, including Ireland, are OECD members, participated in this new assessment domain. The OECD average for the digital reading scale is based on the 16 OECD countries that participated.

Print Reading

Ireland's print reading performance was significantly above the average of 500 across OECD countries in 2000, with students achieving a mean score of 527 (the fifth highest score among OECD countries) (OECD, 2001). Between 2000 and 2009, the print reading performance of students in Ireland dropped by 31 points to 496, a mean score that was not significantly different from the corresponding OECD average (493; Figure 2.3) (OECD, 2010a). The 31 point drop, which was the largest drop across all countries with data for both cycles, includes an 11 point drop which occurred between 2000 and 2003. Although this decline was deemed to be statistically significant in 2003, it was later considered to be non-significant using revised statistical techniques (OECD, 2007).

Print reading performance in Ireland improved slightly between 2003 and 2006 (by about 2 points) meaning that most of the 31 point decline (22 points) occurred between 2006 and 2009. Both France and Sweden also experienced declines in their mean print reading scores which meant that their position relative to the OECD average changed from being significantly above it in 2000 to being not significantly different from it in 2009, although the decline was not statistically significant for France (OECD, 2010a).

Figure 2.3. Mean score on the overall reading scale for Ireland and the average across OECD countries from 2000 to 2009



Note: 26 OECD countries participated in PISA 2000, 29 in PISA 2003, 30 in PISA 2006 and 34 in PISA 2009.

With the exception of the Reflect & Evaluate scale, there was little variation in the performance of students in Ireland across the reading subscales in 2009. Students in Ireland performed best on the Reflect & Evaluate scale, achieving a mean score that was significantly above the corresponding OECD average. Irish students achieved mean scores on the other four subscales (Access & Retrieve; Integrate & Interpret; Continuous; and Non-continuous) that did not differ significantly from the corresponding OECD averages (OECD, 2010b).

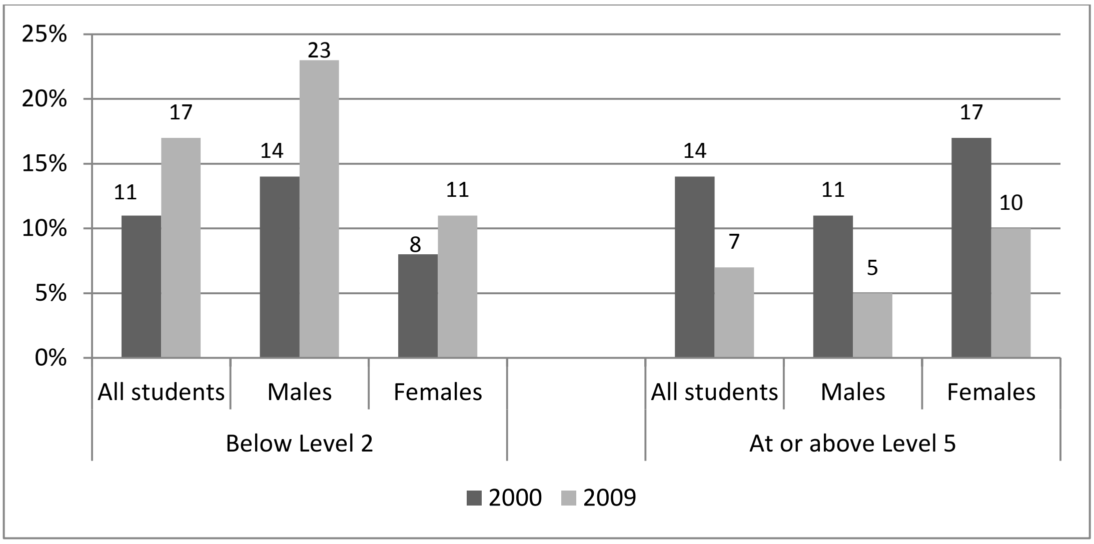
There have also been changes in the proportion of higher- and lower-achieving students in Ireland since 2000 (Figure 2.4). The percentage of students achieving a print reading score below Level 2 in Ireland increased significantly, from 11% in 2000 to 17% in 2009, while the corresponding proportion across the 26 OECD countries with valid data for both cycles declined only slightly from 19% to 18%. The percentage of lower-achieving students in Ireland was significantly below the corresponding

OECD average in 2000, but was not significantly different from it in 2009. There has also been a decrease in the proportion of higher-achieving students in Ireland. The percentage of students performing at or above Level 5 on the print reading scale has halved (from 14% to 7%) since 2000. In 2009, Ireland had significantly fewer higher-performing students compared to the 26 OECD country average, which decreased only slightly, from 9% in 2000 to 8%. Furthermore, while there was little change in the OECD average scores at the 10th, 25th, 75th and 90th percentiles between 2000 and 2009, the print reading performance of students in Ireland dropped uniformly across these key benchmarks between the two cycles (OECD, 2010a).

The gender difference in print reading achievement widened both in Ireland and across OECD countries, between 2000 and 2009. In Ireland, female students' performance advantage increased from 29 to 39 points between 2000 and 2009, although this increase is not statistically significant. On average across OECD countries, the gender difference increased from 32 points in 2000 to 39 points in 2009, meaning that the gender difference in Ireland in 2009 is identical to that across the OECD. The average print reading score dropped significantly for both males and females in Ireland between 2000 and 2009, although the drop was greater for male students. This differs somewhat from the pattern across OECD countries, where the performance of male students dropped by four points while the performance of female students improved by three points (OECD, 2010a).

On average across the 26 OECD countries that have valid data for both cycles, the percentage of females performing below Level 2 decreased by 2 points between 2000 and 2009, while the corresponding percentage of males did not change. In Ireland, the percentage of lower-performing male students increased significantly by almost 10 percentage points, while the corresponding percentage of females increased by just three percentage points (Figure 2.4). There were also significant decreases in percentages of males and females who performed at or above Level 5 in Ireland between 2000 and 2009. The drop among higher-performing females (8 points) was slightly larger than the decrease among higher-performing male students (7 points). There were also small decreases in the percentage of higher-performing male (1 percentage point) and female (0.5 percentage points) students across the 26 OECD countries that have data for both cycles (OECD, 2010a).

Figure 2.4. Percentages of students below proficiency level 2 and at or above proficiency level 5 on the overall reading scale in Ireland in 2000 and 2009.



Possible explanations for the overall decline in print reading performance in Ireland include: significant demographic changes in the school-going population in Ireland since 2000 (including increases in the proportion of migrant students and students who speak a language other than English/Irish at home; greater numbers of students with special educational needs integrated into mainstream classes; and greater retention rates) as well as technical issues such as the linking and scaling methodologies used in PISA. There is also some evidence that there were lower levels of engagement with the assessment among participating students in Ireland in 2009. However, without a direct measure of effort no firm conclusions can be drawn (for a more detailed consideration of the changes in performance in PISA 2009 and some reasons behind them, see Perkins et al., 2012).

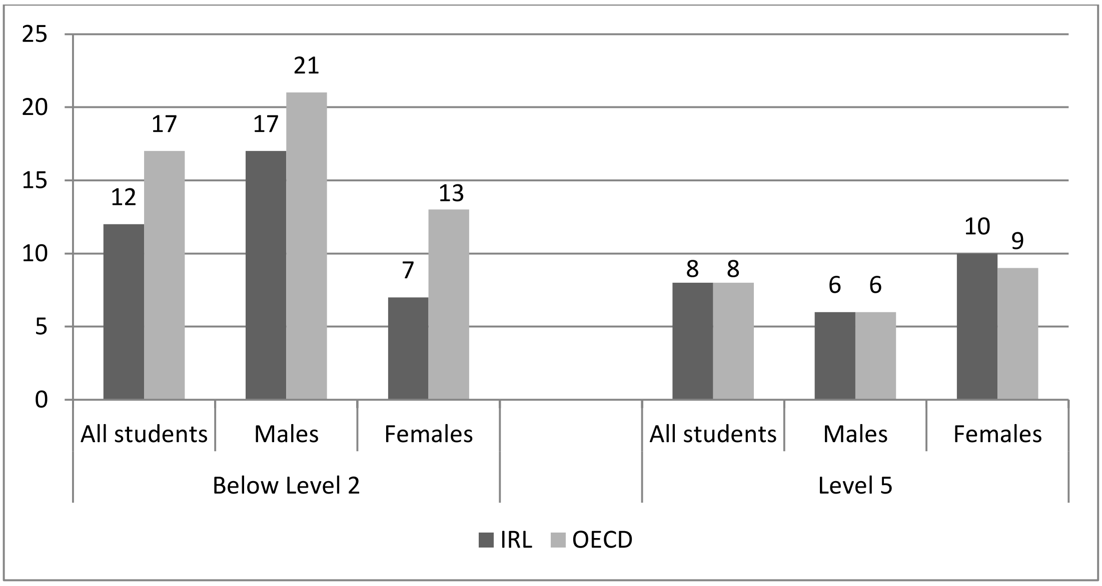
Digital Reading

In 2009, Ireland's mean digital reading score (509) was significantly above the corresponding 16-country OECD average (499) (OECD, 2011). The mean score of students in Ireland did not differ significantly from the score of students in Hong Kong-China, Sweden, Iceland and Belgium. The difference between the mean score of students in Ireland at the 5th percentile (the lowest percentile marker) and the mean score at the 95th percentile (the highest percentile marker) was 286 points, which was slightly lower than the average across 16 OECD countries (293). Students in Ireland obtained an average score at the 10th percentile (396) that was 8 points higher than the corresponding 16-country OECD average (380), while the difference in favour of Irish students at the 90th percentile was just over 7 points (616 in Ireland versus 609 on average across OECD countries).

Four proficiency levels are described for the digital reading scale (Level 2, Level 3, Level 4 and Level 5). Like print reading, Level 2 is considered the baseline level of proficiency for digital reading, while Level 5 or above is considered to be the level associated with advanced reading. Approximately 12% of students in Ireland achieved a digital reading score below Level 2, compared to almost 17% on average across the 16 OECD countries (Figure 2.5). At the other end of the scale, the percentage of students in Ireland achieving at or above Level 5 was identical to the 16-country OECD average (8%) (OECD, 2011). Thus, it seems that the above-average performance of students in Ireland relative to the 16-country OECD average could be attributable to the stronger performance of students at the lower end of the achievement distribution.

As was the case for print reading, females outperformed males on the digital reading scale in Ireland in 2009. The difference (31 points) was the third largest of all 19 countries that participated in the assessment, and larger than (although not significantly so) the corresponding 16-country OECD average (25 points). Almost 17% of boys in Ireland achieved a mean digital reading score that was below Level 2, compared to almost 21% on average across the 16 OECD countries (Figure 2.5). While 13% of female students across the 16 OECD countries obtained a mean score below Level 2, just over 7% of girls in Ireland had a mean score below Level 2. At the upper end of the achievement distribution, almost 6% of boys and 10% of girls in Ireland had digital reading scores at Level 5. These were similar to the corresponding percentages across the 16 participating OECD countries (6.3% and 9.3%, respectively) (OECD, 2011).

Figure 2.5. Percentages of students below proficiency level 2 and at or above proficiency level 5 on the digital reading scale in Ireland and on average across the 16 participating OECD countries in 2009



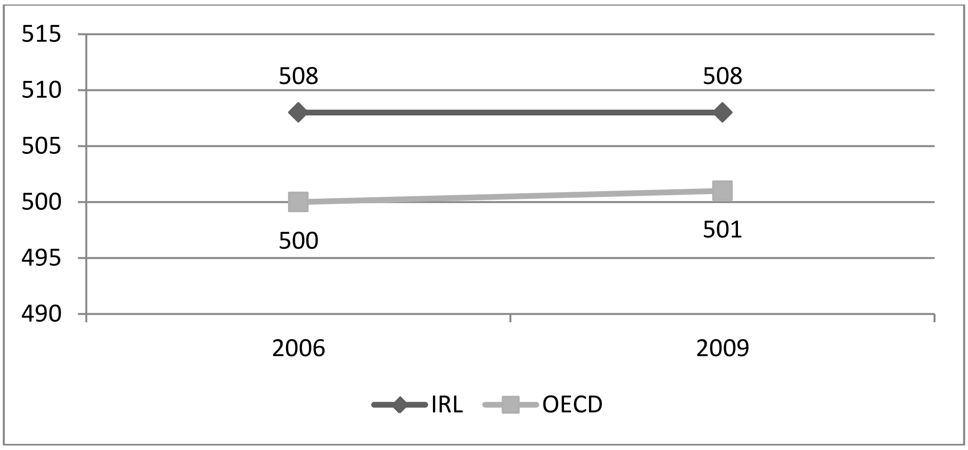
Students' navigational behaviour was also recorded during the digital reading assessment. Three indices were produced: total number of page visits during the assessment, number of relevant page visits, and number of relevant pages visited. The number of relevant pages visited showed the strongest relationship with achievement in Ireland and also across the OECD (correlations of .82 and .81, respectively), followed by the number of visits to relevant pages (r=.64 in Ireland and .62 across OECD countries) and number of page visits (r=.42 in Ireland and across OECD countries). Ireland's average score on the number of relevant pages visited was significantly above the OECD average, while the scores for number of visits to relevant pages and number of page visits did not differ significantly from the corresponding OECD averages (OECD, 2011).

2.1.4. Science Achievement in Previous PISA Cycles

Ireland's mean score on the science scale did not change significantly between 2006 (when science was first assessed as a major domain) and 2009, declining only marginally, from 508.3 to 508.0 (OECD, 2007). In both cycles, Ireland's mean score was significantly above the corresponding OECD average score. The OECD average also changed only slightly from 500 in 2006 to 501 in 2009. The achievement of Irish students did not differ significantly from those of nine countries, including the United Kingdom, Slovenia, Poland, Belgium, the United States and Norway (OECD, 2010a).

There was some variation in the mean scores of students in Ireland across subscales in 2006. Students obtained mean scores on the Identifying Scientific Issues (516), Using Scientific Evidence (506) and Earth & Space Systems (508) subscales that were significantly above the corresponding OECD averages. However, there was no significant difference between Ireland's scores on the Explaining Phenomena Scientifically (506), Living Systems (506) and Physical Systems (505) subscales and the corresponding OECD averages (OECD, 2007).

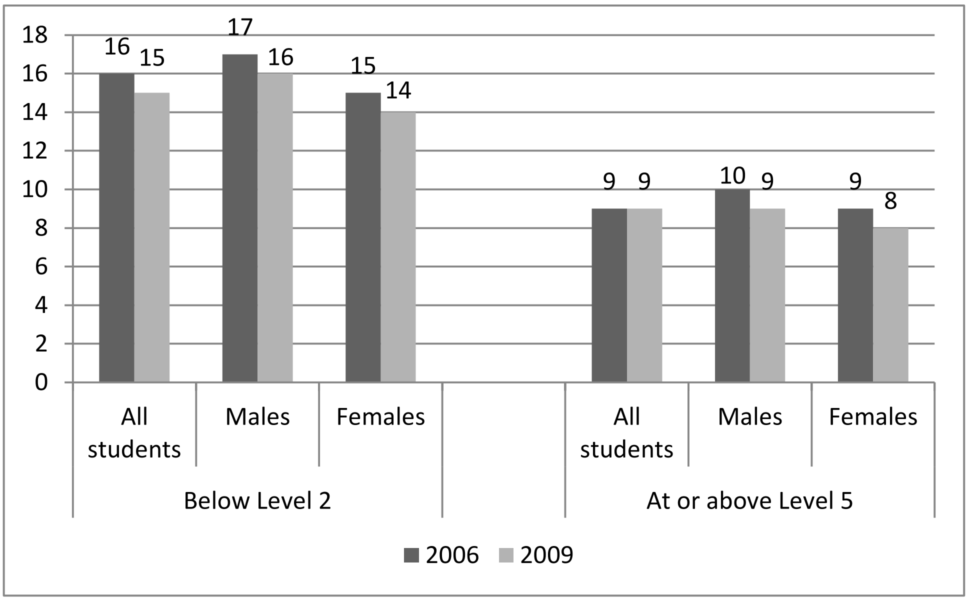
Figure 2.6. Mean score on the overall science scale for Ireland and the average across OECD countries, 2006 and 2009.



Note: 30 OECD countries participated in PISA 2006 and 34 in PISA 2009.

The percentage of lower- (below Level 2) and higher-achieving (at Level 5 or above) students in Ireland did not change significantly between 2006 and 2009 (Figure 2.7). Almost 16% of students in Ireland obtained a mean score below Level 2 in 2006, while just over 15% did so in 2009. The percentage of students at or above Level 5 was approximately 9% in both cycles. Across OECD countries there was a significant decrease in the proportion of students achieving below Level 2 (from 20% in 2006 to 18% in 2009), while there was no significant change in the proportion of students who obtained a score at or above Level 5 (9% in both 2006 and 2009) (OECD, 2010a).

Figure 2.7. Percentages of students below proficiency level 2 and at or above proficiency level 5 on the overall science scale in Ireland in 2006 and 2009.



The mean score of female students on the science scale in Ireland increased slightly by 0.9 points between 2006 and 2009, while the score for male students decreased marginally by 1.5 points. This means that there was a small but non-significant increase in the gender difference in Ireland (from 0.4 points to 2.8 points). On the other hand, the gender difference across OECD countries narrowed from 2.2 points to 0.1 points in favour of male students. In 2009, slightly more males than females perform below Level 2, both in Ireland (16% of males compared to 14% of females; Figure 2.7) and on average across OECD countries (19% of males compared to 17% of females). In 2009, the percentages of male and female higher-achieving students (at Level 5 or above) were similar in Ireland (9% of males and 8% of females). However, on average across the OECD, there were slightly more male than female students achieving a score at or above Level 5 (9% of males compared to8% of females). The proportions of higher- and lower-achieving students on the science assessment in Ireland changed very little between 2006 and 2009 (OECD, 2010a).

2.1.5. Achievement Outcomes in Other International and National Assessments

This section considers other sources of information on achievement from recent large-scale surveys. These sources include recent national assessments of reading and mathematics conducted at primary level (Eivers et al., 2010); international assessments of reading, mathematics and science (Eivers & Clerkin, 2012) and an international survey of adult literacy, numeracy and problem solving conducted in 2011-2012 (OECD, 2013f). Notwithstanding differences in the ages of the participants, the content of the tests and the aims of these different surveys, taken together with PISA, they can nonetheless provide a broad indication of Ireland’s strengths and weaknesses.

Third Year students who were selected to participate in PISA 2012 (61% of the achieved PISA 2012 sample) would have been eligible to participate in the 2009 National Assessments of Mathematics and Reading when they were in Sixth class and therefore results from these assessments may provide some insight into the performance of this cohort in the PISA 2012 assessment. The national assessments were administered for the first time in Second and Sixth classes in 2009. Hence, no trend data are available.

In mathematics, the overall percent correct scores for Sixth class was 55%[21]. Performance among Sixth class pupils varied quite considerably across the four content strands measured. Performance was lowest for the Measures strand, with just 38% of items being answered correctly, while 64% of items were answered correctly in the Data strand. Performance was similar on the Number & Algebra and Shape & Space strands, with 58% and 59% of items answered correctly, respectively. There was also considerable variation in performance among the five mathematics process skills measured: performance was lowest for Apply & Problem-solve process, with 44% of such items answered correctly, followed by the Recall (54% correct), Integrate & Connect and Implement (both 59% correct). Performance was strongest on the Reason subscale with 63% of items answered correctly. While there was no significant gender difference on overall mathematics performance, a significant difference of 9 scale-score points was found in favour of boys on the Measures subscale.

Sixth class pupils answered 65% of reading items correctly. Performance was similar across the two content areas measured, with 64% of Vocabulary items and 66% of Comprehension items answered correctly. There was more variation in performance across the four process skills measured. Performance was lowest on the Interpret & Integrate process subscale, with 54% of items answered correctly. Performance was similar on the Examine & Evaluate and Infer subscales, with 63% and 65% of items answered correctly, respectively. Pupils performed best on the Retrieve items, with 70% of these items answered correctly. While girls obtained a slightly higher percent correct score than boys, the gender difference was not statistically significant for overall reading or for any of the content area or process skills subscales.

[21] In the 2009 National Assessments, the scales for both reading and mathematics were set to have a national mean of 250 and a standard deviation of 50. However, percent-correct scores are reported except in the case of gender difference, where reference is made to scale scores.

Primary schools in Ireland also participated in two large international comparative studies of achievement in 2011: the Progress in International Reading Literacy Study (PIRLS) and the Trends in International Mathematics and Science Study (TIMSS). In these studies, the achievement of Fourth class students was measured in reading, mathematics and science and scaled to have an international centrepoint of 500 and a standard deviation of 100. Scores in PIRLS and TIMSS 2011 were linked back to the years in which the assessments were first administered (1995 for TIMSS and 2001 for PIRLS). Hence, the international centrepoint refers to 1995 for mathematics and science, and to 2011 for reading literacy. Ireland performed well on the reading assessment, obtaining a mean score of 552, which is significantly above the international centrepoint. Just five countries/economies (Hong Kong, the Russian Federation, Finland, Singapore and Northern Ireland) obtained mean scores significantly higher than Ireland. Twice as many pupils in Ireland reached the Advanced Benchmark in terms of the skills they were able to demonstrate for reading, when compared to the international median (16% compared to 8%). Over half of Irish pupils reached the High Benchmark, while just 3% did not reach the Low Benchmark (compared to 5% internationally).[22] Ireland's performance on the two process subscales (Retrieve/Infer and Interpret/Evaluate) was similar to the overall national average. However, for the purpose subscales, students in Ireland obtained a significantly higher mean score on the Literary subscale and a significantly lower mean score on the Informational subscale, when compared to the overall national average. Girls significantly outperformed boys by 15 points in Ireland, a difference which is similar to the international average gender difference (17 points).

On TIMSS mathematics, pupils in Ireland achieved a mean mathematics score of 527, which was significantly above the international centrepoint and Ireland was placed 17th out of 50 participating countries. Just over twice as many pupils in Ireland reached the Advanced Benchmark than the international average (9% versus 4%); however, many more students reached this benchmark in the highest-achieving countries, including Northern Ireland (24%) and England (18%). Pupils in Ireland obtained significantly higher mean scores on the Number content area and the Knowing cognitive process area, while they had significantly lower mean scores on the Geometric Shapes and Measures and Data Display content areas and the cognitive process of Reasoning, when compared to the overall national average. The difference between girls and boys in Ireland on the overall mathematics scale was just 3 points and not significant.

Ireland's score on the science scale (516) was significantly above the international centrepoint and placed Ireland in 22nd position out of 50 countries. Both boys and girls obtained identical scores in Ireland. Seven percent of students in Ireland reached the Advanced Benchmark while 35% reached the High Benchmark (compared to international medians of 5% and 32%, respectively). There was little variation in performance on the science content domains in Ireland, with pupils obtaining mean scores on the Life Science, Physical Science and Earth Science content domains that were similar to the overall national mean. While students in Ireland obtained mean scores on the Knowing and Applying cognitive domains that were not significantly different from the overall national average, performance on the Reasoning subscale was significantly poorer than the overall national average.

Ireland also participated in the OECD's Programme for the International Assessment of Adult Competencies (PIAAC) in 2011-2012. This survey, which was conducted in 24 countries, assesses the skills of adults aged between 16 and 65 years in the areas of literacy, numeracy and problem solving

[22] Unlike PISA, PIRLS and TIMSS reports cumulative percentage reaching each benchmark.

in technology-rich environments. The scores on each scale range from 0 to 500. In Ireland, adults were found to have an adjusted average (i.e. adjusted to account for non-response bias) score of 266 on the literacy scale, which is slightly but significantly below the study average of 270. Ireland's mean literacy score is ranked 17th out of 24 participating countries and is similar to the mean scores in Germany, Poland, Austria, Flanders (Belgium) and Northern Ireland. Almost 18% of adults in Ireland performed at or below the lowest level of proficiency measured by PIAAC (Level 1), compared to just under 17% on average across participating countries.

PIAAC also assessed the reading ability of those with the weakest literacy skills in three areas: word meaning, sentence processing and passage comprehension. In Ireland, adults whose literacy was assessed as being below Level 1 answered on average 95% of the word meaning, 84% of the sentence processing and 91% of the passage comprehension tasks correctly, suggesting that many adults at the lower end of the PIAAC literacy scale have basic literacy skills.

The data from the International Adult Literacy Survey (IALS), which was conducted in Ireland in 1994, was rescaled to make it comparable with the data from PIAAC. While there was no significant difference in the average literacy scores of adults in Ireland between 1994 and 2012 (the mean score for IALS was 264 and the mean score for PIAAC was 267[23]), the percentage of adults who were assessed as being below Level 1 on the literacy scale has dropped from 22%[24] to 18%. However, caution is advised when interpreting trends between IALS and PIAAC as considerable changes have occurred in the population in Ireland in the intervening period (CSO, 2013).

Ireland's adjusted mean score on the PIAAC numeracy scale was 255, which is significantly below the study average of 266, and places Ireland 19th out of 24 participating countries. Ireland performance on the numeracy scale is similar to the performance in Northern Ireland and France. Twenty-six percent of adults in Ireland performed at or below Level 1 on the numeracy assessment, compared to 20% on average across participating countries. The assessment of problem solving in technology-rich environments assesses respondents' ability to use computer applications (such as email, spread sheets or internet browsers) to do various tasks. More than two-fifths (42%) of adults in Ireland scored at or below Level 1 on the assessment of problem solving in technology-rich environments, which is the same as the study average.[25] On the other hand, 25% of adults in Ireland obtained scores at Levels 2 and 3 (the highest levels) compared to the study average of 34%.

While PIAAC and PISA assess similar skills, there are considerable differences between the surveys (in particular their target populations, data collection processes and assessment design), meaning that direct comparisons cannot be made between the two surveys. However, analyses carried out by the Central Statistics Office (CSO, 2013) have examined Ireland's performance relative to the average performance on both surveys, allowing for broad comparisons between them.[26] Four age

[23] The mean scores reported for trends analysis between IALS and PIAAC are unadjusted scores.
[24] The original figure was 25% at this level but the IALS data was rescaled by the OECD in 2012 resulting in a revised figure of 22% in Ireland (CSO, 2013).
[25] In Ireland, the response rate for the problem solving in technology rich environments is somewhat lower than for the other assessment areas as a certain proportion of adults who indicated they had no computer experience, or who failed the computer skills assessment or who opted to not take a computer-based assessment were not included the assessment of problem solving in technology rich environments, though they were classified as scoring below proficiency level 1.
[26] The PIAAC and PISA mean scores on literacy and numeracy were transformed into standard scores or Z scores. For more information on this analysis see CSO (2013).

groups corresponding with each round of PISA were isolated from the PIAAC sample (e.g. the 26-28 age group in PIAAC would have been eligible to participate in PISA 2000). For Ireland, the patterns of results from the two surveys are quite different for both literacy and numeracy. In Ireland, the PISA literacy results are consistently above the average (with the exception of PISA 2009), while the numeracy results are at the average. The PIAAC literacy and numeracy results, on the other hand, are considerably below the corresponding averages for selected cohorts. It is unclear at this time why the results of the two assessments are different; however, caution is advised when drawing conclusions from any comparisons between the two studies (OECD, 2013g).

The results of these assessments, taken together with the results from previous PISA cycles, provide us with a broad picture of the achievement levels of students in Ireland in the areas of reading, mathematics and science. While the results for reading are somewhat mixed, the performance of Ireland in mathematics has been consistently disappointing. The mathematical content areas of Space & Shape and Measures have been highlighted as areas of particular weakness for students in Ireland. Ireland's performance in science, on the other hand, appears to be somewhat stronger, with Ireland consistently performing above average in assessments of scientific literacy.

2.2. Characteristics Associated with Achievement in Previous Cycles of PISA

One of the main goals of PISA is to relate data on student achievement to background and contextual factors that may help to explain patterns of achievement. This information is gathered through the administration of school and student questionnaires. Multi-level models of achievement have been developed in Ireland for each cycle of PISA (Shiel, Cosgrove, Sofroniou & Kelly, 2001; Cosgrove, Shiel, Sofroniou, Zastrutzki & Shortt, 2005; Cosgrove & Cunningham, 2011; Perkins et al., 2012) and are used to examine the associations between particular variables and achievement, while controlling for other related variables. While there are some differences in the variables that have been found to be associated with achievement across domains and cycles of PISA, a number of characteristics have been found to be consistently related to achievement in Ireland. Variables which are related to achievement more generally rather than to specific domains, are discussed below.

The variance in achievement gives an indication of the distribution of achievement scores in a country. The smaller the total variance, the narrower the distribution of achievement. Between-school variance (usually expressed as a percentage of total variance) is an indication of the extent to which schools differ with respect to average achievement, i.e. the lower the between-school variance, the more equitable the school system with respect to student achievement. The percentage of variance in performance attributable to differences between schools tends to be smaller in Ireland compared to the averages across OECD countries for all domains. However, between-school variance increased in Ireland in all domains since 2000 (by about 10 percentage points), indicating that schools in Ireland were more different from one another in terms of average achievement (in all domains) in 2009 than they were in 2000 (Perkins et al., 2012). There were also increases in the average between-school variance in reading performance across OECD countries between 2000 and 2009 (and also for mathematics and science between 2000 and 2006), although to a smaller extent (Table 2.1).

Table 2.1. Between-school variance in achievement (expressed as a percentage of total variance) for all domains, in Ireland and on average across OECD countries between 2000 and 2009

	Ireland				OECD			
Domain	2000	2003	2006	2009	2000	2003	2006	2009
Print Reading	17.8	22.5	23.4	28.7	34.7	31.4	36.0	39.3
Mathematics	11.4	16.7	19.4	23.5*	31.4	32.7	34.7	
Science	14.1	16.2	17.2	25.0*	30.6	29.9	32.7	

Note: *Estimates for mathematics and science for 2009 were computed in HLM 6.0®. OECD average estimates for mathematics and science are not available for 2009.

2.2.1. Student Economic, Social and Cultural Status (ESCS)

In PISA, student socio-economic status is measured using an index of Economic, Social and Cultural Status (ESCS) that is made up of six variables (parental occupation, home educational resources, cultural possessions, material possessions, books in the home and parental education). There is a consistently strong link between ESCS and achievement, with students from high ESCS homes obtaining significantly higher achievement scores in all domains than those from medium or low ESCS homes. Differences between students from high and medium ESCS homes ranged from between 33 and 40 score points (depending on domain and cycle), while differences between students from high and low ESCS families ranged from between 75 and 87 points (again depending on domain and cycle).

Significant relationships have also been found between achievement and the separate variables that make up the ESCS index. For example, higher levels of parental occupation (as measured by the International Standard Classification of Occupations [ISCO] and transformed into the International Socio-economic Index [ISEI]) and parental education (as measured by the International Standard Classification of Education [ISCED]) are significantly associated with higher student achievement. For example, in 2009, significant positive correlations were found between student reading achievement and parental occupation (r=.317) and between reading achievement and parental education (r=.238) (OECD, 2010c). In 2000, 2003 and 2006, students who came from high ISEI families significantly outperformed those who came from medium and low ISEI families[27]. Differences between students from high and medium ISEI homes ranged from between 15 to 33 points (depending on domain and cycle), while differences between students from high and low ISES families ranged from between 49 and 72 points (depending on domain and cycle). Also, students who had a least one parent who had obtained a third-level or postgraduate degree outperformed all other students in PISA 2000, 2003 and 2006[28] (Shiel et al., 2001; Cosgrove et al., 2004; Eivers, Shiel & Cunningham, 2008).

The number of books in a student's home has also been found to be significantly related to achievement in each PISA cycle in Ireland, with greater number of books associated with higher achievement levels. Likewise, higher levels of home educational resources (e.g., having a desk to study at, technical reference books or a computer to help with schoolwork) and cultural resources (e.g., having classic literature, books of poetry or works of art) in the home has been associated with higher achievement in all cycles (Shiel et al., 2001; Cosgrove et al., 2004; Eivers et al., 2008). The relationship between material possessions (including students having a room of their own, an Internet connection, and numbers of mobile phones, cars and televisions) and achievement is somewhat more complex. For example, while significant positive correlations were observed

[27] In 2009, the ISEI scale was not split into high, medium and low categories.
[28] For 2009 this variable was converted to education in years.

between material possessions and achievement in all domains in 2009, the correlations were much weaker than those involving the other ESCS subscales. Furthermore, across OECD countries in 2009, increases on all ESCS subscales were associated with increases in achievement (when a range of other student background variables were held constant), with the exception of the index of material possessions (OECD, 2010c).

2.2.2. School Socio-economic Composition/Disadvantaged Status

As well as exploring the relationship between student ESCS and achievement, PISA allows us to examine the relationship between the average ESCS of schools and student achievement (i.e. each student is assigned the average of the ESCS scores of all PISA students in their school). Across all cycles and domains, students attending schools with higher mean ESCS scores (i.e. with lower concentrations of socio-economically disadvantaged students) outperformed those attending schools with lower ESCS scores (OECD, 2001; 2004a, 2007, 2010c).

In fact, in each cycle of PISA, the association between school average ESCS and student achievement in Ireland was stronger than the relationship between individual student socio-economic background and achievement. In Ireland, half a unit (standard deviation) increase on the ESCS index at the school level is associated with an increase of between 21 and 27 points on the student achievement scales. On the other hand, half a unit increase on the ESCS index at the student level is associated with an increase of between 13 and 15 points on the achievement scales, confirming the existence of a social-context effect. However, the school ESCS association in Ireland is weaker than on average across OECD countries where a half unit change on the ESCS index at the school level is associated with between 28 and 32 points on the achievement scales (OECD, 2001; 2004a, 2007, 2010c).

Another school socio-economic indicator that has been shown to be related to achievement in Ireland is school disadvantaged/DEIS status.[29] Students attending schools designated as disadvantaged (in 2000, 2003 and 2006) or that are part of the School Support Programme (SSP) under DEIS (in 2009) obtained significantly lower achievement scores than those in non-designated/SSP schools. Differences ranged from just over a third of a standard deviation to seven-tenths of a standard deviation (depending on the cycle and domain) (Shiel et al., 2001; Cosgrove et al., 2004; Eivers et al., 2008).

2.2.3. Family Structure

Family structure variables, such as one-parent status and number of siblings, have also been found to be related to achievement in earlier cycles of PISA. Students who were classified as belonging to one-parent families performed significantly less well than those in dual-parent families on all domains, with differences ranging from between 23 and 34 points, depending on the cycle and domain. Belonging to a one-parent family is also associated with significantly lower ESCS. In 2009, the achievement difference associated with one-parent families in Ireland was reduced, from 25 to 13 points, when ESCS was held constant, indicating that differences between one- and dual-parent

[29] DEIS (Delivering Equality of Opportunity), which was introduced in 2006, is an initiative provided by the Department of Education and Skills aimed at addressing the needs of disadvantaged students at both primary and post-primary schools. Post-primary schools were considered for inclusion in this initiative based on socio-economic and educational indicators. DEIS was preceded by the Disadvantaged Area Scheme (DAS), which also used indicators of socio-economic and educational disadvantage to identify schools.

families cannot be completely explained by differences in socio-economic background (OECD, 2010c).

The findings on the relationship between number of siblings and achievement in all domains indicate that students in larger families tend to have slightly lower levels of achievement, though there are relatively few such families. In all cycles, students with one other sibling had higher mean scores than those with no siblings, while those with four or more siblings obtained the lowest mean scores. Differences between students with one sibling and those with four or more siblings ranged from 27 points to 44 points depending on domain and cycle. Students from larger families also tended to have lower ESCS; for example, the mean ESCS score of students in Ireland with four or more siblings was almost one-quarter of a standard deviation below the overall average ESCS score across OECD countries (OECD, 2001; 2004a, 2007, 2010c).

2.2.4. Language Spoken at Home

The percentage of students in the PISA sample in Ireland who speak a language other than English or Irish at home increased considerably between 2000 and 2009, from just under 1% to almost 4% (Perkins et al, 2012). While the proportion of 'other language' students was too small in 2000 and 2003 to make reliable comparisons, the data from 2006 and 2009 indicate that these students performed considerably less well than either native students or immigrant students who speak English or Irish (OECD, 2007, 2010c). In 2006, the difference between 'other language' and native students was only significant for science (61 points), although large differences were also observed for reading (49 points) and mathematics (57 points). Differences in 2009 were over a quarter of a standard deviation and significant for all domains. Also, 'other language' students and native students had statistically equivalent socio-economic status in 2009, indicating that differences between these two groups cannot be wholly explained by socio-economic factors.

2.2.5. Grade Level

As PISA is aimed at an age-based cohort of 15-year-old students, the sample in Ireland is spread across four grade levels – Second Year, Third Year, Transition Year and Fifth Year. Since 2000, Transition Year students have displayed significantly higher average performance levels than students in all other year levels, with the exception of mathematics in 2009, which did not differ significantly from that of Fifth Year students (Shiel et al., 2001; Cosgrove et al., 2004; Eivers et al., 2008; Perkins et al, 2012). Between 2000 and 2006, Fifth Year students significantly outperformed students in Third Year across all domains. In 2009, however, the relative achievement levels of Third and Fifth Year students differed by domain – Fifth Year students had significantly higher mean scores in digital reading and mathematics, while differences between these year levels in print reading and science were not significant.

There have been some changes in the distribution of students across grade levels since 2000. While the proportion of Second and Third Year students has remained relatively stable, there has been a substantial increase in the percentage of PISA students participating in Transition Year (from 16% in 2000 to 24% in 2009) and a corresponding decrease in the proportion of Fifth Year students (from 19% to 14%) between the same years. The socio-economic composition of students at different grade levels has also changed. While the mean ESCS scores for students in Second, Third and Fifth Years have steadily increased since 2003, there has been a corresponding decrease in the ESCS of students in Transition Year. However, students in Transition Year have had the highest mean ESCS of all grade levels since 2000 (Perkins et al, 2012).

2.2.6. Student Engagement with the Education System

Two variables related to student engagement with the education system that have been found to be associated with achievement are early school leaving intent and absence from school. Since PISA 2000, students in Ireland have been asked whether they intended to stay in school until they had completed the Leaving Certificate Examination. In each cycle, students identified as being at risk of dropping out of school early (i.e. before the Leaving Certificate) obtained significantly lower achievement scores than those who were regarded as likely to complete the Leaving Certificate, with differences in scale scores ranging from 64 to 111 points, depending on domain and cycle (Shiel et al., 2001; Cosgrove et al., 2004; Eivers et al., 2008; Perkins et al, 2012).

Students were also asked to indicate the number of days that they were absent from school in the two weeks prior to the assessment day. In each cycle, there was a clear linear relationship between number of days absent and achievement. Students who indicated that they were not absent on any day in the fortnight preceding the assessment obtained the highest mean scores. Achievement scores were lower for those who were absent 1 or 2 days and lower again for those who were absent 3 or more days. The difference in achievement scores between those who were not absent any day and those who were absent 3 or more days ranged from 31 points to 55 points, depending on domain and cycle (Shiel et al., 2001; Cosgrove et al., 2004; Eivers et al., 2008; Perkins et al, 2012).

2.2.7. Attitudes Towards and Engagement with the Assessment Domain

In each cycle, PISA gathers information on students' attitudes towards and engagement with the major domain of the assessment. In both 2000 and 2009, students' ratings of enjoyment of reading as a leisure activity and frequency of students' leisure reading were positively associated with reading achievement. The relevance of these variables is highlighted in the final models of reading reported on in national PISA reports in 2000 and 2009 (Shiel et al., 2001; Cosgrove et al., 2004; Cosgrove & Cunningham, 2011; Perkins et al, 2012). Students' engagement and attitudes towards reading explained substantial amounts of variance in achievement in reading over and above demographic and socio-economic factors for print reading in both years and for digital reading in 2009. Reading engagement and use of reading strategies accounted for two-thirds of the gender difference in both the print and digital reading in 2009, suggesting that much of the gender difference observed in reading can be explained by differences in reading practices. A matter of concern is the significant decrease in the percentage of students in Ireland who indicated that they read for enjoyment since 2000 (from 67% to 58%), a decrease which was more evident among female than male students (Perkins et al, 2012).

In 2003, self-efficacy in mathematics and anxiety about mathematics were examined in terms of their associations with mathematics achievement. Students who reported high self-efficacy in mathematics achieved a significantly higher mathematics score than students with medium or low self-efficacy. In fact, the difference in favour of students with high self-efficacy over those with low-self-efficacy was 109 points. On the other hand, students with high levels of anxiety about mathematics achieved a mean score that was significantly lower than those with medium (35 points lower) and low levels of anxiety (69 points lower). In Ireland, male students had significantly higher self-efficacy and significantly lower anxiety scores than female students. Additional care should be exercised in interpretation of associations between self-efficacy in mathematics, anxiety about mathematics, and mathematics achievement, as self-efficacy and anxiety can affect, and be affected by, students' recent achievement (Cosgrove, Shiel, Oldham & Sofroniou, 2004). Indeed, Williams and Williams (2010) found evidence that mathematics self-efficacy and mathematics performance in PISA 2003 influence and are influenced by each other (i.e. 'reciprocal determinism') in 26 countries, although there was no evidence for this in Ireland.

General engagement with science explained approximately 20% of the total variance in the final national model of PISA 2006 science (Cosgrove & Cunningham, 2011). In particular, enjoyment of science and science self-efficacy accounted for 5% of the total variance. In Ireland, a one unit (standard deviation) increase on the index of self-efficacy was associated with an increase of 40 points in science achievement. Male students in Ireland had significantly higher levels of self-efficacy in science than females. Interest in science was examined through five different indices, including general interest in science, instrumental motivation to learn science, enjoyment of science, engagement in science-related activities and future-orientated motivation to learn science. Each of these indices was positively associated with achievement, i.e. an increase of one standard deviation on each of these indices was associated with an increase in science achievement, ranging from 25 to 37 points. Female students in Ireland had significantly higher levels of general interest in science, instrumental motivation to learn science and future-oriented motivation to learn science than males, while male students reported engaging in science-related activities significantly more often than females.

2.3. Recent and Current Developments in the Teaching and Learning of Mathematics in Ireland.

This section considers recent and current developments relating to the mathematics curriculum at post-primary level (i.e. Project Maths), intended revisions of the curriculum at junior cycle (DES, 2012), and the *National Strategy to Improve Literacy and Numeracy Among Children and Young People, 2011-2020* (DES, 2011).

The post-primary mathematics syllabus has recently undergone major national reform with the introduction of Project Maths. This reform involves changes in the curriculum, assessment and the teaching and learning of mathematics at both junior and senior cycles. Project Maths focuses on developing students' understanding of mathematical concepts and their mathematical skills, so that they can apply their knowledge and skills to solving both familiar and unfamiliar problems, using examples from everyday life which are meaningful to students (NCCA/DES, 2011a, 2011b). Project Maths also aims to foster students' enthusiasm for mathematics and to encourage students to think creatively about the ways mathematics can be used and applied (Jeffes et al., 2012). One of the key elements of Project Maths is a greater emphasis on an investigative approach, meaning that students become active participants in developing their mathematical knowledge and skills.

Both the Junior Certificate and Leaving Certificate syllabuses are divided into five strands, which have been introduced on a phased basis at both junior and senior cycles simultaneously. The five strands are 1) Statistics and Probability; 2) Geometry and Trigonometry; 3) Number; 4) Algebra; and

5) Functions. Strands 1 and 2 were introduced in an initial group of 23[30] schools (referred to as 'initial schools' in this report) in September 2008, followed by Strands 3 and 4 in September 2009 and Strand 5 in September 2010. The experience of the initial schools was used to inform and refine the initiative on an on-going basis. The new curriculum and assessment was subsequently rolled out to all other schools (again on a phased basis) from September 2010 (see Table 2.2.). Rollout will have been completed at senior cycle by June 2014, and at junior cycle by June 2015.

Table 2.2. Timeline for Project Maths

	Cohort	Years of study at Junior Cycle	Years of study at Senior Cycle	Syllabus strands
Initial 23 schools	1	2008 – 2011	2008 – 2010	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry
	2	2009 – 2012	2009 – 2011	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry Strand 3: Number Strand 4: Algebra
	3	2010 - 2013	2010 – 2012	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry Strand 3: Number Strand 4: Algebra Strand 5: Functions
All schools	1	2010 – 2013	2010 – 2012	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry
	2	2011 – 2014	2011 – 2013	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry Strand 3: Number Strand 4: Algebra
	3	2012 – 2015	2012 – 2014	Strand 1: Statistics and Probability Strand 2: Geometry and Trigonometry Strand 3: Number Strand 4: Algebra Strand 5: Functions

Note: Students taking the Leaving Certificate in 2015 and beyond will study all the material in strand 1 (statistics and probability).

An inital report exploring the impact of Project Maths on student achievement, learning and motivation (Jeffes et al., 2012) found that while students at junior and senior cycles generally performed well in many aspects of the revised mathematics syllabus, no significant differences were found between the skills of students following the revised mathematics syllabus and those following the previous syllabus. A follow-up study (Jeffes et al., 2013) suggested an advantage on some aspects of mathematics at junior cycle for students in phase one (initial) schools, though this may have related to the time of year at which testing was conducted.

Although the majority of students who participated in PISA 2012 would not have experienced the complete Project Maths programme, the results from this cycle of PISA offer us an interesting opportunity to compare the initial schools to all other schools at a relatively early stage of the implementation process. An upcoming ERC report*, PISA and Project Maths*, will explore the results of PISA 2012 in the initial schools and make comparisons with performance in non-initial schools. The

[30] One of the original 24 Project Maths initial schools amalgamated with another school and therefore was not included as a Project Maths school in the sample for PISA 2012.

ERC has already published a report (Cosgrove et al., 2012), examining teachers' views on the implementation of Project Maths, which was based on a survey of mathematics teachers and mathematics school co-ordinators implemented as part of PISA 2012.

Mathematics education in Ireland is also undergoing changes within the wider context of educational reform. Both the *National Strategy to Improve Literacy and Numeracy Among Children and Young People, 2011-2020* (DES, 2011) and the *Framework for Junior Cycle* (DES, 2012) recognise literacy and numeracy as fundamental skills and propose a number of targets and reforms that have relevance for the teaching and learning of mathematics in post-primary schools. In particular, literacy and numeracy will be embedded in the learning outcomes of every junior cycle subject and short course, emphasising the important role that all teachers play in developing students' literacy and numeracy skills.

With regard to literacy and numeracy in post-primary schools, the National Literacy and Numeracy Strategy aims to 1) ensure that all post-primary schools set demanding but realistic targets for improving the literacy and numeracy skills of their students and that progress in achieving these goals is monitored; 2) assess the performance of students at the end of Second Year through the standardised assessments of mathematics, science and English reading so that existing levels of achievement can be established and targets for improvement can be set; 3) increase the percentage of 15-year-old students performing at or above Level 4 in the PISA literacy and numeracy assessments by 5 percentage points by 2020 and halve the percentage performing below Level 1, relative to 2009 levels; and 4) increase the percentage of students taking the Higher Level mathematics examination to 60% at the end of the junior cycle and to 30% in the Leaving Certificate, by 2020 (DES, 2011). To help achieve these goals, a number of strategies are outlined aimed at: enabling parents and communities to support children's literacy and numeracy development; improving the professional practice of teachers; enabling principals and deputy principals to lead improvements in literacy and numeracy; helping students with additional learning needs to achieve their potential; and improving assessment and evaluation to support better learning in literacy and numeracy.

Intended reform of the junior cycle envisages that students will study a mix of subjects and short courses (and priority learning units in the case of some students with general learning disabilities), with English and mathematics, along with Irish, being viewed as core subjects for all students. A minimum requirement of 240 hours of instruction is to be provided for these subjects, thus recognising their key roles in supporting literacy and numeracy (DES, 2012). The most significant change to the junior cycle is in the area of assessment. The Junior Certificate examination is to be phased out, and replaced by a school-based approach to assessment that focuses on 'assessment for learning' as well as 'assessment of learning'. At the end of the junior cycle, students will receive a School Certificate which will serve the purpose of supporting student learning and improving outcomes. In addition to the standardised testing in Second Year, required as part of the National Literacy and Numeracy Strategy, and assessment for certification, there will also be national assessments in mathematics and English reading for a sample of junior cycle students (DES, 2012, p28). The *Framework* states that these national assessments, as well as participation in PISA, will allow for national and international comparisons of standards.

The results of PISA 2012 come at an interesting time when mathematics education and post-primary education in general are in transition and should be considered in this broader context.

2.4. Summary

This chapter provides an overview of the findings for Ireland from previous cycles of PISA and other national and international surveys of achievement. As well as achievement results, characteristics associated with achievement are described. Also, a broad overview of recent and current developments in the teaching and learning of mathematics is provided to give a context through which the finding of PISA 2012 should be considered.

The achievement findings from previous PISA cycles are somewhat mixed. Up to 2009, the results for Ireland were characterised by higher-than-average performance for reading, average performance for mathematics and slightly above-average performance for science. In 2009, however, the mean scores for reading and mathematics in Ireland dropped significantly (and were regarded as average and below average, respectively), while science performance remained stable. The findings for Ireland from other international assessments of achievement are also rather varied. Results from PIRLS are consistent with the PISA reading findings before 2009 (i.e. well above average). Results for TIMSS are more positive for mathematics (i.e. above average) and about the same for Science (also above average), although averages in TIMSS are based on all participating countries rather than a selected group, such as OECD countries in PISA. The recent findings from the survey of adult skills (PIAAC) indicate that adults in Ireland slightly below have average literacy skills and well below average numeracy skills, while 42% of adults in Ireland are performing at Level 1 on the assessment of problem solving in technology rich environments, which is about the same as the study average. In PISA, the mathematical content area of Space & Shape has been highlighted as a particular area of weakness for students in Ireland. Furthermore, the relative underperformance of higher-achieving students in Ireland, especially in mathematics, is a matter for concern.

A number of factors have been found to be consistently associated with achievement in Ireland, including school and student socio-economic status, family structure, immigrant and language status, grade level, engagement with the education system and attitude towards and engagement with the assessment domain. The percentage of variance attributable to differences between schools tends to be smaller in Ireland compared to the average across OECD countries, but has increased in Ireland between 2000 and 2009.

A number of recent developments have taken place in the teaching and learning of mathematics in Ireland, and in post-primary education in general. The results for PISA 2012 should be considered in the context of these developments.

3. Performance on Mathematics

This chapter looks at performance on print and computer-based mathematics in PISA 2012. First, the performance of students in Ireland on the overall print mathematics scale is described. Next, performance on the seven print mathematics subscales is presented. Performance on the three process subscales (*Formulating*, *Employing* and *Interpreting*) is then outlined, followed by performance on the four content subscales (*Change & Relationships*, *Space & Shape, Quantity,* and *Uncertainty & Data*). Finally, the performance of students in Ireland on the computer-based assessment of mathematics is described.

Comparisons of average performance by country/economy are presented along with descriptions of variation in performance, performance by proficiency level, and gender differences, for the overall print mathematics scale, each mathematics subscale, and computer-based mathematics. Where relevant, results for Ireland are presented alongside the results for other participating countries/economies or for a subset of countries/economies selected on the basis of high performance, cultural or linguistic similarity, similar population sizes and/or recent educational reforms. Comparison countries/ economies include Shanghai-China (the highest performing region), Korea (the highest performing OECD country), Finland, Poland, Germany, New Zealand, France, the United Kingdom and the United States. Results for Northern Ireland are also presented in the comparison tables and referred to throughout the text but are not presented in the country/economy ranking tables as they are included in the mean scores for the United Kingdom. In the relevant tables, the countries/economies are arranged in descending order of mean print mathematics score, with the exception of Northern Ireland and Shanghai-China, as they are regions rather than countries. Supplementary tables are provided in the *PISA 2012 E-appendix,* available at www.erc.ie/p12eappendix.

Changes in the performance of students on print mathematics since 2003 are examined in Chapter 7. Readers are also referred to Chapter 1 for information on how to interpret the achievement outcomes.

3.1. Overall Performance on Print Mathematics

Students in Ireland achieved a mean score of 501.5 on the overall print mathematics scale, which is significantly above the corresponding OECD average of 494.0 (Table 3.1). Ireland's performance is ranked 13th out of 34 OECD countries and 20th out of 65 participating countries/economies. Taking measurement and sampling error into account (applying a 95% confidence interval), Ireland's true rank ranges from 11th to 17th among OECD countries, and from 18th to 24th among all participating countries/economies. Shanghai-China significantly outperformed every other country/economy, with a mean score of 612.7, followed by Singapore with a mean score of 573.5.

Sixteen countries/economies, including 10 OECD countries, achieved significantly higher mean scores than Ireland. Nine other countries (Vietnam, Austria, Australia, Slovenia, Denmark, New Zealand, Czech Republic, France and the United Kingdom) obtained mean scores that were not significantly different from Ireland's, while 15 OECD countries performed significantly less well than Ireland. The mean score for Northern Ireland is 486.9, which is below both the OECD average and the mean print mathematics score for Ireland.

Table 3.1. Mean country/economy scores, standard deviations and standard errors for the print mathematics scale and positions relative to the OECD and Irish means, for all participating countries/economies

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
Shanghai-China	612.7	(3.29)	101.0	(2.28)	▲	*Russian Fed.*	482.2	(3.04)	86.4	(1.57)	▼
Singapore	573.5	(1.32)	105.4	(0.92)	▲	Slovak Republic	481.6	(3.43)	100.8	(2.46)	▼
Hong Kong-China	561.2	(3.22)	96.3	(1.92)	▲	United States	481.4	(3.60)	89.9	(1.30)	▼
Chinese Taipei	559.8	(3.30)	115.6	(1.92)	▲	*Lithuania*	478.8	(2.64)	89.1	(1.36)	▼
Korea	553.8	(4.58)	99.1	(2.15)	▲	Sweden	478.3	(2.26)	91.7	(1.28)	▼
Macao-China	538.1	(0.96)	94.5	(0.94)	▲	Hungary	477.0	(3.19)	93.6	(2.40)	▼
Japan	536.4	(3.59)	93.5	(2.19)	▲	*Croatia*	471.1	(3.54)	88.5	(2.55)	▼
Liechtenstein	535.0	(3.95)	95.3	(3.70)	▲	Israel	466.5	(4.68)	104.9	(1.82)	▼
Switzerland	530.9	(3.04)	94.3	(1.45)	▲	Greece	453.0	(2.50)	87.8	(1.34)	▼
Netherlands	523.0	(3.47)	91.6	(2.10)	▲	*Serbia*	448.9	(3.39)	90.7	(2.21)	▼
Estonia	520.5	(2.02)	80.9	(1.17)	▲	Turkey	448.0	(4.83)	91.1	(3.05)	▼
Finland	518.8	(1.94)	85.3	(1.16)	▲	*Romania*	444.6	(3.76)	81.3	(2.21)	▼
Canada	518.1	(1.84)	88.8	(0.80)	▲	*Cyprus*	439.7	(1.07)	93.1	(0.84)	▼
Poland	517.5	(3.62)	90.4	(1.89)	▲	*Bulgaria*	438.7	(3.99)	93.9	(2.19)	▼
Belgium	514.7	(2.08)	102.3	(1.42)	▲	*UAE*	434.0	(2.43)	89.5	(1.19)	▼
Germany	513.5	(2.88)	96.3	(1.64)	▲	*Kazakhstan*	431.8	(3.03)	71.2	(1.76)	▼
Vietnam	511.3	(4.84)	85.8	(2.65)	O	*Thailand*	426.7	(3.45)	82.2	(2.14)	▼
Austria	505.5	(2.67)	92.5	(1.70)	O	Chile	422.6	(3.07)	80.8	(1.46)	▼
Australia	504.2	(1.64)	96.3	(1.19)	O	*Malaysia*	420.5	(3.18)	81.1	(1.62)	▼
Ireland	501.5	(2.25)	84.6	(1.26)		Mexico	413.3	(1.35)	74.3	(0.72)	▼
Slovenia	501.1	(1.23)	91.7	(1.02)	O	*Montenegro*	409.6	(1.05)	82.7	(1.07)	▼
Denmark	500.0	(2.29)	82.1	(1.30)	O	*Uruguay*	409.3	(2.76)	88.7	(1.74)	▼
New Zealand	499.7	(2.21)	99.6	(1.22)	O	*Costa Rica*	407.0	(3.04)	68.4	(1.80)	▼
Czech Republic	499.0	(2.85)	94.9	(1.62)	O	*Albania*	394.3	(2.00)	91.5	(1.40)	▼
France	495.0	(2.45)	97.5	(1.67)	O	*Brazil*	391.5	(2.06)	77.7	(1.63)	▼
United Kingdom	493.9	(3.30)	94.5	(1.75)	O	*Argentina*	388.4	(3.53)	76.7	(1.73)	▼
Iceland	492.8	(1.70)	91.9	(1.31)	▼	*Tunisia*	387.8	(3.91)	78.2	(3.07)	▼
Latvia	490.6	(2.75)	81.9	(1.51)	▼	*Jordan*	385.6	(3.12)	77.6	(2.67)	▼
Luxembourg	489.8	(1.09)	95.4	(0.86)	▼	*Colombia*	376.5	(2.89)	74.3	(1.71)	▼
Norway	489.4	(2.73)	90.5	(1.33)	▼	*Qatar*	376.4	(0.76)	99.9	(0.74)	▼
Portugal	487.1	(3.81)	93.9	(1.37)	▼	*Indonesia*	375.1	(4.04)	71.4	(3.25)	▼
Italy	485.3	(2.03)	92.8	(1.15)	▼	*Peru*	368.1	(3.69)	84.4	(2.20)	▼
Spain	484.3	(1.90)	87.7	(0.73)	▼	OECD average	494.0	(0.49)	91.9	(0.27)	

(dark shading)	Significantly above OECD average	▲	Significantly higher than Ireland
(no shading)	At OECD average	O	Not significantly different from Ireland
(light shading)	Significantly below OECD average	▼	Significantly lower than Ireland

Note: OECD countries are in regular font, partner countries/economies are in italics.

3.2. Variation in Performance on Print Mathematics

The standard deviation, which provides an indication of the spread of achievement scores within a country/economy, is provided for each country/economy in Table 3.1. The standard deviation for Ireland is 84.6, which is significantly lower than the standard deviations for the highest performing countries/economies (101.0 for Shanghai-China and 105.4 for Singapore) and the average across OECD countries (91.8). The standard deviation for Northern Ireland is 93.3, which is also significantly larger than the standard deviation for Ireland.

The distribution of achievement within a country/economy can also be examined with reference to the difference between scores at the 5th and 95th percentiles, which accounts for the scores achieved by 90% of the population (Table 3.2). In Ireland, the difference between the highest- (95th percentile) and the lowest- (5th percentile) performing students is 280.3, which is significantly lower than the average difference across OECD countries (301.4). The difference between the highest- and lowest- performers in Ireland is not significantly different from that in Finland, Poland and the United States, but is significantly narrower than all other comparison countries/economies.

The score achieved by students in Ireland at the 10th percentile is significantly above the corresponding average score across OECD countries and is also significantly above the corresponding scores in New Zealand, France, the United Kingdom, the United States and Northern Ireland. Scores of students at the 10th percentile in Shanghai-China, Korea, Finland and Poland are significantly higher than the corresponding score in Ireland.[31]

On the other hand, students at the 90th percentile in Ireland have a score of 609.8, which is not significantly different from the corresponding OECD average score or scores in the United Kingdom, the United States and Northern Ireland. Students at the 90th percentile in Ireland perform significantly less well than their counterparts in all other comparison countries/economies.

Table 3.2. Mean scores of students at key percentile markers on the print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries

	5th		10th		25th		75th		90th		95th	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Korea	386.5	(7.37)	425.1	(5.76)	486.3	(4.79)	624.4	(5.06)	679.4	(6.00)	709.8	(7.50)
Finland	375.6	(4.51)	409.1	(3.27)	462.8	(2.53)	576.9	(2.36)	628.5	(3.06)	656.9	(3.17)
Poland	373.0	(3.94)	401.8	(2.77)	453.8	(3.29)	579.9	(4.89)	636.0	(6.05)	669.3	(7.12)
Germany	353.1	(5.41)	384.7	(4.69)	446.9	(3.62)	583.1	(3.58)	636.7	(3.75)	666.9	(4.07)
Ireland	**359.3**	**(5.01)**	**391.0**	**(3.63)**	**445.3**	**(3.22)**	**559.2**	**(2.37)**	**609.8**	**(2.46)**	**639.6**	**(3.21)**
New Zealand	340.3	(4.89)	371.4	(3.62)	428.1	(3.22)	570.1	(2.81)	632.1	(2.97)	664.9	(4.40)
France	330.2	(5.05)	365.4	(4.68)	428.6	(2.74)	564.7	(3.43)	621.4	(3.50)	651.7	(3.69)
United Kingdom	336.2	(4.72)	370.8	(5.04)	429.2	(4.16)	559.9	(3.69)	615.9	(4.07)	648.3	(5.06)
United States	339.2	(4.21)	367.6	(3.90)	417.7	(3.73)	543.3	(4.40)	600.4	(4.26)	633.8	(5.41)
OECD	343.3	(0.80)	375.0	(0.68)	430.3	(0.58)	558.3	(0.63)	613.6	(0.71)	644.7	(0.82)
Shanghai -China	434.6	(6.85)	474.5	(5.76)	546.4	(4.37)	684.7	(3.51)	736.9	(3.50)	765.2	(5.61)
Northern Ireland	332.4	(6.92)	365.3	(6.20)	421.8	(3.67)	552.9	(4.21)	608.5	(5.5)	637.5	(3.93)

3.3. Performance on Print Mathematics Proficiency Levels

Performance in mathematics can also be described in terms of proficiency levels. Proficiency levels group students' achievement scores at different points on a continuous scale into levels so that the skills and competencies of students at each level can be described. Six proficiency levels are described for mathematics in 2012 (Table 3.3). Level 6 is the highest proficiency level and describes the skills of students who are able to successfully complete the most difficult PISA items. While Level 1 is defined as the lowest proficiency level, PISA does include some mathematics items that assess proficiency below Level 1. Students performing at these levels are likely to correctly answer only the easiest PISA items.

Level 2 is considered a baseline level of mathematical proficiency that is required to participate fully in society and future learning (OECD, 2013b). In Ireland, 16.9% of students are performing below this level, which is significantly lower than the corresponding OECD average percentage (23.0%). The

[31] The alpha level for these comparisons is set to .05.

proportion of students at or above Level 5 in Ireland (10.7%) is also significantly lower than the corresponding OECD average (12.6%).

Table 3.3. Descriptions of the six levels of proficiency on the overall print mathematics scale and percentages of students achieving each level in Ireland and on average across OECD countries

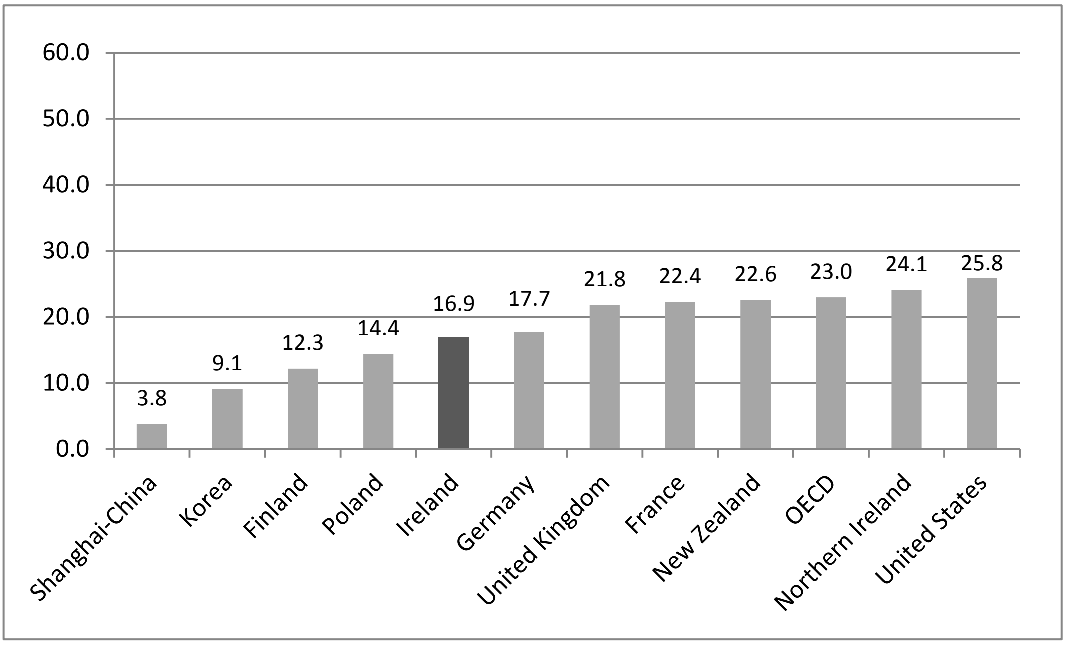
Level (*Cut-point*)	Students at this level are capable of:	OECD		Ireland	
		%	SE	%	SE
6 *(669 and above)*	Conceptualising, generalising and using information based on their investigations and modelling of complex problem situations; using knowledge in relatively non-standard contexts; linking different 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; reflecting on their actions and formulating and precisely communicating their actions and reflections regarding their findings, interpretations and arguments, and explaining why they were applied to the original situation. Students at this level are able to successfully complete the most difficult PISA items.	3.3	(0.08)	2.2	(0.23)
5 *(607 to less than 669)*	Developing and working with models of complex situations, including identifying constraints and specifying assumptions; 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; beginning to reflect on their work and formulating and communicating their interpretations and reasoning.	9.3	(0.11)	8.5	(0.51)
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; using their limited range of skills and reasoning with some insight in straightforward contexts; constructing and communicating explanations and arguments based on their interpretations, arguments and actions.	18.2	(0.14)	20.3	(0.76)
3 *(482 to less than 545)*	Executing clearly described procedures (including those that require sequential decisions); making sufficiently sound interpretations to be able to build simple models or select and applying simple problem-solving strategies; interpreting and using representations based on different information sources and reasoning directly from them; handling percentages, fractions and decimal numbers and working with proportional relationships; engaging in basic interpretation and reasoning.	23.7	(0.15)	28.2	(0.87)
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; making literal interpretations of results. Level 2 is considered the baseline level of mathematical proficiency that is required to participate fully in modern society.	22.5	(0.15)	23.9	(0.72)
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; performing actions that are almost always obvious and follow immediately from the given stimuli.	15.0	(0.13)	12.1	(0.70)
Below Level 1 *(below 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; performing arithmetic calculations with whole numbers by following clear and well-defined instructions.	8.0	(0.12)	4.8	(0.55)

Source: OECD (2013b)

The proportion of students performing below Level 2 in Ireland (16.9%) is similar to the corresponding proportions in Poland (14.4%) and Germany (17.7%), while considerably fewer students performed at this level in Korea (9.1%), Finland (12.3%) and Shanghai-China (3.8%; Figure 3.1). New Zealand (22.6%), France (22.4%), the United Kingdom (21.8%), the United States (25.8%) have considerably higher proportions of students performing below Level 2 when compared to

Ireland. The percentage of students who have scores below Level 2 in Northern Ireland (24.1%) is considerably larger than the corresponding percentage in Ireland.

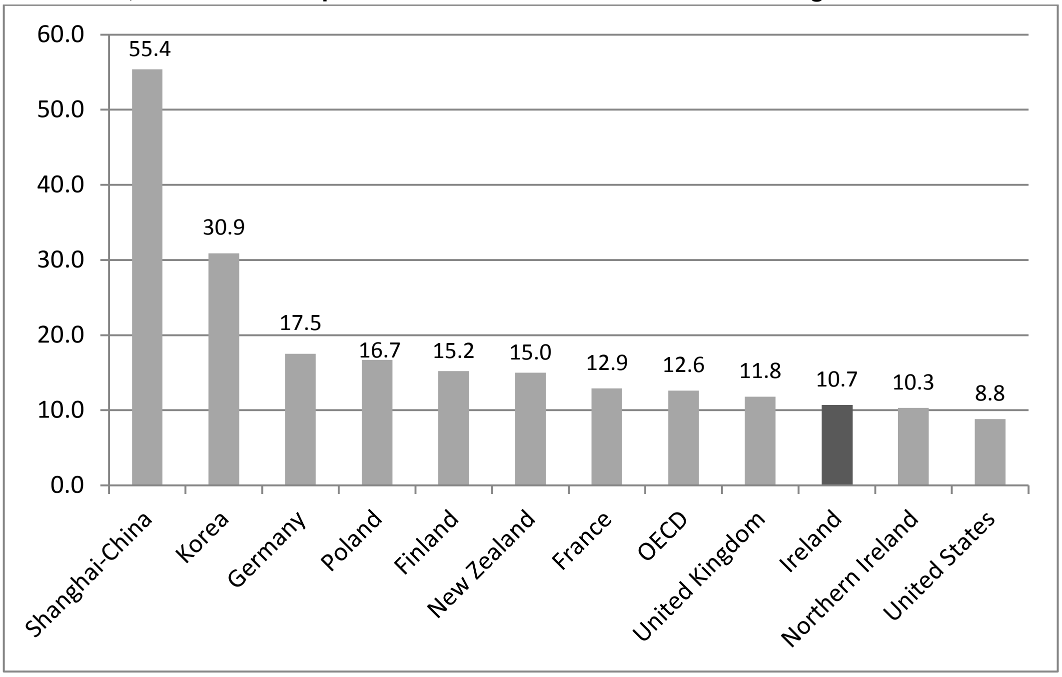
Figure 3.1. Percentages of students performing below Level 2 on the overall print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries



Note: See Table A3.1 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level on the overall print mathematics scale in Ireland, in selected comparison countries and on average across OECD countries

The proportion of students scoring at Level 5 or above in Ireland (10.7%) is similar to the corresponding proportion in the United Kingdom (11.8%) and is almost identical to the proportion in Northern Ireland (10.3%). All other comparison countries/economies have higher proportions of students performing at this level, with the exception of the United States, which has a somewhat lower proportion of students scoring at Level 5 or above (8.8%). In Shanghai-China, over half (55.4%) of students have scores at the two highest proficiency levels.

Figure 3.2. Percentages of students performing at or above Level 5 on the overall print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries



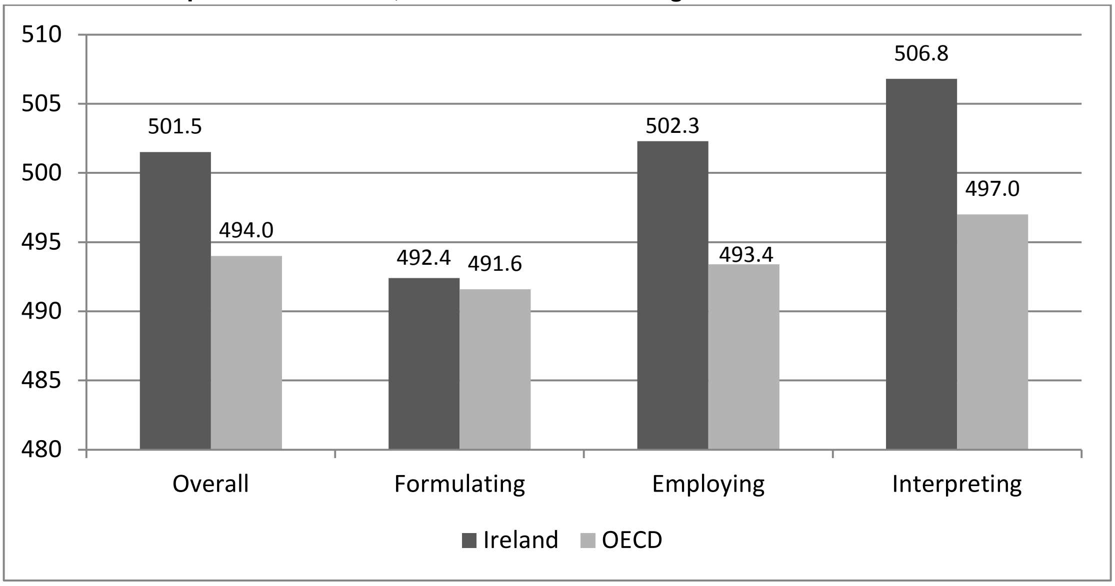
Note: See Table A3.1 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the overall print mathematics scale, in selected comparison countries and on average across OECD countries

3.4. Performance on Print Mathematics Process Subscales

PISA 2012 also reports mathematical literacy according to three mathematical processes, which represent the stages through which PISA tasks are solved. These processes are *formulating* situations mathematically; *employing* mathematical concepts, facts, procedures and reasoning; and *interpreting*, applying and evaluating mathematical outcomes. Formulating situations mathematically involves recognising an opportunity to use mathematics in a real-world context, and translating the problem into formal mathematical language. The Employing process involves the application of mathematical concepts, facts, procedures and reasoning to mathematically-formulated problems, to obtain mathematical results, while the Interpreting process involves translating mathematical solutions back into the original problem context and evaluating whether the solution makes sense (see Chapter 1 for an overview of the mathematical literacy framework for PISA 2012). Each mathematical item is classified according to the prevalent process required to solve the problem. Just under 30% of print mathematics items assess the Formulating process, while approximately 45% assess the Employing process and about a quarter of items assess the Interpreting process.

Figure 3.3 presents the mean scores for students in Ireland and the corresponding OECD average scores for the overall mathematics scale and each of the three process subscales for print mathematics. Students in Ireland perform best on the Interpreting subscale, obtaining a mean score of 506.8, which is significantly above the corresponding OECD average score (497.0). Students in Ireland also have a significantly higher mean score on the Employing subscale (502.3) compared to the corresponding OECD average (493.4), while the performance of students in Ireland on the Formulating subscale (492.4) does not differ significantly from the average across OECD countries (491.6).

Figure 3.3. Mean scores on the overall mathematics scale and the three mathematical process subscales for print mathematics, in Ireland and on average across OECD countries



Note: See Tables A3.2 to A3.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores, standard deviations and standard errors for all participating countries and positions relative to the OECD and Irish means for each process subscale.

There is little variation in Ireland's performance rankings across the three process subscales. Among OECD countries, Ireland's performance is ranked 17th on the Formulating subscale, 14th on the Employing subscale and 16th on the Interpreting subscale. Among all participating countries/ economies, the performance of Ireland is ranked 24th on the on the Formulating subscale, 21st on the Employing subscale and 22nd on the Interpreting subscale (see Table A3.5 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for the range of rankings when sampling and measurement error are accounted for).

In general, countries that have similar mean scores to Ireland on the overall print mathematics scale also tend to score similarly to Ireland on the mathematics process subscales. For example, Austria, Vietnam, New Zealand and the United Kingdom have mean scores on either the Formulating or the Interpreting subscales that do not differ significantly from the corresponding mean scores for Ireland. Likewise, students in Australia, the Czech Republic and Slovenia do not differ significantly from students in Ireland in terms of their performance on both the Formulating and the Employing subscales, while students in France have similar mean scores to students in Ireland on the Employing and Interpreting subscales. Although Norway and Latvia perform significantly less well than Ireland on the overall print mathematics scale, they both have mean scores on the Formulating subscale that do not differ from the corresponding mean score for Ireland (Latvia also obtained a similar mean score to Ireland on the Employing subscale). Poland, Belgium and Estonia have significantly higher mean scores than Ireland on the overall print mathematics scale but do not differ significantly from Ireland in terms of performance on the Interpreting subscale.

Table 3.4 presents the mean scores and standard deviations for the three mathematical process subscales for Ireland, the OECD average and selected comparison countries/economies. Country/ economy ranking tables for each mathematical process subscale are presented in Tables A3.2 to A3.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix). Shanghai-China significantly outperforms all other countries/economies on each of the mathematical process subscales. The mean scores for Northern Ireland on the Formulating, the Employing and the Interpreting subscales are significantly below the corresponding scores for Ireland.

Table 3.4. Mean scores, standard deviations and standard errors for the three mathematical processes subscales for print mathematics in Ireland, in selected comparison countries/economies and on average across OECD countries

	Formulating				Employing				Interpreting			
	Mean	(SE)	SD	(SE)	Mean	(SE)	SD	(SE)	Mean	(SE)	SD	(SE)
Korea	562.2	(5.13)	111.1	(2.45)	553.1	(4.34)	94.7	(1.98)	540.2	(4.23)	97.7	(1.78)
Finland	518.8	(2.35)	97.3	(1.36)	515.5	(1.80)	80.6	(0.92)	528.1	(2.17)	88.2	(1.11)
Poland	515.5	(4.19)	101.8	(2.08)	518.6	(3.47)	88.2	(1.68)	514.9	(3.54)	89.4	(1.91)
Germany	510.5	(3.36)	105.3	(1.71)	515.7	(2.82)	94.7	(1.62)	516.6	(3.16)	105.4	(2.23)
Ireland	492.4	(2.44)	95.0	(1.44)	502.3	(2.36)	83.5	(1.33)	506.8	(2.52)	90.9	(1.44)
New Zealand	496.0	(2.50)	108.9	(1.37)	495.1	(2.18)	99.7	(1.22)	510.7	(2.52)	107.8	(1.35)
France	483.2	(2.80)	105.7	(2.05)	496.4	(2.33)	97.1	(1.84)	510.6	(2.55)	106.9	(1.97)
United Kingdom	488.6	(3.70)	104.2	(2.01)	491.7	(3.07)	93.9	(1.50)	501.1	(3.51)	101.6	(1.99)
United States	475.3	(4.14)	97.7	(1.58)	479.9	(3.47)	90.0	(1.38)	489.3	(3.87)	95.7	(1.60)
OECD	491.6	(0.55)	101.3	(0.32)	493.4	(0.49)	90.9	(0.27)	497.0	(0.52)	97.7	(0.29)
Shanghai-China	624.4	(4.09)	119.4	(2.79)	612.8	(3.01)	92.9	(2.16)	578.7	(2.94)	97.6	(2.02)
Northern Ireland	479.4	(3.77)	100.2	(2.36)	485.9	(3.10)	93.3	(2.06)	495.7	(3.52)	101.6	(2.40)

Note: See Tables A3.2 to A3.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores, standard deviations and standard errors for all participating countries and positions relative to the OECD and Irish means.

The standard deviations for Ireland for the Formulating and Interpreting subscales (95.0 and 90.9, respectively) are somewhat larger than the standard deviation for the overall mathematics scale (84.6), but are significantly below the OECD average standard deviations for the Formulating and Interpreting subscales (101.3 and 97.7, respectively). The spread of achievement scores on the Employing subscale in Ireland (i.e. the standard deviation) is about the same as for the overall print mathematics scale (83.5 and 84.6, respectively) and is significantly smaller than the OECD average standard deviation for the Employing subscale (90.9). In Northern Ireland, the standard deviation for the Formulating subscale (100.2) does not differ significantly from the standard deviation for Ireland, while the standard deviations for the Employing and Interpreting subscales (93.3 and 101.6, respectively) are significantly larger than the corresponding standard deviations for Ireland.

Table 3.5 shows the distribution or range of achievement scores (i.e. the difference between the lowest- [5th percentile] and highest- [95th percentile] performing students) as well as the mean scores of students performing at the 10th and 90th percentiles for each of the process subscales for Ireland, the OECD average and selected comparison countries/economies. In Ireland, the difference between the lowest- and highest-performing students is widest for the Formulating subscale (314.3 points) and narrowest for the Employing subscale (276.2 points). For each of the mathematical process subscales, the distribution of achievement in Ireland is narrower than the corresponding OECD average distributions. In fact, the distributions of achievement across each of the process subscales tend to be narrower in Ireland than in all other comparison countries/economies, with the exceptions of Finland (for the Employing and Interpreting subscales) and Poland (for the Interpreting subscale).

Table 3.5. Range, scores at the 10th and 90th percentiles and standard errors for the three mathematical processes subscales for print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries

	Formulating					Employing					Interpreting				
	Range	10th	(SE)	90th	(SE)	Range	10th	(SE)	90th	(SE)	Range	10th	(SE)	90th	(SE)
Korea	361.0	417.1	(6.04)	704.4	(6.87)	305.7	429.9	(5.24)	671.5	(5.61)	320.1	412.3	(5.73)	662.1	(4.79)
Finland	319.4	392.9	(3.41)	645.2	(3.29)	265.5	411.0	(2.99)	619.4	(2.80)	290.2	414.5	(3.70)	639.1	(2.96)
Poland	333.8	386.8	(4.22)	649.9	(7.12)	289.4	405.9	(3.72)	635.5	(5.28)	293.3	399.8	(4.00)	629.6	(5.38)
Germany	344.2	371.6	(4.48)	646.9	(4.27)	309.0	389.4	(4.71)	636.1	(3.03)	341.8	376.2	(4.59)	649.9	(4.15)
Ireland	314.3	369.4	(4.41)	614.7	(3.06)	276.3	393.7	(4.62)	608.8	(2.99)	300.8	389.0	(4.58)	621.7	(2.54)
New Zealand	357.1	358.6	(3.63)	641.4	(4.67)	325.0	367.4	(3.41)	625.7	(3.07)	350.8	370.1	(4.04)	649.5	(3.56)
France	347.6	345.5	(4.06)	620.0	(4.08)	319.3	367.4	(4.56)	620.3	(3.79)	349.6	370.0	(4.88)	646.1	(3.76)
United Kingdom	343.7	354.8	(6.21)	626.3	(5.15)	309.9	368.4	(4.72)	612.9	(3.86)	333.1	369.7	(5.22)	631.9	(3.97)
United States	321.9	352.4	(4.90)	606.3	(6.01)	294.0	364.7	(3.99)	599.9	(4.79)	312.6	366.7	(5.13)	615.2	(4.04)
OECD	332.5	361.8	(0.75)	623.8	(0.85)	297.9	375.5	(0.69)	611.1	(0.69)	319.9	370.2	(0.74)	622.4	(0.70)
Shanghai-China	393.8	462.4	(7.44)	769.4	(5.23)	304.3	485.6	(6.50)	725.7	(2.80)	319.7	448.5	(4.76)	699.6	(4.12)
Northern Ireland	330.8	349.8	(6.47)	609.0	(5.77)	304.7	363.5	(4.87)	608.5	(5.56)	333.9	365.6	(6.01)	627.9	(6.04)

Note: See Tables A3.6 to A3.8 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores of students at key percentile markers on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

In Ireland, the performance of students scoring at the 10th percentile on the Employing subscale is significantly higher than the performance of those scoring at the 10th percentile on the Formulating subscale, but does not differ significantly from the performance of such students on the Interpreting subscale. On the other hand, the performance of students at the 90th percentile on the Interpreting subscale is significantly higher than the performance of the corresponding students on the Employing subscales, but does not differ significantly from the performance of such students on the Formulating subscale.

In Ireland, the score of students at the 10th percentile on the Formulating subscale (369.4) is slightly, although not significantly, higher than the corresponding OECD average score (361.8), while the score of students at the 90th percentile on this subscale (614.7) is significantly lower than corresponding OECD average score (623.8), suggesting that Ireland's relatively lower performance on the Formulating subscale can be attributed to the relative underperformance of higher-achieving students. The scores of lower-performing students in Ireland (i.e. those at the 10th percentile) on both the Employing and Interpreting subscales are significantly higher than the corresponding OECD average scores, while the scores of students in Ireland at the 90th percentile on these subscales do not differ from the corresponding OECD average scores.

Lower-performing students in Shanghai-China, Korea, Finland and Poland significantly outperform their counterparts in Ireland on each of the process subscales (with the exception of Poland for the Interpreting subscale), while lower-performing students in Ireland have significantly higher scores on each of the process subscale when compared to the corresponding scores in France, the United States and Northern Ireland. On the other hand, higher-performing students in the United States and Northern Ireland have similar scores to their counterparts in Ireland on each of the process subscales, while such students in Shanghai-China, Korea, Finland, Poland, Germany and New Zealand have significantly higher scores on each of the process subscales than their counterparts in Ireland (with the exception of Poland on the Interpreting subscale). Higher-achieving students in the United

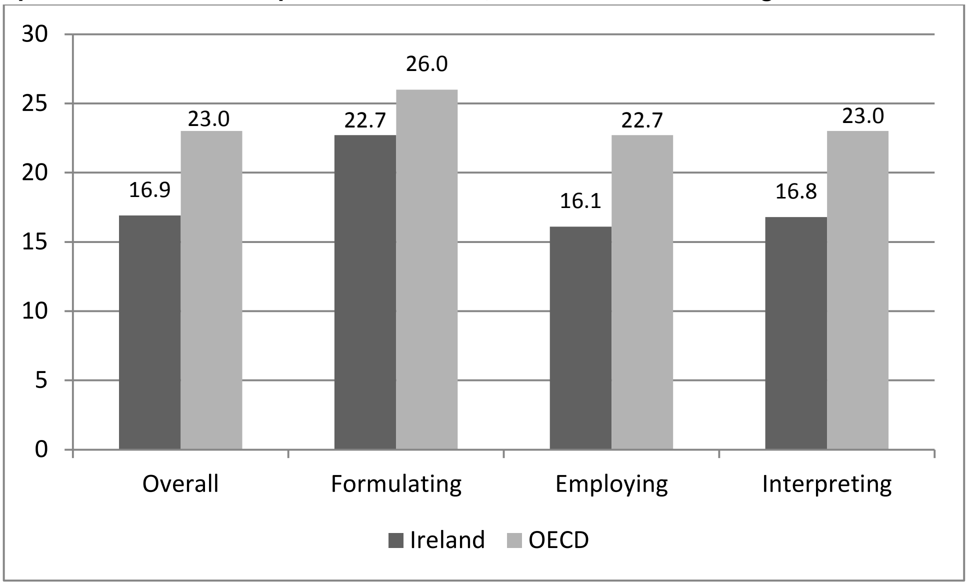
Kingdom achieve similar scores to their counterparts in Ireland on the Formulating and Employing subscales, but significantly outperform them on the Interpreting subscale.

As with the overall print mathematics scale, performance can be described in terms of proficiency levels for each of the process subscales. Six proficiency levels (using the same cut points as for the overall print mathematics proficiency levels) are described for the three process subscales and Level 2 is considered by the OECD as the baseline level of mathematical proficiency that is required to participate fully in society and future learning (see Tables A3.9 to A3.11 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for descriptions of the kinds of competencies and skills of students at different levels of proficiency on each of the process subscales).

Figure 3.4 presents the percentage of students performing below Level 2 on the overall print mathematics scale and the three process subscales in Ireland and the average across OECD countries. In Ireland, the proportions of students performing below Level 2 on the Employing and Interpreting subscales are similar to the overall print mathematics scale, while the corresponding proportion for the Formulating subscale is somewhat higher. Ireland has fewer lower-performing students (below Level 2) on each of the process subscales compared to the corresponding OECD averages.

Table 3.6 presents the percentages of students performing below Level 2 and at or above Level 5 on the three process subscales for Ireland, the OECD average and selected comparison countries/economies. Shanghai-China, Korea and Finland have considerably lower proportions of students performing below Level 2 on each of the process subscales compared to Ireland, while the United Kingdom, the United States and Northern Ireland have considerably higher proportions of students performing below Level 2 on each of the process subscales.

Figure 3.4. Percentages of students performing below Level 2 on the overall print mathematics scale and the three process subscales for print mathematics, in Ireland and on average across OECD countries



Note: See Tables A3.12 to A3.14 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

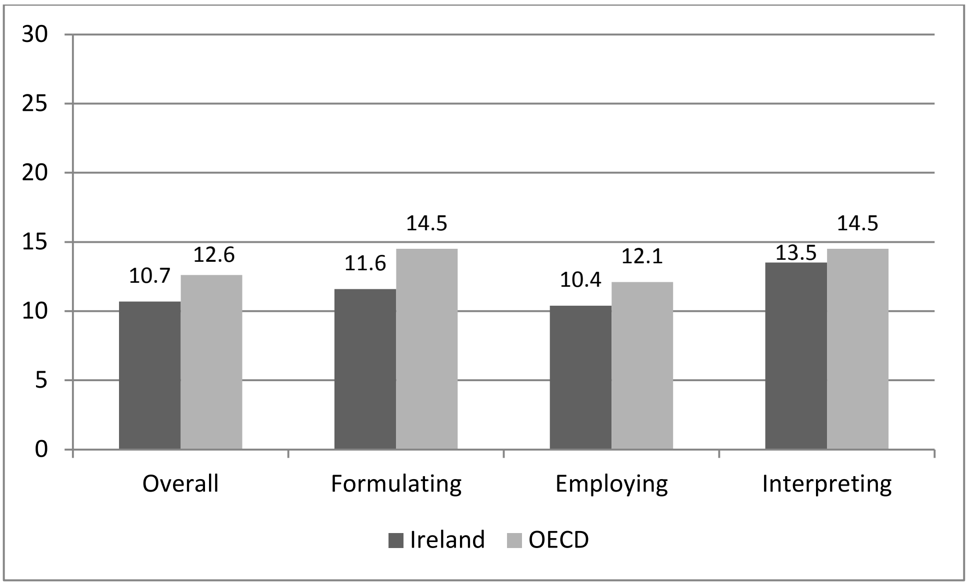
Table 3.6. Percentages of students below proficiency level 2, at or above proficiency level 5 and standard errors for the three mathematical processes subscales for print mathematics in Ireland, in selected comparison countries/economies, and on average across OECD countries

	Formulating		Employing		Interpreting	
	Below Level 2	At or above Level 5	Below Level 2	At or above Level 5	Below Level 2	At or above Level 5
Korea	10.5	35.5	8.3	29.7	11.3	25.5
Finland	15.6	18.5	11.9	13.1	10.9	18.6
Poland	18.0	19.2	13.6	16.8	14.8	15.3
Germany	20.4	18.9	16.6	17.8	18.7	20.2
Ireland	22.7	11.6	16.1	10.4	16.8	13.5
New Zealand	25.8	16.5	23.7	14.0	20.9	19.5
France	28.0	12.4	22.2	12.9	19.9	19.3
United Kingdom	26.1	13.5	22.8	11.2	21.4	15.1
United States	30.2	9.9	26.4	8.7	24.5	11.8
OECD	26.0	14.5	22.7	12.1	23.0	14.5
Shanghai-China	5.5	58.4	2.8	56.1	5.8	40.5
Northern Ireland	28.5	10.3	24.9	10.3	23.3	13.8

Note: See Tables A3.12 to A3.14 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

In Ireland, the proportions of students performing at Level 5 or above on each of the process subscales are similar to the corresponding proportion for the overall print mathematics scale, but are slightly lower than the corresponding OECD averages (Figure 3.5). The United States, the United Kingdom and Northern Ireland also have similar proportions of such students to Ireland on the three process subscales, while Shanghai-China and Korea have substantially greater proportions of students performing at or above Level 5 when compared to Ireland (Table 3.6).

Figure 3.5. Percentages of students performing at or above Level 5 on the overall print mathematics scale and the three process subscales for print mathematics in Ireland and on average across OECD countries



Note: See Tables A3.12 to A3.14 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

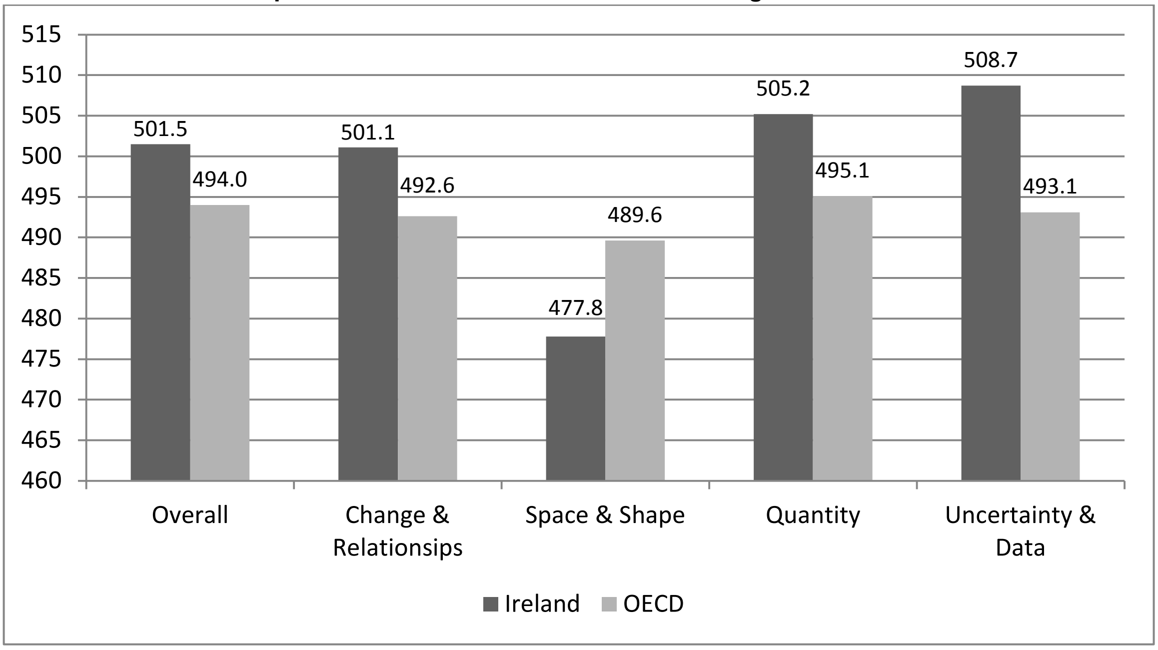
3.5. Performance on Print Mathematics Content Subscales

As well as reporting mathematical literacy according to mathematical processes, PISA also describes performance on four mathematical content areas. These four content areas (Change & Relationships; Space & Shape; Quantity; and Uncertainty & Data) relate to broad parts of the mathematics curriculum found in all countries and economies and as such will reflect differences in course content and curriculum priorities available to 15-year-olds (OECD, 2013b). Tasks on the Change & Relationship subscale involve understanding types of change and recognising when they occur in order to use suitable mathematical models to describe and predict change. The Space & Shape subscale entails 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. The Quantity subscale involves the application of knowledge of number and number operations in a wide variety of settings, while the Uncertainty & Data subscale includes knowledge of variation in processes, uncertainty and error in measurement, and chance (see Chapter 1 for an overview of the mathematical literacy framework for PISA 2012). The PISA test items are split almost evenly across the four content areas; therefore approximately 25% of items address each content area. Items used to construct the four content subscales comprise the same set of items distributed over the three process subscales.

The mean scores for students in Ireland and the corresponding OECD average scores for the overall print mathematics scale and the four content area subscales are presented in Figure 3.6. In Ireland, performance on the Change & Relationships subscale (501.1) is similar to performance on the overall print mathematics scale (501.5), while performance on the Quantity (505.2) and Uncertainty & Data (508.7) subscales is marginally higher. The mean score for Ireland on the Space & Shape subscale (477.8) is considerably lower than the overall mean print mathematics score. Students in Ireland have significantly higher mean scores on the Change & Relationships, Quantity and Uncertainty & Data subscales compared to the OECD average scores; however, they perform significantly less well on the Space & Shape subscale.

With the exception of the Space & Shape subscale, there is little variation in the rankings of Ireland's performance. Among OECD countries, Ireland's performance is ranked 10th on the Uncertainty & Data subscale, 12th on the Quantity subscale, 13th on the Change & Relationships subscale and 24th on the Space & Shape subscale. Among the 65 participating countries/economies, Ireland's performance is ranked 17th on the Uncertainty & Data subscale, 19th on the Quantity subscale, 20th on the Change & Relationships subscale and 33rd on the Space & Shape subscale (see Table A3.15 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for the range of rankings when sampling and measurement error are accounted for).

Figure 3.6. Mean scores on the overall mathematics scale and the four mathematical content area subscales for print mathematics in Ireland and on average across OECD countries



Note: See Tables A3.16 to A3.19 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores, standard deviations and standard errors for all participating countries and positions relative to the OECD and Irish means for each content area subscale.

Many of the same countries that have similar mean scores to Ireland on the overall print mathematics scale also score similarly to Ireland on the Change & Relationships and Quantity subscales. For example, Vietnam, Austria, Slovenia, Denmark, New Zealand and the Czech Republic have mean scores on the Change & Relationships and Quantity subscales that do not differ significantly from Ireland's. Of the five countries that have similar mean scores to Ireland's on the Space & Shape subscale, four of them (Norway, Spain, Hungary and Lithuania) perform significantly less well than Ireland on the overall print mathematics scale. Only the United Kingdom score similarly to Ireland on both the overall print mathematics scale and the Space & Shape subscale. Of the eight countries that do not differ from Ireland in terms of performance on the Uncertainty & Data subscale, four (Australia, New Zealand, Denmark and the United Kingdom) achieve similar mean scores to Ireland on the overall print mathematics scale, while four (Poland, Estonia, Germany and Belgium) perform significantly higher than Ireland.

Table 3.7 presents the mean scores and standard deviations for the four mathematical content subscales for Ireland, the OECD average and selected comparison countries/economies. Country/economy ranking tables for each mathematical content area subscale are presented in Tables A3.16 to A3.19 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix). As with the mathematical process subscales, Shanghai-China significantly outperform all other countries/economies on each of the mathematical content area subscales. Students in Northern Ireland achieve mean scores on all of the mathematical content subscales that are significantly below the corresponding scores for Ireland.

Table 3.7. Mean scores, standard deviations and standard errors for the four mathematical content areas subscales for print mathematics in Ireland, in selected comparison countries/economies and on average across OECD countries

	Change & Relationships				Space & Shape				Quantity				Uncertainty & Data			
	Mean	SE	SD	SE	Mean	SE	SD	SE	Mean	SE	SD	SE	Mean	SE	SD	SE
Korea	558.8	(5.15)	106.7	(2.74)	573.1	(5.21)	112.1	(2.38)	537.5	(4.06)	94.1	(1.95)	537.9	(4.21)	97.2	(1.90)
Finland	520.3	(2.61)	96.5	(2.28)	506.8	(2.10)	90.3	(1.25)	526.5	(1.93)	86.8	(0.99)	518.6	(2.37)	90.7	(1.41)
Poland	509.2	(4.15)	100.4	(2.07)	524.2	(4.20)	100.9	(2.21)	518.5	(3.47)	88.6	(1.62)	516.6	(3.50)	87.5	(1.87)
Germany	515.8	(3.76)	114.0	(3.35)	507.2	(3.21)	97.6	(1.86)	517.1	(3.06)	99.6	(1.88)	508.9	(3.01)	100.9	(1.77)
Ireland	501.1	(2.57)	87.0	(1.54)	477.8	(2.62)	93.9	(1.39)	505.2	(2.58)	92.0	(1.41)	508.7	(2.52)	87.5	(1.39)
New Zealand	500.8	(2.53)	112.0	(1.65)	490.8	(2.45)	99.9	(1.69)	498.8	(2.35)	103.5	(1.35)	505.7	(2.63)	105.6	(1.59)
France	496.8	(2.73)	107.4	(2.42)	488.9	(2.73)	99.5	(1.92)	496.3	(2.63)	102.5	(1.76)	491.9	(2.69)	102.8	(1.76)
United Kingdom	496.1	(3.45)	99.4	(1.81)	475.4	(3.45)	99.2	(1.76)	494.2	(3.82)	101.7	(1.90)	502.3	(3.01)	96.5	(1.65)
United States	488.1	(3.52)	95.0	(1.39)	463.3	(3.99)	96.4	(1.49)	477.8	(3.89)	98.9	(1.72)	488.2	(3.53)	89.3	(1.53)
OECD	492.6	(0.56)	101.5	(0.35)	489.6	(0.54)	98.0	(0.31)	495.1	(0.52)	97.3	(0.28)	493.1	(0.50)	93.3	(0.29)
Shanghai-China	624.0	(3.65)	112.1	(2.43)	648.9	(3.63)	113.9	(2.45)	590.9	(3.22)	97.5	(2.37)	591.9	(3.04)	96.1	(1.91)
Northern Ireland	485.6	(3.84)	99.2	(2.34)	463.4	(3.60)	97.7	(2.53)	491.3	(3.67)	100.2	(2.56)	496.0	(3.43)	95.4	(2.32)

Note: See Tables A3.16 to A3.19 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores, standard deviations and standard errors for all participating countries and positions relative to the OECD and Irish means for each content area subscale.

In Ireland, the standard deviations for the Change & Relationships (87.0) and Uncertainty & Data (87.5) subscales are about the same as for the overall print mathematics scale (84.6), while the standard deviations for the Space & Shape (93.9) and Quantity (92.0) subscales are somewhat larger. The standard deviations for each content subscale are significantly smaller in Ireland compared to the corresponding OECD standard deviations. The standard deviations for each content area subscale in Northern Ireland are significantly larger than the standard deviations for Ireland, with the exception of Space & Shape subscale, where the standard deviation does not differ significantly from Ireland's.

Table 3.8 presents the difference between the lowest- and highest-performing students (those scoring at the 5th and 95th percentiles, respectively) on each of the four content area subscales for Ireland, the OECD average and selected comparison countries/economies. In Ireland the difference between the lowest- and highest-performing students is widest for the Space & Shape subscale (308.4 points) and narrowest for the Change & Relationships subscale (286.9 points). For each of the mathematical content subscales, the distribution of achievement in Ireland is significantly narrower than the corresponding OECD average distribution. The distribution of achievement for each content area subscale tends to be narrower in Ireland than in the selected comparison countries/economies, with the exception of Finland (for the Space & Shape and Quantity subscale) and Poland (for the Quantity and Uncertainty & Data subscales).

Table 3.8. Range of scores for the four mathematical content area subscales for print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries

	Change & Relationships	Space & Shape	Quantity	Uncertainty & Data
Korea	345.9	365.2	305.4	315.5
Finland	313.7	297.0	287.4	297.2
Poland	330.5	327.0	289.1	285.9
Germany	367.9	320.5	325.2	329.2
Ireland	286.9	308.4	303.3	287.6
New Zealand	367.2	329.5	336.6	347.9
France	353.8	326.4	336.7	335.3
United Kingdom	326.1	327.6	333.6	318.2
United States	310.1	317.3	324.6	290.9
OECD	331.6	322.1	319.5	306.0
Shanghai-China	366.6	376.2	321.7	314.3
Northern Ireland	329.4	321.6	328.4	315.3

Note: See Tables A3.20 to A3.23 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores of students at key percentile markers on each of the content area subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

Table 3.9 shows the scores of students performing at the 10th and 90th percentiles for each mathematical content area subscale, for Ireland, the OECD average and selected comparison countries/economies. In Ireland, the scores of both lower- and higher-performing students (those at the 10th and 90th percentiles, respectively) on the Space & Shape subscale are significantly lower than the corresponding scores on all the other content area subscales. The performance of students scoring at the 10th percentile on the Uncertainty & Data subscale is higher than the performance of those scoring at the 10th percentile on all the other content area subscales, but the difference is only significant for the Space & Shape subscale. The performance of students at the 90th percentile on the Quantity subscale is significantly higher than the performance of the corresponding students on Change & Relationships and Space & Shape subscales, but does not differ significantly from the performance of such students on the Uncertainty & Data subscale.

In Ireland, the score of students at the 10th percentile on the Change & Relationships subscale is significantly higher than the corresponding OECD average score, while the score of students at the 90th percentile on this subscale is significantly lower than corresponding OECD average score. On the Space & Shape subscale, the performance of students scoring at the 10th percentile in Ireland is significantly lower than the OECD average, while students scoring at the 90th percentile also perform significantly less well than the OECD average. The scores of lower-performing students in Ireland (i.e. those at the 10th percentile) on both the Quantity and Uncertainty & Data subscales are significantly higher than the corresponding OECD average scores. However, while the performance of students at the 90th percentile on the Uncertainty & Data subscale in Ireland is significantly higher than the OECD average, there is no significant difference between the performance of such students on the Quantity subscale in Ireland and the corresponding OECD average.

Table 3.9. Scores at the 10th and 90th percentiles and standard errors for the four mathematical content areas subscales for print mathematics in Ireland, in selected comparison countries/economies and on average across OECD countries

	Change & Relationships				Space & Shape				Quantity				Uncertainty & Data			
	10th	(SE)	90th	(SE)	10th	(SE)	90th	(SE)	10th	(SE)	90th	(SE)	10th	(SE)	90th	(SE)
Korea	422.3	(6.15)	691.7	(6.98)	428.1	(5.63)	716.4	(7.49)	415.7	(6.07)	653.7	(4.86)	413.0	(5.68)	660.8	(4.84)
Finland	400.3	(3.52)	642.7	(3.39)	392.8	(2.72)	623.9	(3.11)	415.4	(2.87)	637.9	(3.30)	402.5	(3.26)	633.6	(3.03)
Poland	380.3	(3.98)	640.6	(6.79)	398.5	(3.40)	660.1	(6.79)	405.8	(3.81)	634.0	(5.25)	403.3	(3.66)	629.6	(5.81)
Germany	368.4	(6.58)	655.5	(4.25)	379.0	(5.09)	633.2	(4.48)	384.2	(5.08)	643.2	(4.06)	375.5	(4.25)	638.9	(4.41)
Ireland	389.2	(4.85)	612.9	(2.47)	356.5	(4.18)	598.4	(2.77)	385.5	(4.57)	623.5	(3.11)	395.0	(4.36)	619.4	(2.46)
New Zealand	356.0	(4.08)	646.4	(4.12)	366.0	(4.30)	624.3	(4.70)	365.2	(3.94)	633.7	(3.36)	370.3	(4.54)	643.6	(3.78)
France	355.0	(6.30)	631.7	(4.16)	360.4	(3.75)	618.7	(4.41)	361.7	(4.91)	627.8	(3.59)	355.2	(4.15)	621.7	(4.01)
United Kingdom	367.5	(5.24)	625.5	(4.40)	347.3	(4.65)	605.2	(4.25)	361.7	(6.38)	624.7	(3.70)	377.5	(4.03)	625.9	(3.73)
United States	368.1	(4.03)	614.2	(4.32)	342.0	(4.42)	591.4	(5.25)	353.6	(5.46)	609.7	(5.13)	374.2	(3.92)	604.0	(4.33)
OECD	362.1	(0.82)	622.5	(0.77)	364.8	(0.70)	617.8	(0.84)	369.1	(0.76)	620.4	(0.70)	372.5	(0.71)	613.2	(0.70)
Shanghai-China	473.2	(6.51)	763.8	(4.08)	493.2	(7.07)	787.2	(4.29)	460.1	(5.78)	709.8	(4.25)	463.9	(5.10)	711.5	(3.63)
Northern Ireland	357.6	(6.25)	614.3	(6.28)	339.5	(5.07)	590.9	(6.59)	360.2	(5.45)	620.5	(5.35)	372.9	(5.61)	619.3	(5.54)

Note: See Tables A3.20 to A3.23 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores of students at key percentile markers on each of the content area subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

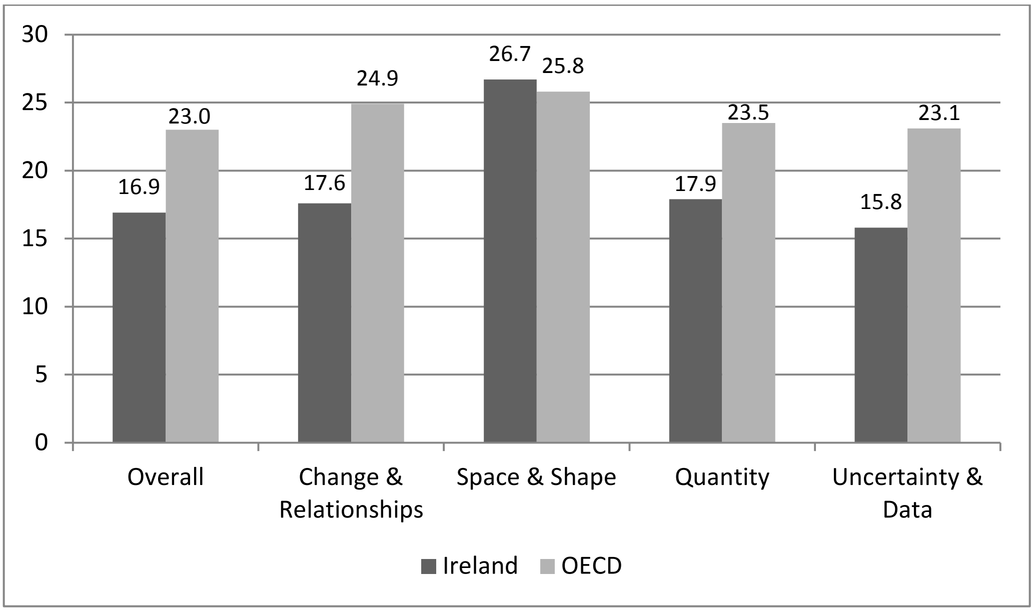
Lower-performing students (i.e. those at the 10th percentile) in Shanghai-China and Korea significantly outperform their counterparts in Ireland on the Change & Relationships and Uncertainty & Data subscales, while lower-performing students in Ireland have significantly higher scores on these subscales when compared to the corresponding scores in Germany, New Zealand, France, the United Kingdom, the United States, and Northern Ireland. For the Quantity subscale, lower-achieving students in Shanghai-China, Korea, Finland and Poland significantly outperform their counterparts in Ireland, while lower-achieving students in all other selected comparison countries/ economies (with the exception of Germany) perform significantly less well than Ireland. Of the selected comparison countries/economies, only lower-performing students in the United States and Northern Ireland perform significantly less well than their counterparts in Ireland on the Space & Shape subscale, while lower-performing students in New Zealand, France and the United Kingdom obtain similar mean scores to those in Ireland.

For the Change & Relationships and Space & Shape subscales, higher-achieving students (i.e. those at the 90th percentile) in Ireland perform significantly less well than their counterparts in the other selected comparison countries/economies, with the exceptions of the United States, Northern Ireland and the United Kingdom (for the Space & Shape subscale only). In Ireland, the performance of higher-achieving students (i.e. those at 90th percentile) on the Quantity and Uncertainty & Data subscales does not differ significantly from the performance of such students in France, the United Kingdom and Northern Ireland, but is significantly higher than the performance of higher-achieving students in the United States.

Performance on each of the mathematical content area subscales is also described in terms of proficiency levels. As with the overall print mathematics scale and the mathematical process subscales, six proficiency levels are described (using the same cut points) with Level 2 considered by the OECD as the baseline level of proficiency required to participate fully in society and future learning (see Tables A3.24 to A3.27 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for descriptions of the kinds of competencies and skills of students at different levels of proficiency on each of the content subscales).

Figure 3.7 displays the percentage of students performing below Level 2 on the overall print mathematics scale and the four mathematical content subscales in Ireland and on average across OECD countries. In Ireland, the proportions of students performing below Level 2 on the Change & Relationships, Quantity and Uncertainty & Data subscales are similar to the overall print mathematics scale, while the corresponding proportion for the Space & Shape subscale is considerably higher. Ireland has fewer lower-performing students (below Level 2) on each of the content area subscales compared to the corresponding OECD averages, with the exception of the Space & Shape subscale.

Figure 3.7. Percentages of students performing below Level 2 on the overall print mathematics scale and the four mathematical content area subscales for print mathematics in Ireland and on average across OECD countries



Note: See Tables A3.28 to A3.31 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

Table 3.10 presents the percentage of students performing below Level 2 and at or above Level 5 on the four mathematical content area subscales for Ireland, the OECD average and selected comparison countries/economies. Shanghai-China, Korea and Finland have considerably lower proportions of students performing below Level 2 on each of the content area subscales compared to Ireland, while Poland and Germany also have considerably lower proportions of such students on the Space & Shape subscale. On the other hand, Northern Ireland, the United Kingdom and the United States have higher proportions of students performing below Level 2 compared to Ireland on each of the content area subscales. France and New Zealand have higher proportions of such students on the Change & Relationships, Quantity and Uncertainty & Data subscales compared to Ireland, but have about the same proportions on the Space & Shape subscale.

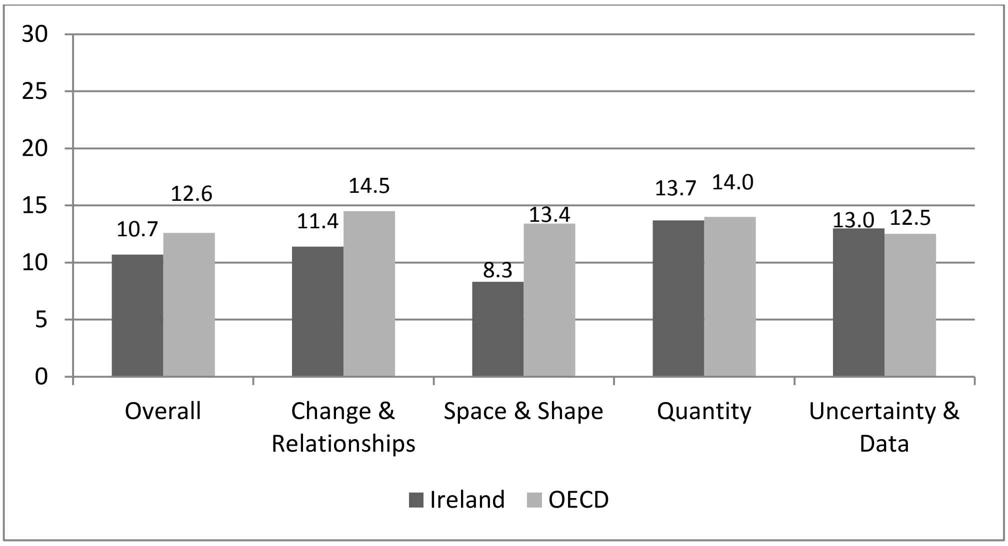
In Ireland, slightly more students are performing at Level 5 or above on the Quantity and Uncertainty & Data subscales compared to the overall print mathematics scale, while the proportion is somewhat lower for the Space & Shape subscale (Figure 3.8). The proportions of higher-achieving students (i.e. those at Level 5 or above) in Ireland on the Change & Relationships and Space & Shape subscales are lower than the corresponding OECD averages. However, the percentage of Irish students performing at Level 5 or above on the Quantity and Uncertainty & Data subscales are similar to the corresponding OECD average proportions. Shanghai-China and Korea have considerably higher proportions of students performing at or above Level 5 compared to Ireland on each of the content area subscales, while Finland, Germany, Poland and New Zealand also have considerably higher proportions of such students compared to Ireland on the Change & Relationships and Space & Shape subscales.

Table 3.10. Percentages of students below proficiency level 2, at or above proficiency level 5 and standard errors for the four mathematical content areas subscales for print mathematics in Ireland, in selected comparison countries/economies and on average across OECD countries

	Change & Relationships		Space & Shape		Quantity		Uncertainty & Data	
	Below Level 2	At or above Level 5	Below Level 2	At or above Level 5	Below Level 2	At or above Level 5	Below Level 2	At or above Level 5
Korea	9.6	33.4	8.8	39.0	10.8	23.9	11.2	24.7
Finland	14.2	18.1	16.6	13.8	11.0	17.8	13.7	16.3
Poland	19.1	17.0	15.3	21.4	13.6	16.7	14.0	15.6
Germany	19.2	22.0	19.1	15.8	17.7	19.1	19.5	17.4
Ireland	17.6	11.4	26.7	8.3	17.9	13.7	15.8	13.0
New Zealand	24.4	17.8	24.9	13.1	23.4	15.6	21.5	17.6
France	23.5	15.1	25.4	12.3	23.4	14.6	24.6	13.0
United Kingdom	22.3	13.8	29.5	9.7	23.7	13.6	20.1	14.1
United States	24.8	11.4	34.4	7.6	29.3	10.5	23.1	9.4
OECD	24.9	14.5	25.8	13.4	23.5	14.0	23.1	12.5
Shanghai-China	4.1	58.0	3.1	66.7	5.0	46.2	4.4	46.0
Northern Ireland	26.3	11.2	33.5	7.5	24.5	12.8	22.3	12.8

Note: See Tables A3.28 to A3.31 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

Figure 3.8. Percentages of students performing at or above Level 5 on the overall print mathematics scale and the four mathematical content area subscales for print mathematics in Ireland and on average across OECD countries



Note: See Tables A3.28 to A3.31 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students at each proficiency level on each of the process subscales for print mathematics in Ireland, in selected participating countries and on average across OECD countries

3.6. Gender Differences on Print Mathematics

Male students significantly outperform females on the overall print mathematics scale in Ireland and on average across OECD countries (Table 3.11). The difference between male and female students is slightly larger in Ireland (15.3 points) compared to the average difference across OECD countries (10.7 points), but not significantly so. Male and female students do not differ significantly from each other in terms of performance on the overall print mathematics scale in Finland, Poland, the United States and Shanghai-China, and the gender differences in these countries/economies are much smaller compared to Ireland.

Although male students in Northern Ireland outperform female students on the overall print mathematics scale, the difference (10.3 points) is not significant and is similar to the average across OECD countries. The gender difference in Northern Ireland also does not differ significantly from the gender difference in Ireland.

Male students in Ireland score significantly higher than the OECD average for male students and also significantly outperform their counterparts in France, the United States and Northern Ireland. Male students in Shanghai-China, Korea, Finland and Germany have significantly higher mean scores than male students in Ireland.

Female students in Ireland also have a significantly higher mean score than females across OECD countries. Female students in Ireland significantly outperform their counterparts in the United States and Northern Ireland, but have a significantly lower mean score than female students in Shanghai-China, Korea, Finland, Poland and Germany.

Table 3.11. Gender differences on the overall print mathematics scale in Ireland, in selected comparison countries/economies and on average across OECD countries

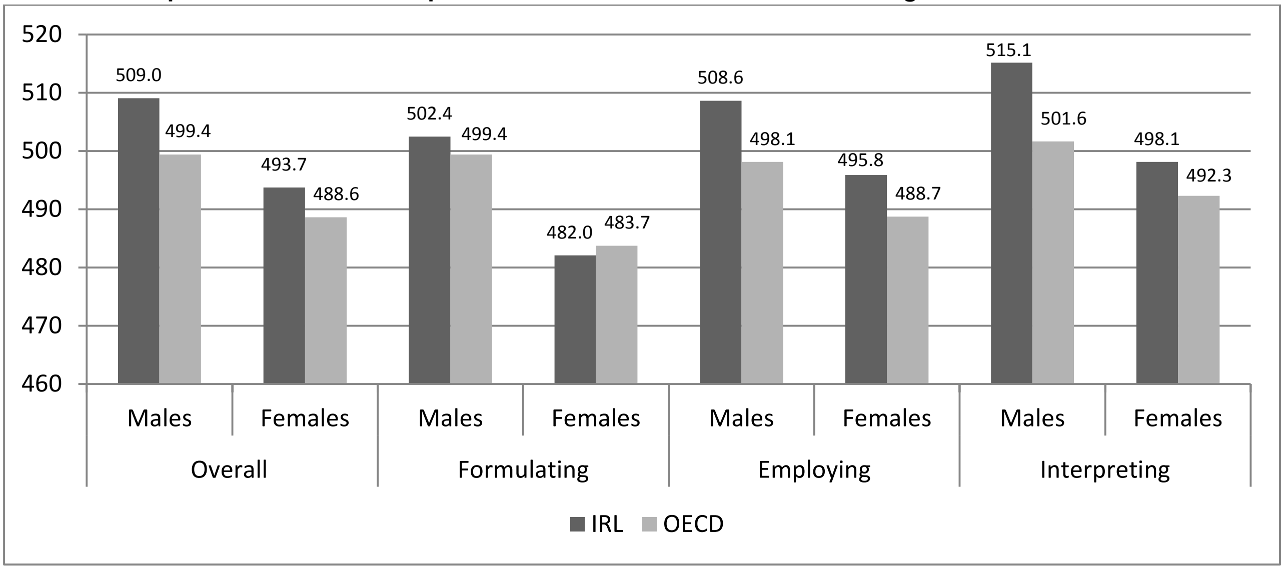
	Males		Females		Difference (Males-Females)	
	Mean	SE	Mean	SE	Score diff	SE
Korea	562.1	(5.82)	544.2	(5.13)	**17.9**	(6.22)
Finland	517.4	(2.63)	520.2	(2.16)	-2.8	(2.87)
Poland	519.6	(4.25)	515.5	(3.76)	4.0	(3.42)
Germany	520.2	(3.04)	506.6	(3.37)	**13.6**	(2.77)
Ireland	509.0	(3.25)	493.7	(2.62)	**15.3**	(3.79)
New Zealand	507.1	(3.21)	492.1	(2.92)	**15.1**	(4.27)
France	499.4	(3.41)	490.9	(2.55)	**8.5**	(3.41)
United Kingdom	500.3	(4.20)	487.8	(3.84)	**12.5**	(4.68)
United States	483.6	(3.81)	479.0	(3.91)	4.7	(2.80)
OECD	499.4	(0.62)	488.6	(0.54)	**10.7**	(0.63)
Shanghai-China	615.6	(3.97)	609.9	(3.38)	5.7	(3.26)
Northern Ireland	491.8	(5.02)	481.5	(5.36)	10.3	(8.27)

Note: Significant differences are in bold

Male students significantly outperform female students on each of the mathematical process subscales, in Ireland and on average across OECD countries (Figure 3.9). On each of the process subscales, the difference between males and females is larger in Ireland compared to the corresponding OECD average difference.

Male students in Ireland have significantly higher mean scores than the average for males across OECD countries on the Employing and Interpreting subscales, but the difference is not significant for the Formulating subscale. Female students in Ireland have a significantly higher mean score on the Employing subscale than the average for female students across OECD countries. The differences between female students in Ireland and on average across OECD countries are not significant for the Formulating and the Interpreting subscales (see Table A3.32 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix]).

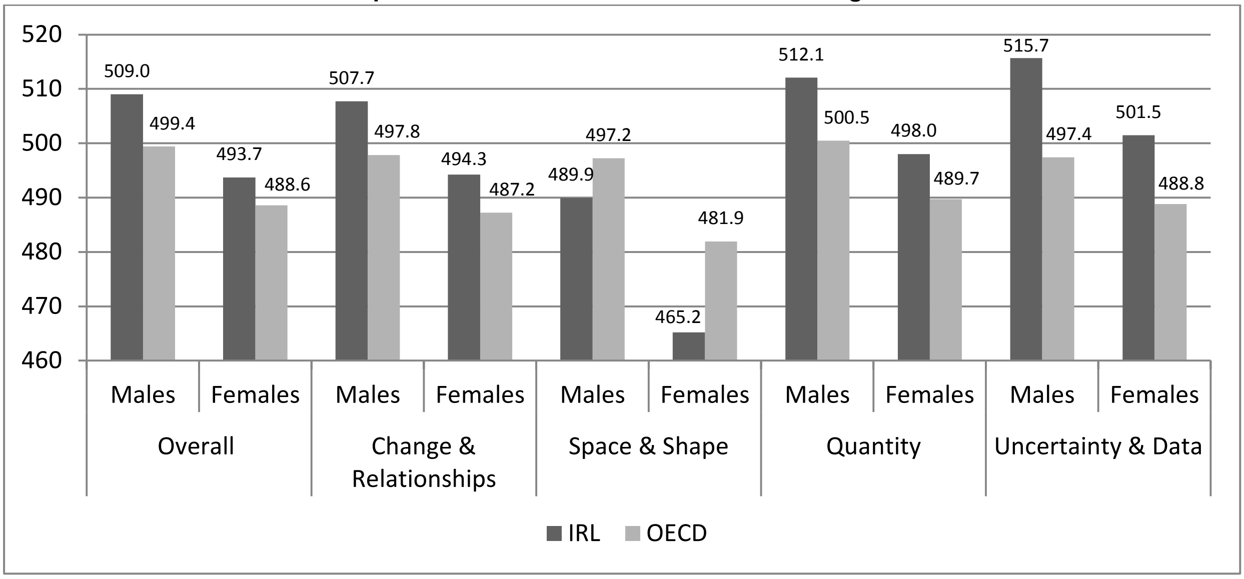
Figure 3.9. Mean scores of males and females on the overall mathematics scale and the three mathematical process subscales for print mathematics in Ireland and on average across OECD countries



Note: See Table A3.32 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores of male and female students on the process subscales in Ireland and on average across OECD countries.

A broadly similar pattern emerges for the four content subscales, with male students significantly outperforming female students on each of the content subscales, both in Ireland and on average across OECD countries (Figure 3.10). As with the process subscales, gender differences are larger in Ireland for each content subscale when compared to the corresponding OECD average gender difference. Male students in Ireland have a significantly higher mean score than the average for males across OECD countries on each of the content area subscales, with the exception of the Space & Shape subscale. Female students in Ireland perform significantly higher than the OECD average for females on the Change & Relationships, Quantity and Uncertainty & Data subscales, while the OECD average score for females on the Space & Shape subscale is significantly higher than the corresponding score for Ireland (see Table A3.33 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix]).

Figure 3.10. Mean scores of male and female students on the overall mathematics scale and the four content area subscales for print mathematics in Ireland and on average across OECD countries

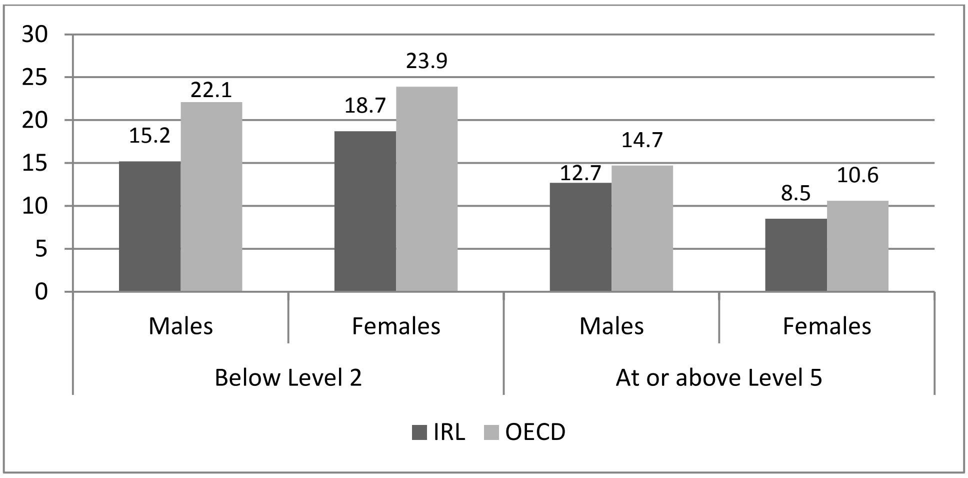


Note: See Table A3.33 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores of male and female students on the content area subscales, in Ireland and on average across OECD countries.

Figure 3.11 presents the percentages of male and female students scoring below Level 2 and at or above Level 5 for the overall print mathematics scale, for Ireland and the OECD average. In Ireland, slightly more females than males perform below Level 2 on the overall print mathematics scale (18.7% compared to 15.2%). The proportion of female students performing below Level 2 in Ireland is somewhat lower than the corresponding proportion across OECD countries (18.7% and 23.9%, respectively). Similarly, the percentage of male students in Ireland performing below Level 2 is considerably lower than the corresponding percentage across OECD countries (15.2% and 22.1%, respectively).

In Ireland and on average across OECD countries, more male than female students achieve print mathematics scores at Level 5 or above (12.7% compared to 8.5% for Ireland, and 14.7% compared to 10.6% across OECD countries). The percentages of male and female students performing at or above Level 5 in Ireland are slightly below the corresponding OECD percentages.

Figure 3.11. Percentages of male and female students achieving below proficiency level 2 and at or above proficiency level 5 on the overall print mathematics scale in Ireland and on average across OECD countries



Note: See Table A3.34 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of male and female students at each proficiency level on the overall print mathematics scale, in Ireland and on average across OECD countries.

3.7. Performance on Computer-based Mathematics

Thirty-two countries/economies, including Ireland and 22 other OECD countries[32], also participated in a computer-based assessment of mathematics (see chapter 1 for an overview of the framework for mathematics for PISA 2012). Of the selected comparison countries/economies described for print mathematics, six (Shanghai-China, Korea, Germany, France, the United States and Poland) also took part in the computer-based assessment of mathematics and Ireland's results for computer-based mathematics are presented alongside the results for these countries/economies.

3.7.1 Overall Performance on Computer-based Mathematics

Students in Ireland have a mean score of 493.1 on the assessment of computer-based mathematics, which does not differ significantly from the corresponding OECD average (497.1; Table 3.12). Ireland's score is ranked 15th among the 23 participating OECD countries and 20th among all 32 participating countries/economies. Applying a 95% confidence interval, which takes account of measurement and sampling error, the true rank for Ireland is between 12th and 18th among the 23 participating OECD countries and between 16th and 23rd among all 32 participating countries/economies.

Fourteen countries/economies, including nine OECD countries, achieve mean computer-based mathematics scores that are significantly higher than Ireland's. Nine other countries (Italy, the United States, Norway, the Slovak Republic, Denmark, Sweden, the Russian Federation, Poland and Portugal) have mean scores that do not differ significantly from the mean score for Ireland. The remaining eight countries, including five OECD countries, perform significantly less well than Ireland on the assessment of computer-based mathematics.

The differences between computer-based and print mathematics scores for all countries/economies that participated in both assessments are shown in Figure 3.12 (see Table A3.35 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for the mean scores, standard deviations and position relative to the Irish means on the computer-based and print mathematics assessments for the 32 countries/economies that participated in both assessments). While there is some variation between the print and computer-based mathematics scores of countries/economies, there is little difference between the rankings of the top performing countries/economies for both (i.e. the same nine countries/economies appear in the top nine positions in both computer-based and print mathematics rankings, although in a slightly different order). Likewise, the same six countries obtain the lowest scores for both modes.

Fifteen countries/economies have higher print mathematics than computer-based mathematics scores, while 17 countries/economies achieve higher computer-based mathematics than print mathematics scores. Three countries/economies (Shanghai-China, Poland and Chinese Taipei) perform over 20 points higher on print mathematics than computer-based mathematics, while two countries (Brazil and Colombia) perform over 20 points lower on print mathematics compared to computer-based mathematics. The OECD averages for the 23 OECD countries that participated in both assessments are almost identical.

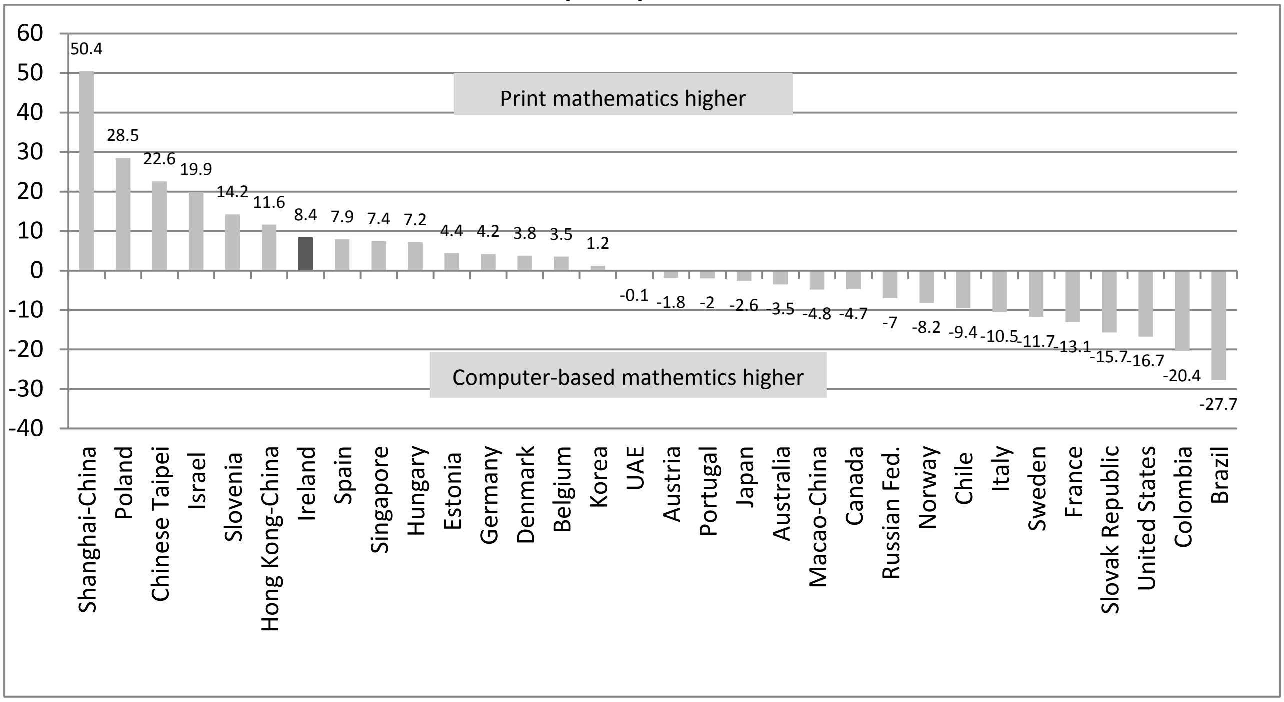
[32] Of the 23 OECD countries that participated in the computer-based assessment of mathematics, 12 have a mean print mathematics score that is above the OECD average for print mathematics, while three score at the OECD average and eight below the OECD average.

Table 3.12. Mean country/economy scores, standard deviations and standard errors for computer-based mathematics scale and positions relative to the 23-country OECD and Irish means, for all participating countries/economies

	Mean	SE	SD	SE	IRL
Singapore	566.0	1.29	98.3	(1.04)	▲
Shanghai-China	562.3	3.44	93.6	(2.07)	▲
Korea	552.6	4.52	90.1	(2.27)	▲
Hong Kong-China	549.6	3.36	86.7	(2.26)	▲
Macao-China	542.9	1.11	82.8	(0.82)	▲
Japan	539.0	3.32	87.8	(2.43)	▲
Chinese Taipei	537.3	2.76	88.8	(1.85)	▲
Canada	522.8	2.24	91.9	(1.49)	▲
Estonia	516.1	2.20	82.1	(1.41)	▲
Belgium	511.2	2.37	100.0	(1.60)	▲
Germany	509.4	3.34	95.5	(1.96)	▲
France	508.1	3.28	91.9	(4.14)	▲
Australia	507.7	1.64	90.9	(1.24)	▲
Austria	507.3	3.50	88.7	(2.24)	▲
Italy	498.8	4.16	83.1	(2.60)	O
United States	498.0	4.05	88.8	(2.20)	O
Norway	497.6	2.76	87.2	(1.58)	O
Slovak Republic	497.3	3.51	86.1	(2.36)	O
Denmark	496.2	2.68	86.4	(1.45)	O
Ireland	493.1	2.90	80.5	(1.95)	
Sweden	489.9	2.89	86.1	(1.60)	O
Russian Fed.	489.1	2.61	79.8	(1.46)	O
Poland	489.0	3.98	86.0	(1.97)	O
Portugal	489.0	3.09	85.1	(1.57)	O
Slovenia	486.9	1.16	87.8	(0.99)	▼
Spain	475.1	3.17	82.0	(1.54)	▼
Hungary	469.8	3.87	92.6	(2.56)	▼
Israel	446.6	5.62	111.3	(3.53)	▼
UAE	434.1	2.24	84.3	(1.53)	▼
Chile	432.0	3.34	81.5	(1.64)	▼
Brazil	420.7	4.66	83.9	(3.06)	▼
Colombia	396.8	3.16	73.3	(1.76)	▼
OECD Average	497.1	(0.70)	88.8	(0.45)	

(dark shading)	Significantly above OECD average	▲	Significantly higher than Ireland
(no shading)	At OECD average	O	Not significantly different from Ireland
(light shading)	Significantly below OECD average	▼	Significantly lower than Ireland

Figure 3.12. Differences between computer-based and print mathematics scores for all countries/economies that participated in both assessments



Note: See Table A3.35 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean scores, standard deviations and position relative to the Irish means on the computer-based and print mathematics assessments for the 32 countries/economies that participated in both assessments

Students in Ireland perform significantly less well on the computer-based assessment of mathematics than on the print mathematics assessment. Of the nine countries that do not differ significantly from Ireland in terms of performance on computer-based mathematics, only Denmark also has a print mathematics score that does not differ significantly from the print mathematics score of Ireland. Poland also has a computer-based mathematics score that is not significantly different from Ireland's, but performs significantly higher than Ireland on the print mathematics assessment. Indeed, Poland's mean print mathematics score is significantly above the corresponding OECD average, while their mean computer-based mathematics score is significantly below the computer-based OECD average. Italy, the United States and the Slovak Republic perform significantly below the OECD average on the print mathematics scale, but do not differ from the OECD average on the computer-based mathematics scale. While France and Portugal have mean print mathematics scores that are not significantly different from the corresponding 34-country OECD average[33], France performs significantly above the OECD average and Portugal performs significantly below the OECD average on the computer-based mathematics scale.

3.7.2. Variation in Performance on Computer-based Mathematics

The difference between the lowest- (5th percentile) and highest- (95th percentile) performing students in Ireland on the computer-based mathematics scale is 264.1 points, which is significantly smaller than the corresponding average difference across the 23 participating OECD countries (290.7 points; Table 3.13) and the differences in each of the selected comparison countries/economies, with the exception of Poland (282.8 points). In Ireland, the difference between the highest- and lowest-performing students on the computer-based mathematics assessment is also somewhat

[33] The mean print mathematics score for Portugal is significantly below the corresponding OECD average score based on the 23 OECD countries that participated in both assessments.

narrower than the corresponding difference for print mathematics (264.1 points compared to 280.3 points).

The score of students at the 10th percentile on the computer-based mathematics scale in Ireland does not differ from the corresponding scores in Germany, France, the United States, Poland or the 23-country OECD average. Students performing at the 10th percentile in Shanghai-China and Korea significantly outperform their counterparts in Ireland. Students performing at the 90th percentile on the computer-based mathematics scale in Ireland have a score of 593.6, which does not differ significantly from the corresponding score in Poland but is significantly below the corresponding average of students across the 23 participating OECD countries and the remaining comparison countries/economies.

In Ireland, both higher- (i.e. at the 90th percentile) and lower- (i.e. at the 10th percentile) achieving students performed less well on the computer-based assessment of mathematics than on the print mathematics assessment, although the difference is greater among the higher-achieving students (-3.1 points for students at the 10th percentile and -16.2 points for students at the 90th percentile).

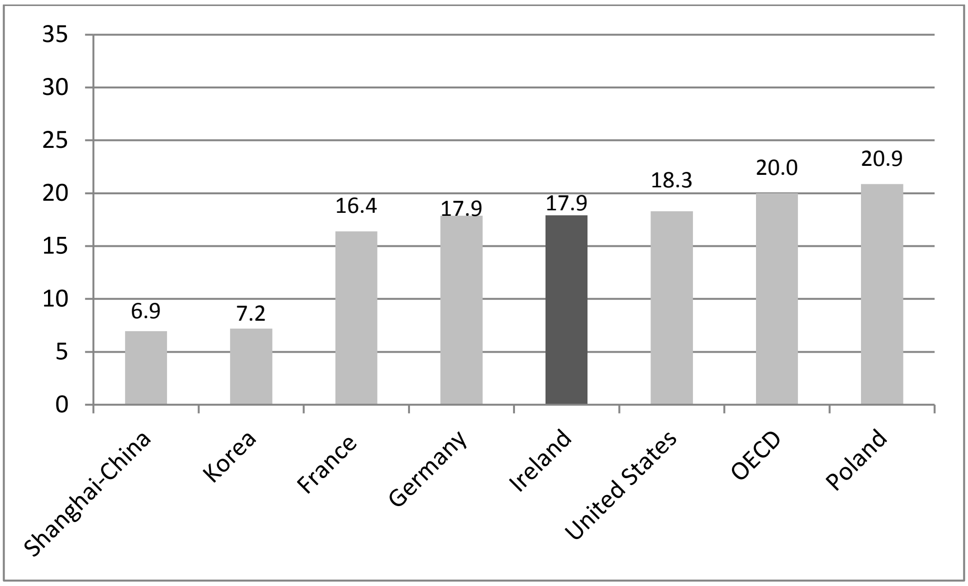
Table 3.13. Scores of students at key percentile markers on the computer-based mathematics scale in Ireland, in selected comparison countries/economies and on average across 23-participating OECD countries

	5th		10th		25th		75th		90th		95th	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Korea	403.0	(5.29)	436.7	(5.39)	493.9	(4.96)	614.6	(5.25)	664.6	(5.86)	694.8	(8.25)
Germany	344.9	(5.60)	381.9	(6.13)	445.6	(4.49)	576.6	(3.98)	629.2	(4.01)	659.6	(5.42)
France	352.9	(8.31)	389.6	(5.76)	449.9	(3.65)	571.6	(3.32)	620.4	(3.97)	647.0	(4.40)
United States	350.2	(7.75)	385.6	(5.50)	439.7	(4.53)	557.6	(4.34)	611.0	(5.95)	642.6	(6.29)
Ireland	355.4	(6.22)	387.9	(4.64)	441.7	(3.76)	548.4	(2.80)	593.6	(3.04)	619.4	(3.22)
Poland	345.1	(5.87)	380.0	(5.49)	432.2	(4.19)	547.6	(4.08)	598.7	(5.13)	627.8	(5.26)
OECD	347.4	(1.27)	382.0	(1.10)	438.5	(0.87)	558.5	(0.77)	609.1	(0.92)	638.1	(1.05)
Shanghai-China	404.1	(5.94)	439.2	(5.33)	499.8	(5.15)	628.2	(3.48)	678.8	(3.52)	707.8	(4.70)

3.7.3. Performance on Computer-based Mathematics Proficiency Levels

As with print mathematics, student performance on computer-based mathematics can be described in terms of proficiency levels (see Table 3.3 for a description of the types of skills that students at each proficiency level are capable of). Six proficiency levels (using the same cut points as for the overall print mathematics proficiency levels) are described for computer-based mathematics. Figure 3.13 presents the percentages of students performing below proficiency level 2 on the computer-based mathematics scale for Ireland, the 23-country OECD average and comparison countries/economies.

Figure 3.13. Percentages of students performing below Level 2 on the computer-based mathematics scale in Ireland, in selected comparison countries/economies and on average across 23 participating OECD countries

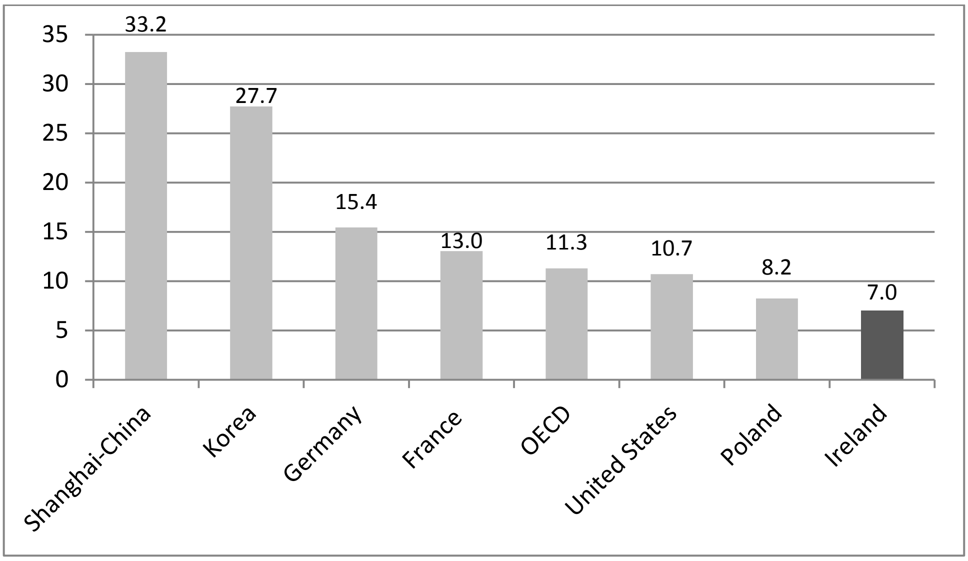


Note: See Table A3.36 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland, in selected comparison countries and on average across OECD countries

In Ireland, 17.9% of students perform below Level 2, which is considered by the OECD as the baseline level of mathematical proficiency that is required to participate fully in society and in future learning. The proportion of students performing below Level 2 in Ireland is similar to the corresponding proportions in Germany (17.9%), France (16.4%) and the United States (18.3%), and is slightly lower than the 23-country OECD average proportion (20.0%). Both Shanghai-China and Korea have considerably lower proportions of students performing below Level 2 than Ireland (6.9% and 7.2%, respectively).

Figure 3.14 presents the percentages of students performing at Level 5 or above on the computer-based mathematics scale for Ireland, the 23-country OECD average and comparison countries/economies. The proportion of higher-achieving students (at or above Level 5) on the computer-based mathematics scale in Ireland (7.0%) is similar to the corresponding proportion in Poland (8.2%) but is somewhat lower than the corresponding 23-country OECD average proportion (11.3%). Considerably larger proportions of students in Shanghai-China and Korea achieved scores at Level 5 or above on the computer-based mathematics scale (33.2% and 27.7%, respectively).

Figure 3.14. Percentages of students performing at or above Level 5 on the computer-based mathematics scale in Ireland, in selected comparison countries/economies and on average across 23-participating OECD countries



Note: See Table A3.36 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland, in selected comparison countries and on average across OECD countries

In Ireland, the proportion of lower-achieving students (i.e. below Level 2) on the computer-based mathematics assessment is higher than for print mathematics (17.9% versus 16.9%), while the proportion of higher-achieving students (i.e. at or above Level 5) is lower (7.0% for computer-based mathematics and 10.7% for print mathematics), although the differences are small.

3.7.4. Gender Differences on Computer-based Mathematics

Male students significantly outperform females on the computer-based mathematics scale in Ireland and on average across OECD countries (Table 3.14). Male students also outperform female students in Shanghai-China, Korea, Germany, France and Poland, while the gender difference on the computer-based mathematics scale is not significant in the United States.

The difference between male and female students for computer-based mathematics is somewhat larger in Ireland (18.6 points) compared to the average difference across OECD countries (12.5 points), but is not significantly different. Of the comparison countries/economies presented in Table 3.41, only the United States has a significantly narrower gender difference than Ireland for computer-based mathematics. In Ireland, the gender difference for computer-based mathematics is slightly larger than for print mathematics (18.6 points and 15.3 points, respectively).

Male students in Ireland do not differ significantly in terms of computer-based mathematics performance from the average for males across the 23 participating OECD countries. The performance of male students in Ireland also does not differ significantly from male students in the United States or Poland, but is significantly lower than Shanghai-China, Korea, Germany and France. Female students in Ireland perform significantly less well on computer-based mathematics than females across the 23 OECD countries, and in each of the comparison countries/economies in Table 3.14, except for Poland.

In Ireland, both male and female students achieve higher mean scores on print mathematics than computer-based mathematics, although the difference is larger for females (10.1 points) than for males (6.8 points).

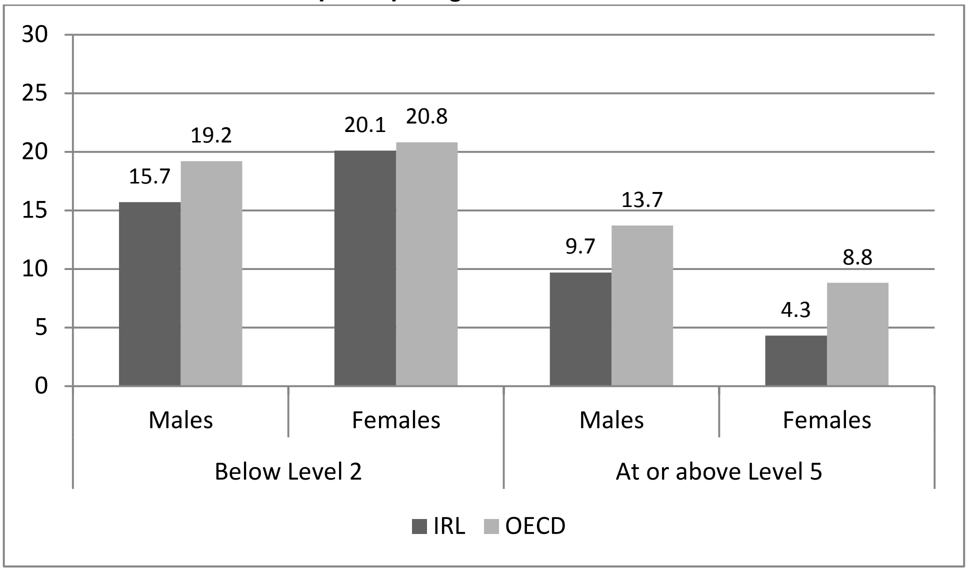
Table 3.14. Gender differences on the computer-based mathematics scale in Ireland, in selected comparison countries/economies and on average across 23-participating OECD countries

	Males		Females		Difference (Males-Females)	
	Mean	SE	Mean	SE	Score diff	SE
Korea	560.8	(5.96)	543.1	(5.17)	**17.7**	(6.72)
Germany	514.1	(3.73)	504.5	(3.50)	**9.7**	(2.69)
France	515.8	(3.71)	500.7	(3.55)	**15.1**	(3.00)
United States	498.1	(4.43)	497.9	(4.19)	0.2	(2.95)
Ireland	502.2	(3.89)	483.6	(2.96)	**18.6**	(3.73)
Poland	494.5	(4.44)	483.8	(4.15)	**10.8**	(3.18)
OECD	503.3	(0.87)	490.8	(0.73)	**12.5**	(0.82)
Shanghai-China	571.7	(4.11)	553.3	(3.34)	**18.4**	(2.87)

Note: Significant differences are in bold

The percentages of male and female students scoring below Level 2 and at or above Level 5 for computer-based mathematics are presented in Figure 3.15 for Ireland and the 23 participating OECD countries. In Ireland, about a fifth of female students perform below Level 2 compared to 15.7% of males. The proportion of female students performing below Level 2 in Ireland (20.1%) is about the same as the corresponding proportion across the 23 OECD countries (20.8%). The percentage of male students in Ireland performing below Level 2 is somewhat lower than the corresponding percentage across OECD countries (15.7% and 19.2%, respectively). In Ireland, over twice as many male as female students have computer-based mathematics scores at Level 5 or above (9.7% compared to 4.3%). The percentage of male students performing at or above Level 5 in Ireland is somewhat lower than the corresponding 23-country OECD average percentage (13.7%), while the proportion of higher-achieving female students in Ireland (4.3%) is about half the corresponding 23-country OECD average proportion (8.8%).

Figure 3.15. Percentages of male and female students achieving below proficiency level 2 and at or above proficiency level 5 on the computer-based mathematics scale, in Ireland and on average across 23 participating OECD countries



Note: See Table A3.37in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of male and female students (and standard errors) at each proficiency level on the computer-based mathematics scale in Ireland, in selected comparison countries and on average across OECD countries

In Ireland, the proportions of lower- (i.e. below Level 2) and higher- (i.e. at or above Level 5) achieving male and female students on the computer-based assessment are broadly similar to the corresponding proportions for print mathematics, although there are slightly more higher-achieving male (+3.0%) and female (+4.3%) students on the print mathematics assessment.

3.8. Summary

Ireland's mean print mathematics score in 2012 is 501.5, which is significantly above the OECD average for print mathematics (494.0). Ireland's performance does not differ significantly from that of Australia (504.2), New Zealand (499.7), France (495.0) and the United Kingdom (493.9). Students in Ireland perform significantly better than their counterparts in Northern Ireland, who have a mean score of 486.9 on the overall print mathematics scale.

Three new mathematical process subscales are described for PISA 2012: Formulating, Employing and Interpreting. The mean scores of students in Ireland on the Interpreting and Employing process subscales (506.8 and 502.3, respectively), are significantly above the corresponding OECD average scores (497.0 and 493.4, respectively), while students in Ireland do not differ significantly from the average of students across OECD countries in terms of performance on the Formulating subscales (492.4 for Ireland and 491.6 for the OECD average).

Of the mathematical content area subscales described, Ireland's performance is best on the Uncertainty & Data subscale (508.7), followed by Quantity (505.2), Change & Relationships (501.1) and Space & Shape (477.8). Students in Ireland have significantly higher mean scores on the Change & Relationships, Quantity and Uncertainty & Data subscales compared to the OECD average scores (492.6, 495.1 and 493.1, respectively); however, they perform significantly less well on the Space & Shape subscale (477.8 for Ireland and 489.6 for the OECD average).

The score of students in Ireland at the 10th percentile (i.e. lower-performing students) on the overall print mathematics scale is 391.0, which is significantly above the corresponding OECD average (375.0). There is considerable variation in the performance of lower-achieving students in Ireland across the process and content area subscales, ranging from 356.5 for the Space & Shape subscale to 395.0 for the Uncertainty & Data subscale. On the other hand, the performance of higher-achieving students (i.e. those at the 90th percentile) on the overall print mathematics scale in Ireland (609.8) is not significantly different from the corresponding OECD average. As with lower-achieving students, there is also considerable variation in Ireland among higher achieving students across the process and content area subscales, ranging from 598.4 for the Space & Shape subscale to 623.5 for the Quantity subscale.

Ireland has considerably fewer students performing below Level 2 on the overall print mathematics scale compared to the OECD average (16.9% and 23.0%, respectively), while the proportion students performing at or above Level 5 in Ireland is about the same as the corresponding OECD average (10.7% and 12.6%, respectively). In Ireland, there is some variation in the proportion students performing below Level 2 across the process and content area subscale (ranging from 15.8% for the Uncertainty & Data subscale to 26.7% for the Space & Shape subscale). The proportion of students performing at or above Level 5 in Ireland ranges from 8.3% for the Space & Shape subscale to 13.7% for the Quantity subscale.

Male students have significantly higher mean print mathematics scores than females in Ireland (509.0 and 493.7, respectively) and on average across OECD countries (499.4 and 488.6, respectively); however the size of the gender difference is larger in Ireland, although not significantly so (15.3 points compared to 10.7 points). The performance of male students is also significantly stronger than that of female students for each of the three process and four mathematical content subscales, both in Ireland and on average across OECD countries. Male students in Ireland have a significantly higher mean score than the corresponding OECD average on the overall mathematics scale and on each of the subscales, with the exception of the Formulating and Space & Shape subscales, where differences are not significant. On the other hand, the performance of female students in Ireland does not differ from the average performance of females across OECD countries on the overall print mathematics scale, or the Formulating and Interpreting subscales. Female students in Ireland perform significantly less well than the average for females across OECD countries on the Space & Shape subscale, but perform significantly higher on the Employing, Change & Relationships, Quantity and Uncertainty & Data subscales.

In Ireland, slightly more females than males perform below Level 2 on the overall print mathematics scale (18.7% and 15.2%, respectively), while a higher percentage of male students than female students obtain print mathematics scores at Level 5 or above (12.7% and 8.5, respectively).

Students in Ireland perform significantly less well on the computer-based assessment of mathematics than on the print mathematics assessment, with a mean score of 493.1, which is not significantly different from the corresponding OECD average score (497.1). Ireland's overall performance on this assessment is similar to the performance of students in Italy (498.8), the United States (498.0), Sweden (489.9) and Poland (489.0). There is considerable variation in the performance of countries across the print and computer-based assessments, with 15 countries obtaining higher print mathematics than computer-based mathematics scores and 17 countries achieving lower scores. The score of students at the 10th percentile on the computer-based mathematics scale in Ireland does not differ from the OECD average (387.9 and 382.0, respectively), while the performance of students at the 90th percentile in Ireland is significantly below the corresponding OECD average (593.6 and 609.1, respectively).

In Ireland, the percentage of students scoring below Level 2 on the computer-based assessment of mathematics (17.9%) is similar to the corresponding percentage for the print mathematics (16.9%) but is slightly below the OECD average for computer-based mathematics (20.0%). On the other hand, there is a somewhat larger proportion of students at Level 5 or above for print mathematics (10.7%) than for computer-based mathematics (7.0%) in Ireland. Also, the proportion of student scoring at Level 5 or above on the computer-based mathematics scale is lower in Ireland than on average across OECD countries (11.3%).

As with print mathematics, male students significantly outperformed female students on the computer-based assessment of mathematics in Ireland (502.2 compared to 483.6). The size of the gender difference in Ireland is slightly larger for computer-based mathematics (18.6 points) than for print mathematics (15.3 points). Male students in Ireland do not differ from the OECD average score for males on computer-based mathematics (503.3); however, female students in Ireland perform significantly less well than their OECD counterparts (490.8). A somewhat higher percentage of female students than male students perform below Level 2 on the computer-based mathematics scale in Ireland (20.1% versus 15.7%), while over twice as many male as female students obtain computer-based mathematics scores at Level 5 or above (9.7% compared to 4.3%).

4. Performance on Reading and Science

This chapter looks at performance on print and digital reading and science in PISA 2012. As well as comparing average performance across countries/economies, it examines variation in performance, performance by proficiency level, and gender differences. As with mathematics, results are examined with reference to 10 comparison countries/economies selected on the basis of high performance, cultural or linguistic similarity, similar population sizes and/or recent educational reforms. In the relevant tables the countries/economies are arranged in descending order of mean scores in the relevant domain, with the exception of Northern Ireland and Shanghai-China as they are regions rather than countries. Reading and science performance are reported with reference to overall scales only (with print and digital reading reported separately), as fewer items are used for minor domains. Supplementary tables are provided in the *PISA 2012 E-the PISA 2012 E-appendix,* available at www.erc.ie/p12eappendix. Trends in reading and science achievement over time are examined in Chapter 7.

4.1. Overall Performance on Print Reading

Ireland's mean score of 523.2 on the overall print reading scale is significantly higher than the OECD average of 496.5 (Table 4.1). Ireland is ranked 4th out of 34 OECD countries and 7th out of all 65 participating countries/economies. Applying a 95% confidence interval, which takes account of measurement and sampling error, Ireland's true rank in print reading is between 3rd and 6th among OECD countries, and between 6th and 10th among all participating countries/economies.

Shanghai-China significantly outperformed every other participating country/economy in print reading, with a mean score of 569.6. The five highest-achieving countries/economies on the print reading scale (Shanghai-China, Hong Kong-China, Singapore, Japan and Korea) have mean print reading scores that are significantly higher than Ireland's. Ireland's mean score did not differ from that of five countries/economies (Finland, Canada, Chinese Taipei, Poland and Liechtenstein). The remaining 54 countries, including 28 OECD countries, perform significantly less well than Ireland. The mean print reading score of students in Northern Ireland sis 497.6, which is significantly below the mean score for Ireland, but is similar to the corresponding OECD average.

4.2. Variation in Performance on Print Reading

One measure of variation in performance is the standard deviation (provided for all countries/economies in Table 4.1). Ireland's standard deviation for print reading is 86.1, which is significantly smaller than the OECD average (94.4), meaning the spread of print reading achievement is less in Ireland than on average across OECD countries. There is considerable variation in the size of the standard deviation displayed by the five top-performing countries/economies, ranging from 80.0 (Shanghai-China) to 100.9 (Singapore).

Table 4.1. Mean country/economy scores, standard deviations and standard errors for the print reading scale and positions relative to the OECD and Irish means, for all participating countries/economies

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
Shanghai-China	569.6	(2.86)	80.0	(1.84)	▲	Israel	485.8	(5.01)	114.4	(2.45)	▼
Hong Kong-China	544.6	(2.79)	85.2	(1.85)	▲	*Croatia*	484.6	(3.31)	86.1	(2.09)	▼
Singapore	542.2	(1.37)	100.9	(1.17)	▲	Sweden	483.3	(3.00)	106.8	(1.79)	▼
Japan	538.1	(3.67)	98.7	(2.27)	▲	Iceland	482.5	(1.80)	98.0	(1.42)	▼
Korea	535.8	(3.94)	86.5	(1.98)	▲	Slovenia	481.3	(1.22)	92.0	(0.88)	▼
Finland	524.0	(2.38)	94.7	(1.34)	O	*Lithuania*	477.3	(2.48)	86.5	(1.50)	▼
Ireland	523.2	(2.55)	86.1	(1.71)		Greece	477.2	(3.27)	98.8	(2.09)	▼
Chinese Taipei	523.1	(3.03)	91.3	(1.83)	O	Turkey	475.5	(4.21)	85.9	(2.37)	▼
Canada	523.1	(1.93)	92.2	(0.94)	O	*Russian Fed.*	475.1	(2.97)	90.7	(1.54)	▼
Poland	518.2	(3.14)	87.3	(1.61)	O	Slovak Republic	462.8	(4.17)	104.3	(3.25)	▼
Estonia	516.3	(2.03)	80.4	(1.16)	▼	*Cyprus*	449.0	(1.18)	111.2	(1.26)	▼
Liechtenstein	515.5	(4.10)	88.0	(4.15)	O	*Serbia*	446.1	(3.44)	92.6	(2.00)	▼
New Zealand	512.2	(2.40)	105.6	(1.64)	▼	*UAE*	441.7	(2.50)	95.3	(1.07)	▼
Australia	511.8	(1.58)	97.1	(1.01)	▼	Chile	441.4	(2.90)	77.9	(1.45)	▼
Netherlands	511.2	(3.47)	93.0	(3.03)	▼	*Thailand*	441.2	(3.08)	78.1	(1.80)	▼
Belgium	509.1	(2.16)	103.1	(1.67)	▼	*Costa Rica*	440.5	(3.50)	74.4	(1.63)	▼
Switzerland	509.0	(2.57)	90.1	(1.12)	▼	*Romania*	437.6	(3.98)	90.3	(2.00)	▼
Macao-China	508.9	(0.91)	82.3	(0.75)	▼	*Bulgaria*	436.1	(6.02)	118.5	(2.84)	▼
Vietnam	508.2	(4.40)	74.1	(2.58)	▼	Mexico	423.6	(1.51)	80.3	(0.99)	▼
Germany	507.7	(2.82)	91.4	(1.70)	▼	*Montenegro*	422.1	(1.18)	92.2	(1.30)	▼
France	505.5	(2.83)	109.1	(2.33)	▼	*Uruguay*	411.3	(3.16)	95.7	(2.03)	▼
Norway	503.9	(3.22)	100.5	(1.86)	▼	*Brazil*	410.1	(2.11)	85.3	(1.17)	▼
United Kingdom	499.3	(3.50)	97.2	(2.26)	▼	*Tunisia*	404.1	(4.51)	88.0	(2.54)	▼
United States	497.6	(3.74)	92.0	(1.56)	▼	*Colombia*	403.4	(3.45)	83.6	(1.93)	▼
Denmark	496.1	(2.65)	85.6	(2.16)	▼	*Jordan*	399.0	(3.56)	91.4	(2.55)	▼
Czech Republic	492.9	(2.87)	88.7	(1.85)	▼	*Malaysia*	398.2	(3.33)	83.7	(1.48)	▼
Italy	489.8	(1.97)	97.1	(0.94)	▼	*Indonesia*	396.1	(4.21)	75.4	(2.68)	▼
Austria	489.6	(2.76)	91.8	(1.77)	▼	*Argentina*	396.0	(3.70)	96.1	(2.25)	▼
Latvia	488.7	(2.39)	84.9	(1.75)	▼	*Albania*	394.0	(3.20)	115.8	(1.96)	▼
Hungary	488.5	(3.16)	91.8	(1.94)	▼	*Kazakhstan*	392.7	(2.69)	73.8	(1.38)	▼
Spain	487.9	(1.91)	92.1	(1.13)	▼	*Qatar*	387.5	(0.82)	112.8	(0.84)	▼
Luxembourg	487.8	(1.54)	105.0	(1.00)	▼	*Peru*	384.2	(4.34)	93.6	(2.28)	▼
Portugal	487.8	(3.75)	93.5	(1.88)	▼	OECD average	496.5	(0.51)	94.4	(0.31)	

(dark shading)	Significantly above OECD average	▲	Significantly higher than Ireland
(no shading)	At OECD average	O	Not significantly different from Ireland
(light shading)	Significantly below OECD average	▼	Significantly lower than Ireland

Note: OECD countries are in regular font, partner countries/economies are in italics.

Scores and standard errors at each of six key percentile markers are presented for Ireland, the average across OECD countries and the 10 comparison countries/economies in Table 4.2. The range in print reading achievement scores in Ireland between the 5th and 95th percentiles is 286.1 score points, which is significantly smaller than the OECD average range of 310.2 points. The difference between the highest and lowest performers in Ireland is not significantly different from the difference in Korea (282.4 points), Poland (289.2 points), Germany (300.0 points), the United States (303.4 points) and Northern Ireland (312.9 points), but is significantly narrower than the gaps in the remaining comparison countries/economies. [34]

At each key percentile marker, Ireland's score is higher than the corresponding OECD score; however, the difference is greatest at the lower end of the achievement scale. The score for students at the 10th percentile in Ireland (401.2) is significantly higher than the corresponding OECD average (371.7). It does not differ significantly from the corresponding scores in Korea, Finland and Poland, but is significantly lower than in Shanghai-China. Lower-performing students (i.e. those at

[34] The alpha level for these comparisons is set to .05.

the 10th percentile) in New Zealand, Germany, France, the United Kingdom and the United States perform significantly less well than their counterparts in Ireland.

Students scoring at the 90th percentile in Ireland (631.5) also have a significantly higher score than students on average across OECD countries at this marker (613.5). Students in Ireland also significantly outperform their counterparts in Germany, the United Kingdom, the United States and Northern Ireland, but perform significantly less well than students in Shanghai-China and New Zealand. Higher-performing students in Ireland (i.e. those at the 90th percentile) have a score that does not differ significantly from the corresponding scores in Korea, Finland, Poland and France.

Table 4.2. Scores of students at key percentile markers on the print reading scale in Ireland, in selected comparison countries/economies and on average across OECD countries

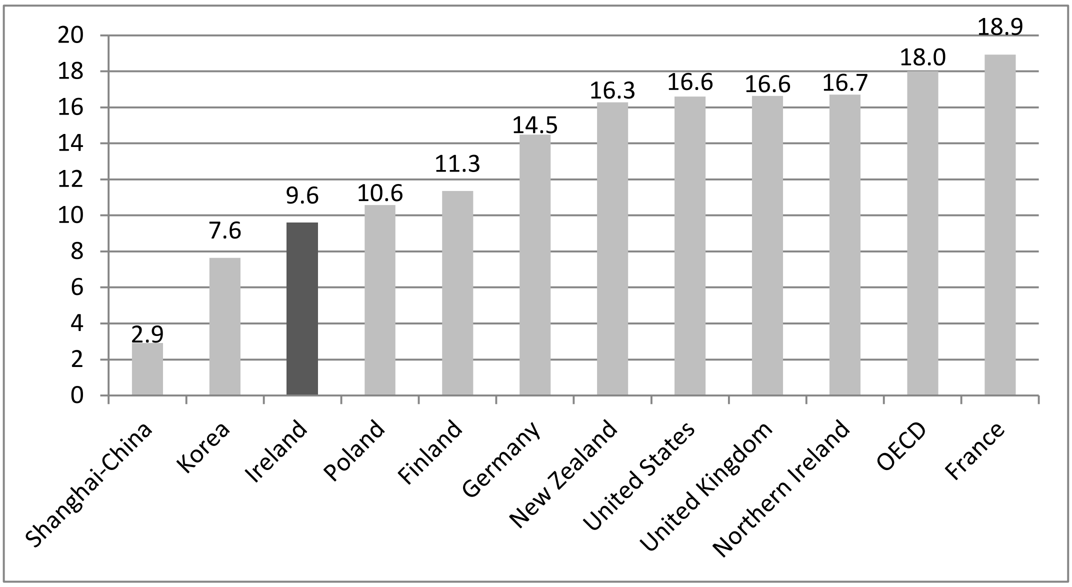
	5th		10th		25th		75th		90th		95th	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Korea	382.5	(8.63)	424.1	(6.21)	483.1	(4.27)	596.4	(4.11)	640.1	(4.03)	664.9	(4.78)
Finland	359.5	(5.68)	399.3	(4.32)	463.3	(3.48)	590.4	(2.28)	638.9	(2.53)	668.7	(3.48)
Ireland	373.2	(7.14)	410.2	(5.67)	469.0	(3.65)	582.3	(2.70)	631.5	(3.17)	659.3	(3.20)
Poland	366.2	(5.88)	404.1	(4.56)	461.0	(3.24)	578.8	(3.59)	625.9	(4.76)	655.5	(6.25)
New Zealand	331.8	(4.74)	373.6	(4.93)	442.7	(3.16)	586.4	(3.08)	644.9	(3.97)	679.0	(4.86)
Germany	346.4	(5.24)	383.7	(4.78)	446.5	(3.61)	574.0	(3.08)	621.1	(3.22)	646.4	(3.33)
France	312.2	(7.67)	358.0	(5.36)	434.9	(4.27)	583.9	(3.64)	638.9	(3.87)	668.9	(5.00)
United Kingdom	330.4	(7.45)	372.3	(7.01)	438.2	(4.76)	566.8	(3.37)	619.2	(3.79)	650.1	(4.32)
United States	342.3	(7.20)	378.3	(4.82)	435.7	(4.53)	561.0	(3.88)	613.8	(4.03)	645.7	(4.75)
OECD	332.1	(1.09)	371.7	(0.86)	435.4	(0.67)	562.9	(0.55)	613.5	(0.61)	642.3	(0.72)
Shanghai-China	430.6	(5.07)	462.8	(4.60)	518.5	(3.56)	625.8	(2.79)	667.0	(3.49)	689.9	(4.68)
Northern Ireland	333.5	(9.56)	373.4	(7.10)	435.8	(4.98)	565.4	(5.66)	617.6	(5.26)	646.4	(5.87)

4.3. Performance on Print Reading Proficiency Levels

The seven proficiency levels used in the PISA 2012 print reading assessment are the same as those established in PISA 2009 – the most recent cycle in which reading was a major domain. The lowest level of proficiency measured is Level 1b, then Level 1a, Level 2, and so on up to Level 6, the highest proficiency level. Students who do not display the skills required for Level 1b are classified as performing below Level 1b; PISA does not collect sufficient information to describe the skills of these students. The OECD (2013b) considers Level 2 to be a baseline level of proficiency, below which students have not acquired the reading literacy skills necessary for their future development. Similarly, performance at or above Level 5 is used as a benchmark for high achievement. Table 4.3 provides descriptions of the types of tasks students at each proficiency level are likely to succeed on, the cut-points on the print reading scale associated with each proficiency level, and the percentages of students at each proficiency level in Ireland and on average across OECD countries.

The percentage of students at the low end of the achievement scale in Ireland, i.e. those scoring below level 2, is just over half of the OECD average (9.6% compared to 18.0%; Figure 4.1). Ireland also has considerably fewer students performing below Level 2 compared with France (18.9%), Northern Ireland (16.7%), the United Kingdom (16.6%), the United States (16.6%), New Zealand (16.3%) and Germany (14.5). The proportions of students performing below Level 2 in Korea (7.6%), Poland (10.6%) and Finland (11.3%) are similar to the percentage in Ireland, while fewer than 3% of students in Shanghai-China perform below this level.

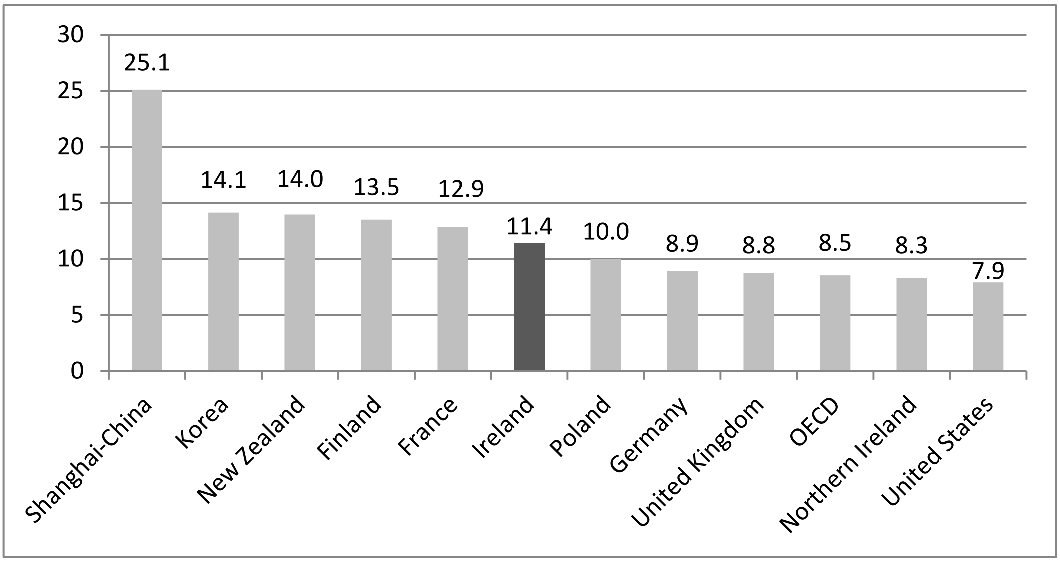
Figure 4.1. Percentages of students performing below Level 2 on the print reading scale in Ireland, in selected comparison countries/economies, and on average across OECD countries



Note: See Table A4.1 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the print reading scale, in selected comparison countries and on average across OECD countries

The percentage of students in Ireland scoring at or above Level 5 (11.4%) is considerably higher than the OECD average (8.5%) and the corresponding percentages in Germany (8.9%), the United Kingdom (8.8%), and the United States (7.9%) (Figure 4.2). The proportion of students performing at Level 5 or above in Ireland is similar to the corresponding proportions in Korea (14.1%), Poland (10.0%) or France (12.9%) but is lower than the proportions in Shanghai-China (25.1%) and Finland (13.5%). Ireland has more high achieving students than Northern Ireland (8.3%) on the print reading scale.

Figure 4.2. Percentages of students performing at or above Level 5 on the print reading scale in Ireland, in selected comparison countries/economies and on average across OECD countries



Note: See Table A4.1 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the print reading scale, in selected comparison countries and on average across OECD countries

Analyses of the variation in print reading performance show that, while Ireland displays above-average achievement (in terms of scores at key percentile markers and percentages at proficiency levels) across all levels of the achievement distribution, Ireland's advantage is more marked at the lower end of the achievement scale (again, both in terms of the scores of low-achieving students, and the percentages of students who can be classified as low-achieving). The analyses also show that the distribution of achievement in print reading is quite narrow in Ireland, by comparison to the OECD average.

Table 4.3. Descriptions of the seven levels of proficiency on the print reading scale and percentages of students achieving each level in Ireland and on average across OECD countries

Level *(Cut-point)*	Students at this level are capable of:	OECD		Ireland	
		%	SE	%	SE
6 *(>699)*	Conducting fine-grained analysis of texts; understanding both explicit and implicit information; reflecting on and evaluating texts; integrating information from more than one text; dealing with both familiar and unfamiliar content areas presented in typical as well as atypical formats; hypothesising about or critically evaluating a complex text taking into account multiple criteria or perspectives and applying sophisticated understandings from beyond the text. These students are highly skilled readers.	1.1	(0.04)	1.3	(0.35)
5 *(>626 to ≤698)*	Locating and organising deeply embedded information within texts; inferring which information in the text is relevant; critically evaluating or hypothesising about texts; drawing on specialised knowledge and dealing with concepts that are contrary to expectations.	7.3	(0.10)	10.1	(0.67)
4 *(>553 to ≤626)*	Locating and organising embedded information; interpreting the meaning of nuances of language in a section of text by taking into account the text as a whole; understanding and applying categories in an unfamiliar context; using formal or public knowledge to hypothesise about or critically evaluate a text; and understanding long or complex texts whose content or form may be unfamiliar.	21.0	(0.16)	26.0	(0.90)
3 *(>480 to ≤553)*	Locating multiple pieces of information, making links between different parts of a text and relating it to familiar everyday knowledge. Tasks at this level are among those that might be expected to be commonly demanded of young and older adults across OECD countries in their everyday lives.	29.1	(0.17)	33.4	(1.17)
2 *(>407 to ≤480)*	Locating information that meets several conditions, making comparisons or contrasts around a single feature, working out what a well-defined part of a text means even when the information is not prominent, and making connections between the text and personal experience. Level 2 can be considered the basic level of proficiency needed to participate effectively and productively in society and future learning.	23.5	(0.16)	19.6	(1.19)
1a *(>335 to ≤407)*	Locating one or more independent pieces of explicitly-stated information; recognising the main theme or idea in a text about a familiar topic and making simple connections between information in the text and common, everyday knowledge.	12.3	(0.13)	7.5	(0.69)
1b *(>262 to ≤335)*	Locating a single piece of explicitly-stated information in short, simple texts with a familiar style and content, such as a narrative or a simple list; making simple connections between adjacent pieces of information. The text typically provides support to the reader (e.g. repetition of information, pictures or familiar symbols) and there is minimal competing information.	4.4	(0.08)	1.9	(0.35)
Below Level 1b *(below 262)*	There is insufficient information on which to base a description of the reading skills of these students.	1.3	(0.05)	0.3	(0.13)

Source: OECD (2013b)

4.4. Gender Differences on Print Reading

Female students significantly outperform male students on the print reading scale in all countries/ economies (Table 4.4). The gender difference is significantly smaller in Ireland (28.5 points) compared to the OECD average (37.6 points) and the gender differences in Finland (61.7 points), Poland (42.0 points), Germany (44.1 points) and France (43.8 points).

Both male and female students in Ireland significantly outperform their OECD counterparts, and the difference is somewhat larger for males than for females (31.3 points and 22.2 points, respectively). Male students in Ireland have a significantly lower mean score than males in Shanghai-China and Korea, but significantly outperform their counterparts in all other comparison countries/economies. Female students in Ireland significantly outperform their counterparts in France, the United Kingdom, the United States and Northern Ireland, but perform significantly less well than female students in Shanghai-China and Finland.

Table 4.4. Gender differences on the print reading scale in Ireland, in selected comparison countries/ economies and on average across OECD countries

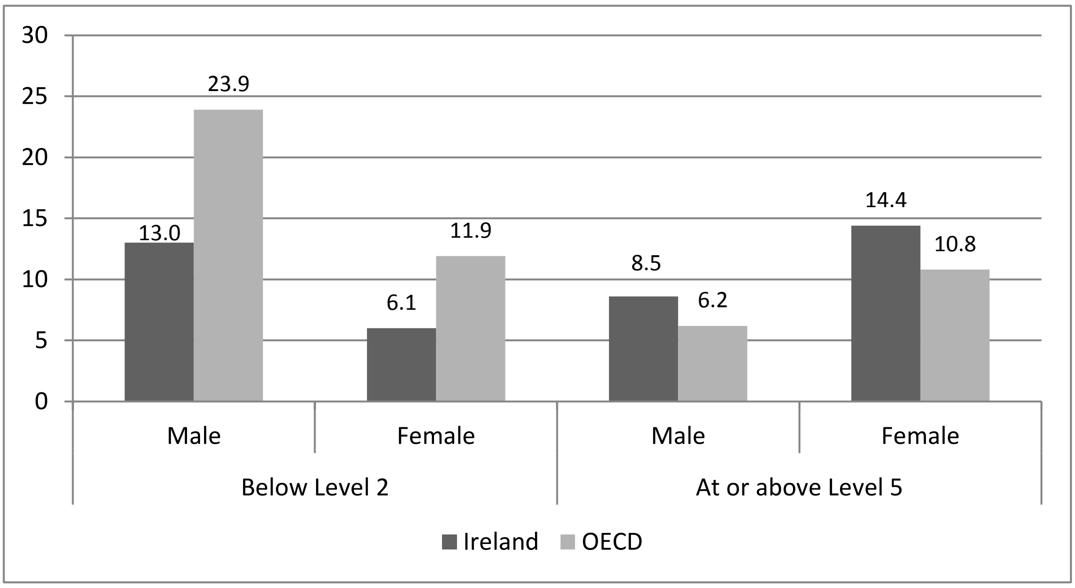
	Males		Females		Difference (males-females)	
	Mean	SE	Mean	SE	Score diff	SE
Korea	525.0	(5.03)	548.2	(4.49)	**-23.2**	(5.39)
Finland	494.0	(3.15)	555.7	(2.38)	**-61.7**	(3.05)
Ireland	509.2	(3.50)	537.7	(3.03)	**-28.5**	(4.22)
Poland	496.7	(3.65)	538.7	(3.14)	**-42.0**	(2.92)
New Zealand	495.4	(3.28)	529.8	(3.55)	**-34.4**	(4.96)
Germany	486.0	(2.89)	530.1	(3.11)	**-44.1**	(2.50)
France	483.0	(3.81)	526.8	(3.01)	**-43.8**	(4.19)
United Kingdom	486.6	(4.55)	511.5	(3.83)	**-24.9**	(4.57)
United States	482.5	(4.10)	513.3	(3.80)	**-30.8**	(2.62)
OECD	477.8	(0.64)	515.4	(0.54)	**-37.6**	(0.63)
Shanghai-China	557.3	(3.34)	581.3	(2.81)	**-24.0**	(2.51)
Northern Ireland	484.5	(5.36)	511.9	(5.25)	**-27.4**	(7.61)

Note: Significant differences are in bold

In Ireland, over twice as many male as female students obtained print reading scores that were below proficiency Level 2 (13.0% compared to 6.1%; Figure 4.3). Also, the proportion of female students who obtained a print reading score at or above Level 5 was considerably larger than the corresponding proportion of male students (14.4% and 8.5%, respectively).

The proportions of both male and female students performing below Level 2 in Ireland are considerably lower than on average across OECD countries (23.9% and 11.9% for males and females across OECD countries). On the other hand, there are somewhat higher proportions of both male and female students performing at or above Level 5 in Ireland compared to the OECD averages (6.2% and 10.8%).

Figure 4.3. Percentages of male and female students achieving below proficiency level 2 and at or above proficiency level 5 on the print reading scale, in Ireland and on average across OECD countries



Note: See Table A4.2 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of male and female students at each proficiency level on the print reading scale, in Ireland and on average across OECD countries

4.5. Overall Performance on Digital Reading

Ireland also participated in an assessment of digital reading in PISA 2012, along with thirty-one other countries/economies. Of the countries/economies that participated in this assessment, 23 are OECD countries[35]; therefore the OECD average for digital reading is based on the average of these 23 countries. Results for Ireland are compared to those for the six comparison countries/economies which also took part in the assessment of digital reading (Shanghai-China, Korea, Germany, France, the United States and Poland).

The mean digital reading score for students in Ireland is 520.1, which is significantly above the corresponding OECD average of 496.9 (Table 4.5). Ireland's score is ranked 5th among the 23 OECD countries and 9th among all 32 participating countries/economies. Applying a 95% confidence interval, which takes account of measurement and sampling error, the true rank for Ireland is between 4th and 7th among 23 OECD countries and between 7th and 11th among all 32 participating countries/ economies.

Six countries/economies, including three OECD countries (Korea, Japan and Canada), have mean digital reading scores that are significantly higher than Ireland's. Six other countries/economies, including Estonia, Australia, Chinese Taipei, Macao-China, the United States and France, have mean scores that do not differ significantly from Ireland's, while the remaining 19 countries, including 15 OECD countries, have mean scores that are significantly below the mean score of Ireland.

[35] Of the 23 OECD countries that participated in the assessment of digital reading, 11 have a mean print reading score that is above the OECD average for print reading, two have mean scores at the OECD average, while ten score below the OECD average.

Table 4.5. Mean country/economy scores, standard deviations and standard errors for the digital reading scale and positions relative to the OECD and Irish means, for all participating countries/economies

	Mean	SE	SD	SE	IRL
Singapore	567.0	(1.25)	90.2	(0.94)	▲
Korea	555.1	(3.61)	80.6	(2.05)	▲
Hong Kong-China	549.8	(3.55)	94.0	(2.36)	▲
Japan	544.8	(3.30)	78.1	(2.08)	▲
Canada	532.3	(2.34)	88.8	(1.24)	▲
Shanghai-China	531.3	(3.73)	84.0	(2.37)	▲
Estonia	522.8	(2.81)	92.9	(1.90)	O
Australia	520.6	(1.75)	96.9	(1.12)	O
Ireland	520.1	(3.03)	82.4	(1.76)	
Chinese Taipei	519.4	(3.03)	88.9	(1.89)	O
Macao-China	515.3	(0.93)	70.4	(0.78)	O
United States	511.2	(4.50)	89.0	(2.24)	O
France	510.9	(3.61)	97.6	(4.19)	O
Italy	504.1	(4.28)	94.9	(2.82)	▼
Belgium	502.3	(2.53)	99.8	(1.79)	▼
Norway	499.7	(3.49)	100.2	(2.57)	▼
Sweden	498.4	(3.41)	96.0	(1.73)	▼
Denmark	494.7	(2.88)	82.8	(1.45)	▼
Germany	493.6	(3.98)	99.1	(3.40)	▼
Portugal	485.9	(4.36)	89.2	(2.29)	▼
Austria	480.0	(3.89)	103.9	(4.33)	▼
Poland	476.8	(4.47)	96.5	(2.47)	▼
Slovak Republic	474.3	(3.51)	94.6	(2.77)	▼
Slovenia	471.3	(1.25)	98.5	(1.08)	▼
Spain	466.1	(3.89)	98.0	(2.42)	▼
Russian Federation	465.6	(3.86)	86.1	(1.59)	▼
Israel	461.0	(5.09)	116.6	(3.16)	▼
Chile	452.2	(3.57)	81.7	(1.84)	▼
Hungary	450.3	(4.39)	112.2	(3.87)	▼
Brazil	435.6	(4.94)	92.4	(2.72)	▼
United Arab Emirates	406.7	(3.33)	110.5	(1.99)	▼
Colombia	395.8	(3.98)	92.1	(2.86)	▼
OECD Average	496.9	(0.75)	94.4	(0.53)	

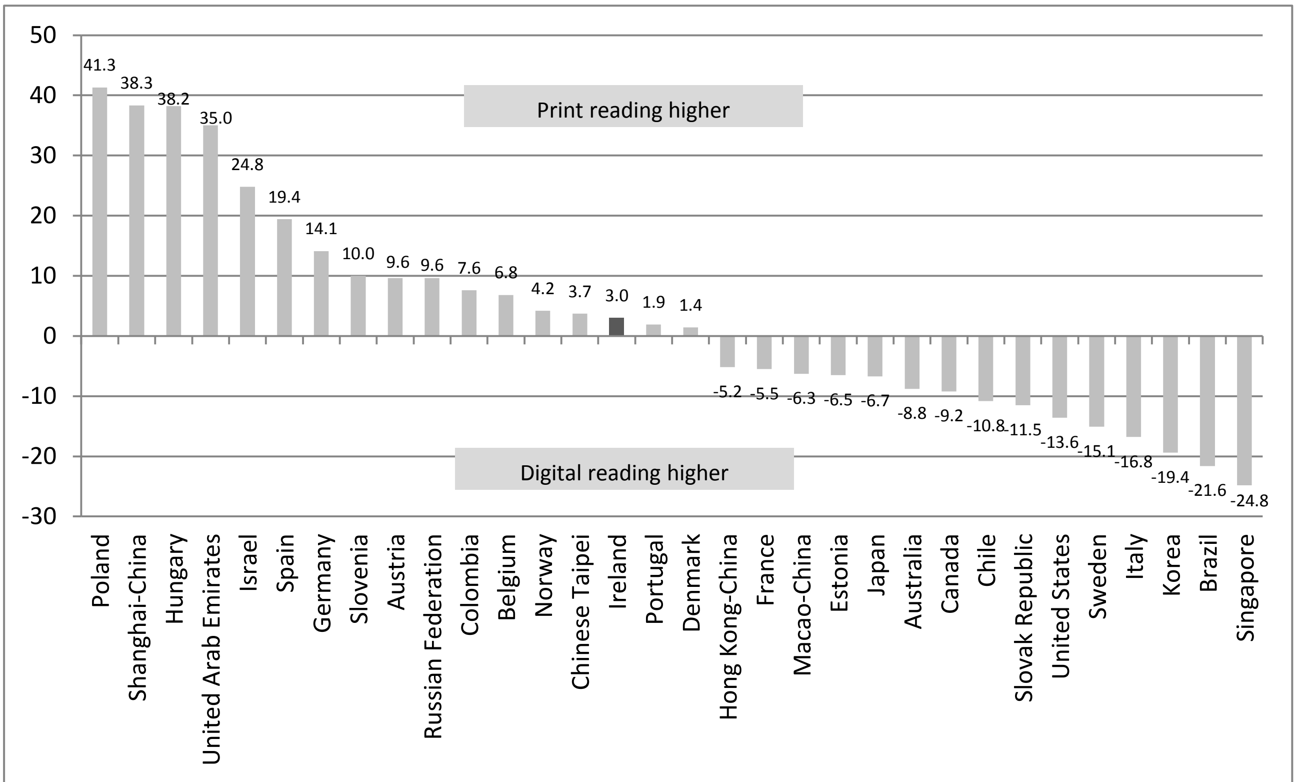
(dark shading)	Significantly above OECD average	▲	Significantly higher than Ireland
(no shading)	At OECD average	O	Not significantly different from Ireland
(light shading)	Significantly below OECD average	▼	Significantly lower than Ireland

The differences between the digital and print reading scores for all countries/economies that participated in both assessments are shown in Figure 4.4 (see Table A4.3 in the *PISA 2012 E-appendix* [www.erc.ie/p12eappendix] for the mean scores, standard deviations and position relative to the Irish means on the digital and print reading assessments for the 32 countries/economies that participated in both assessments). Some variation in the country/economy rankings is evident between the two modes. For example, while Shanghai-China has the highest print reading score, they are ranked 6th on digital reading, and Italy, which is ranked 15th on digital reading and 27th on the print reading scale (or 23rd among the 32 countries/economies that participated in both assessments).

Seventeen countries/economies have higher print reading scores than digital reading scores, while 15 countries/economies achieve higher digital reading than print reading scores. Poland, Shanghai-China, Hungary and the United Arab Emirates score over 35 points higher on the print reading scale than on the digital reading scale, while Brazil and Singapore perform over 20 points lower on print reading compared to digital reading. The OECD average for print reading (based on the 23 OECD countries that participated in both assessments) is higher than the OECD average for digital reading (499.4 and 496.9, respectively).

The difference in the performance of students in Ireland on the digital and print reading assessments is just 3 points and not significant. Of the six countries/economies that do not differ significantly from Ireland in terms of performance on digital reading, only Chinese Taipei also has a print reading score that does not differ significantly from the print reading score for Ireland. Both Italy and Sweden have mean print reading scores that are significantly below the corresponding OECD average but have mean digital reading scores that do not differ significantly from the OECD average for digital reading. On the other hand, Germany and Poland have mean print reading scores that are significantly above the corresponding OECD average; however, the mean digital reading score for Germany does not differ significantly from the OECD average for digital reading, while Poland has a mean digital reading score which is significantly below the corresponding OECD average. Students in the United States have a mean print reading score that does not differ significantly from the corresponding OECD average; however they perform significantly higher relative to the OECD average on digital reading.

Figure 4.4. Differences between digital and print reading scores for all countries/economies that participated in both assessments



Note: See Table A4.3 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean scores, standard deviations and position relative to the Irish means on the digital and print reading assessments for the 32 countries/economies that participated in both assessments

4.6. Variation in Performance on Digital Reading

In Ireland, the difference between the lowest- (5th percentile) and highest- (95th percentile) performing students on digital reading is 272.1 points, which does not differ significantly from the corresponding differences in Korea (257.4 points), the United States (291.7 points) or Shanghai-China (277.2 points), but is significantly smaller than the corresponding average difference across the 23 participating OECD countries (306.8 points; Table 4.6). The difference between the highest and lowest performers in Ireland is also significantly narrower than the differences in France (315.4

points), Germany (320.6 points) and Poland (317.1 points). In Ireland, the difference between the highest- and lowest-performing students on the digital reading assessment is also somewhat narrower than the corresponding difference for print reading (286.1 points).

The score of students at the 10th percentile on the digital reading scale in Ireland does not differ significantly from the corresponding scores in Shanghai-China or the United States, but is significantly below the score of students at the 10th percentile in Korea (Table 4.9). Students performing at the 10th percentile in France, Germany, Poland and on average across 23 OECD countries, perform significantly less well than their counterparts in Ireland. Students at the 90th percentile on the digital reading scale in Ireland perform significantly less well than their counterparts in Shanghai-China or Korea, but significantly outperform their counterparts in Poland and across the 23 participating OECD countries.

In Ireland, there is little difference between the scores of lower- (i.e. at the 10th percentile) achieving students on the digital and print reading assessments (411.6 and 410.2, respectively), while higher-achieving students (i.e. at the 90th percentile) perform less well on digital reading than on print reading (621.6 and 631.5, respectively).

Table 4.6. Scores of students at key percentile markers on the digital reading scale in Ireland, in selected comparison countries/economies and on average across the 23-participating OECD countries

	5th		10th		25th		75th		90th		95th	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Korea	419.9	(5.85)	456.3	(4.35)	507.8	(3.62)	609.0	(4.40)	652.0	(5.05)	677.3	(5.92)
Ireland	374.7	(6.59)	411.6	(5.51)	469.2	(3.66)	577.8	(3.37)	621.6	(3.14)	646.8	(3.68)
United States	357.5	(8.84)	394.0	(8.34)	453.8	(5.81)	573.4	(4.20)	621.0	(4.46)	649.2	(5.09)
France	334.4	(13.14)	384.0	(8.10)	454.5	(4.53)	579.2	(3.60)	624.2	(4.12)	649.8	(5.52)
Germany	318.5	(8.54)	358.2	(7.77)	431.1	(6.09)	563.8	(3.89)	613.0	(4.36)	639.1	(4.43)
Poland	305.2	(8.83)	349.3	(7.28)	416.4	(5.00)	544.9	(4.33)	593.0	(5.02)	622.3	(5.46)
OECD	331.6	(1.72)	372.8	(1.38)	438.0	(0.97)	563.1	(0.78)	611.4	(0.87)	638.4	(0.97)
Shanghai-China	384.5	(7.83)	420.0	(7.06)	477.5	(4.81)	589.9	(3.81)	635.4	(4.74)	661.7	(4.87)

4.7. Performance on Digital Reading Proficiency Levels

Student performance on digital reading is also described in terms of proficiency. Because a smaller number of items were used to assess students' digital reading than print reading, there is no description of tasks that students are likely to accomplish in digital reading below Level 2; nor for Level 6. However, as with print reading, Level 2 is considered by the OECD as the baseline level of digital reading proficiency that is required to participate fully in society and future learning. A description of the kind of skills and competencies that students at each of the proficiency levels can perform is presented in Table 4.7.

Table 4.7: Descriptions of the five levels of proficiency on the digital reading scale and percentages of students achieving each level in Ireland and on average across the 23-participating OECD countries

Level *(Cut-point)*	Students at this level are capable of:	OECD		Ireland	
		%	SE	%	SE
5 *(626 or above)*	Critically evaluating information from several web-based sources using criteria that they have generated themselves. They are also able to navigate across multiple sites without explicit direction, allowing them to locate information efficiently. Students at this level can be regarded as 'top performers' in digital reading.	8.0	(0.2)	9.0	(0.7)
4 *(553 to 625)*	Judging the authority and relevance of sources of information when provided with support. They can locate and synthesise information from several sites when this requires a low-level of inference. They are also capable of dealing with a range of text formats and types and can compare and contrast information from different sites and form opinions about what they read by drawing on information from their everyday life. Students at this level are considered to be able to perform challenging digital reading tasks.	22.1	(0.2)	26.8	(1.0)
3 *(480 to 552)*	Responding to digital tests in both authored and message-based environments. They are able to locate information across several pages and compare and contrast information from a number of texts when given explicit guidance. They evaluate information in terms of its usefulness for a specified purpose or in terms of personal preference. They can be considered able to perform moderately complex digital reading tasks.	29.9	(0.2)	34.9	(0.8)
2 *(407 to 479)*	Using conventional navigation tools to locate information when given explicit instructions. They can perform tasks such as selecting relevant information from search results or drop down menu, locating and transferring information from one text to another and form generalisations (e.g. recognising the intended audience of a website).	22.5	(0.2)	19.8	(0.9)
Below Level 2 *(406 or below)*	The performance of students at this level cannot be described. Students performing below Level 2 lack basic digital reading skills.	17.6	(0.3)	9.4	(0.9)

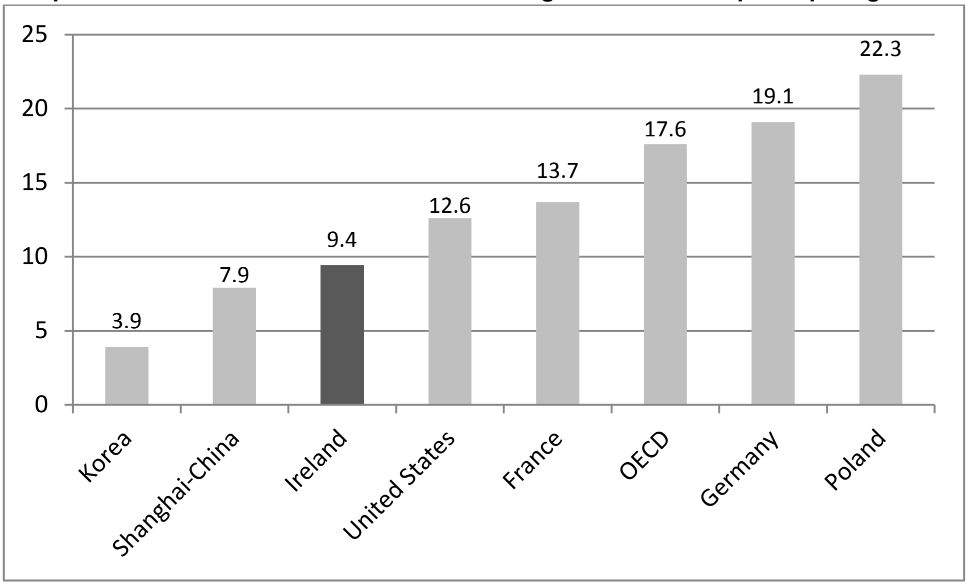
Source: OECD, 2011.

The percentages of students scoring below proficiency level 2 on the digital reading scale for Ireland, the 23 OECD average and comparison countries/economies are presented in Figure 4.5. In Ireland, 9.4% of students perform below Level 2, which is similar to the corresponding proportion in Shanghai-China (7.9%), but is considerably lower than the OECD average (17.6%) and the proportions in Germany (19.1%) and Poland (22.3%). In Korea, just 3.9% of students have a score below Level 2 on the digital reading scale

Figure 4.6 shows the percentages of students scoring at or above proficiency level 5 on the digital reading scale for Ireland, the 23 OECD average and comparison countries/economies. The proportion of higher-achieving students (at or above Level 5) on the digital reading scale in Ireland (9.0%) is similar to the OECD average (8.0%) and the proportions in the United States (9.1%), France (9.7%) and Germany (7.4%) but is almost double the corresponding proportion in Poland (4.6%). The proportion of higher-achieving students in Ireland is more than half the corresponding percentage in Korea (18.2%).

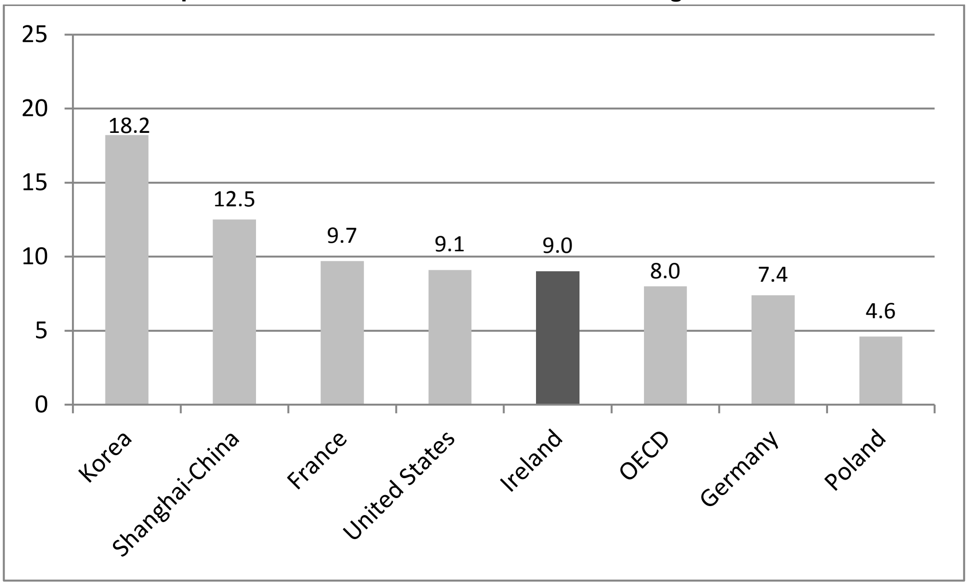
In Ireland, the proportions of lower-achieving students (i.e. below Level 2) on digital and print reading are similar (9.4% and 9.6%, respectively); while the proportion of higher-achieving students (i.e. at or above Level 5) is slightly lower for digital reading (9.0%) than for print reading (11.4%).

Figure 4.5. Percentages of students performing below Level 2 on the digital reading scale in Ireland, in selected comparison countries/economies and on average across the 23-participating OECD countries



Note: See Table A4.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the digital reading scale, in selected comparison countries and on average across the 23-participating OECD countries

Figure 4.6. Percentages of students performing at or above Level 5 on the digital reading scale in Ireland, in selected comparison countries/economies and on average across OECD countries



Note: See Table A4.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the digital reading scale, in selected comparison countries and on average across the 23-participating OECD countries

4.8. Gender Differences on Digital Reading

Female students significantly outperform males on the digital reading assessment in Ireland and on average across OECD countries (Table 4.8). Of the comparison countries/economies presented in Table 4.8, only Korea does not have a significant gender difference on digital reading. The size of the difference between male and female students in Ireland (25.3 points) does not differ significantly from the OECD average gender difference (26.0 points) or the differences in the United States (28.3 points), France (22.4 points), Germany (29.5 points) and Poland (34.0 points). The gender differences in Korea and Shanghai-China are significantly smaller than in Ireland. In Ireland, the gender difference for digital reading is slightly narrower than for print reading (25.3 points and 28.5 points, respectively).

Male students in Ireland do not differ significantly from males in the United States or France but perform significantly less well than their counterpoints in Shanghai-China and Korea. Male students in Germany, Poland and on average across the 23 OECD countries perform significantly less well than male students in Ireland.

Female students in Ireland do not differ from their counterparts in the United States and Shanghai-China on the digital reading scale, but they have a significantly higher mean score than female students in France, Germany and Poland and the average score for female students across the 23 OECD countries. Of the comparison countries/economies, only female students in Korea significantly outperform their Irish counterparts.

In Ireland, both male and female students achieve higher mean scores on print than digital reading, although the differences are small (4.7 points for females and 1.5 points for males).

Table 4.8. Gender differences on the digital reading scale in Ireland, in selected comparison countries/economies and on average across the 23-participating OECD countries

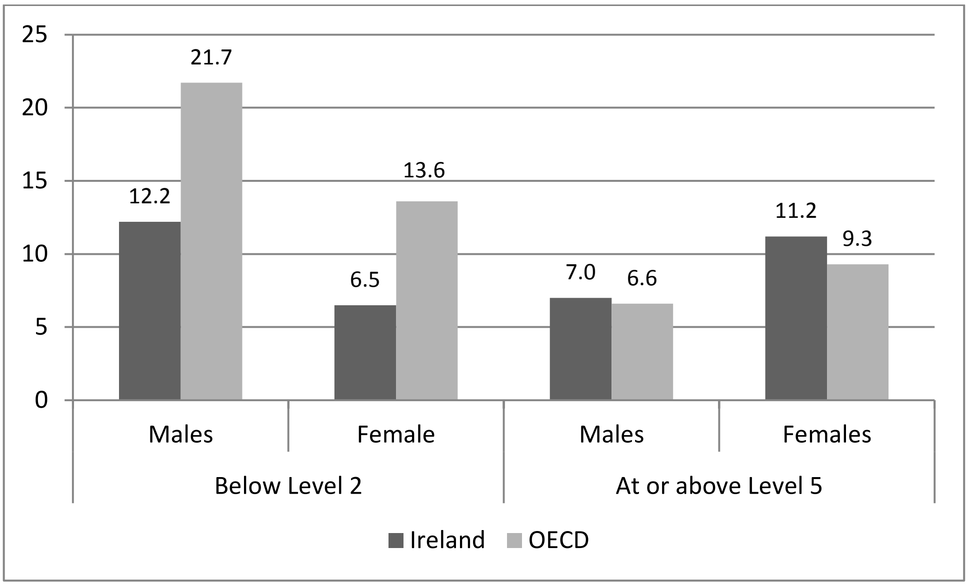
	Males		Females		Difference (Males-Females)	
	Mean	SE	Mean	SE	Score diff	SE
Korea	551.8	(4.79)	559.0	(3.92)	-7.2	(5.07)
Ireland	507.7	(3.96)	533.0	(3.29)	**-25.3**	(4.31)
United States	497.3	(4.83)	525.6	(4.52)	**-28.3**	(2.55)
France	499.4	(4.05)	521.8	(3.97)	**-22.4**	(3.64)
Germany	479.0	(4.35)	508.6	(4.06)	**-29.5**	(2.95)
Poland	459.5	(4.72)	493.4	(4.73)	**-34.0**	(3.42)
OECD	484.0	(0.90)	510.0	(0.80)	**-26.0**	(0.83)
Shanghai-China	526.0	(4.27)	536.3	(3.66)	**-10.2**	(2.84)

Note: Significant differences are in bold

Figure 4.7 presents the percentages of male and female students scoring below proficiency level 2 and at or above proficiency level 5 on the digital reading scale, for Ireland and the OECD average. In Ireland, the proportion of male students performing below Level 2 on the digital reading scale is almost double the proportion of female students (12.2% compared to 6.5%). The proportion of male students performing below Level 2 in Ireland is considerably smaller than the corresponding proportion across OECD countries (12.2% and 21.7%, respectively). Similarly, the percentage of female students in Ireland performing below Level 2 is less than half the corresponding percentage across OECD countries (6.5% and 13.6%, respectively).

The proportion of higher-achieving males (i.e. at or above Level 5) in Ireland is somewhat below the corresponding proportion of female students (7.0% and 11.2%, respectively), but is similar to the average proportion of higher-achieving male students across the 23 OECD countries (6.6%). The percentage of female students performing at or above Level 5 in Ireland is somewhat higher than the corresponding 23-country OECD average percentage (9.3%).

Figure 4.7. Percentages of male and female students achieving below proficiency level 2 and at or above proficiency level 5 on digital reading scale in Ireland and on average across the 23-participating OECD countries



Note: See Table A4.5 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of male and female students (and standard errors) at each proficiency level on the digital reading scale in Ireland, in selected comparison countries and on average across the 23-participating OECD countries

In Ireland, the proportion of lower- (i.e. below Level 2) and higher- (i.e. at or above Level 5) achieving male and female students for digital reading is similar to the corresponding proportions for print reading, although there are slightly more higher-achieving male (+1.6%) and female (+3.2%) students on the print reading assessment.

4.9. Overall Performance on Science

Ireland's mean score for science is 522.0, which is significantly above the OECD average of 501.2. Ireland's score is ranked 9th among 34 OECD countries, and 15th among all 64 participating countries/economies (Table 4.9). Applying a 95% confidence interval, which takes account of measurement and sampling error, Ireland's true rank on the science scale is between 6th and 11th among OECD countries, and between 10th and 18th among all participating countries/economies.

Seven countries/economies, including Shanghai-China, Hong Kong-China, Singapore, Japan, Finland, Estonia and Korea, have a mean score that is significantly above the mean score for Ireland. Ireland's mean score does not differ from that of twelve countries/economies, including eight OECD countries. The remaining 45 countries, including 21 OECD countries, perform significantly less well than Ireland on the science scale.

The mean science score for Northern Ireland is 507.2, which is slightly above the corresponding OECD average score but is significantly lower than the mean score for Ireland.

Table 4.9. Mean country/economy scores, standard deviations and standard errors for the science scale and positions relative to the OECD and Irish means, for all participating countries/economies

	Mean	SE	SD	SE	IRL		Mean	SE	SD	SE	IRL
Shanghai-China	580.1	(3.03)	82.0	(1.82)	▲	*Croatia*	491.4	(3.10)	85.5	(1.82)	▼
Hong Kong-China	554.9	(2.61)	83.5	(1.83)	▲	Luxembourg	491.2	(1.30)	103.2	(0.95)	▼
Singapore	551.5	(1.51)	104.2	(1.23)	▲	Portugal	489.3	(3.75)	88.8	(1.63)	▼
Japan	546.7	(3.60)	95.5	(2.23)	▲	*Russian Fed.*	486.3	(2.85)	84.9	(1.33)	▼
Finland	545.4	(2.20)	93.0	(1.16)	▲	Sweden	484.8	(3.00)	99.7	(1.54)	▼
Estonia	541.4	(1.95)	80.2	(1.12)	▲	Iceland	478.2	(2.12)	99.3	(1.52)	▼
Korea	537.8	(3.66)	81.9	(1.80)	▲	Slovak Republic	471.2	(3.61)	101.2	(2.83)	▼
Vietnam	528.4	(4.31)	77.4	(2.31)	O	Israel	470.1	(4.96)	107.7	(2.13)	▼
Poland	525.8	(3.12)	86.3	(1.54)	O	Greece	466.7	(3.12)	88.4	(1.45)	▼
Canada	525.5	(1.93)	91.0	(0.87)	O	Turkey	463.4	(3.89)	79.9	(1.85)	▼
Liechtenstein	524.7	(3.55)	85.5	(4.08)	O	*UAE*	448.4	(2.81)	93.8	(1.14)	▼
Germany	524.1	(2.96)	95.2	(1.97)	O	*Bulgaria*	446.5	(4.78)	102.2	(2.45)	▼
Chinese Taipei	523.3	(2.33)	83.0	(1.40)	O	Chile	444.9	(2.86)	80.3	(1.47)	▼
Netherlands	522.1	(3.51)	95.2	(2.18)	O	*Serbia*	444.8	(3.40)	87.2	(1.94)	▼
Ireland	522.0	(2.45)	91.3	(1.58)		*Thailand*	444.0	(2.93)	76.4	(1.67)	▼
Australia	521.5	(1.76)	100.4	(1.01)	O	*Romania*	438.8	(3.25)	78.7	(1.95)	▼
Macao-China	520.6	(0.85)	78.8	(0.70)	O	*Cyprus*	437.7	(1.18)	96.7	(1.07)	▼
New Zealand	515.6	(2.14)	104.9	(1.40)	O	*Costa Rica*	429.4	(2.94)	70.5	(1.59)	▼
Switzerland	515.3	(2.71)	90.9	(1.13)	O	*Kazakhstan*	424.7	(2.97)	74.1	(1.51)	▼
Slovenia	514.1	(1.29)	90.7	(1.15)	▼	*Malaysia*	419.5	(3.00)	78.6	(1.43)	▼
United Kingdom	514.1	(3.38)	99.8	(1.84)	O	*Uruguay*	415.8	(2.77)	95.3	(1.71)	▼
Czech Republic	508.3	(2.96)	90.6	(2.07)	▼	Mexico	414.9	(1.31)	70.7	(0.89)	▼
Austria	505.8	(2.70)	92.2	(1.60)	▼	*Montenegro*	410.1	(1.07)	84.5	(0.98)	▼
Belgium	505.5	(2.09)	101.5	(1.39)	▼	*Jordan*	409.4	(3.12)	82.8	(2.05)	▼
Latvia	502.2	(2.75)	78.7	(1.35)	▼	*Argentina*	405.6	(3.88)	86.0	(2.16)	▼
France	499.0	(2.58)	100.1	(2.21)	▼	*Brazil*	404.7	(2.14)	78.5	(1.37)	▼
Denmark	498.5	(2.74)	92.7	(1.73)	▼	*Colombia*	398.7	(3.05)	76.4	(1.57)	▼
United States	497.4	(3.78)	93.9	(1.48)	▼	*Tunisia*	398.0	(3.46)	78.7	(1.95)	▼
Spain	496.4	(1.83)	86.3	(0.90)	▼	*Albania*	397.4	(2.44)	98.7	(1.80)	▼
Lithuania	495.7	(2.55)	85.8	(1.75)	▼	*Qatar*	383.6	(0.75)	106.5	(0.68)	▼
Norway	494.5	(3.09)	99.7	(1.87)	▼	*Indonesia*	381.9	(3.82)	68.3	(2.33)	▼
Hungary	494.3	(2.95)	90.2	(1.86)	▼	*Peru*	373.1	(3.58)	78.2	(1.88)	▼
Italy	493.5	(1.94)	93.0	(1.08)	▼	OECD Average	501.2	(0.49)	92.8	(0.28)	

(dark)	Significantly above OECD average	▲	Significantly higher than Ireland
(white)	At OECD average	O	Not significantly different from Ireland
(light grey)	Significantly below OECD average	▼	Significantly lower than Ireland

Note: OECD countries are in regular font, partner countries/economies are in italics.

4.10. Variation in Performance on Science

The standard deviation for science, which measures the spread of achievement scores, is about the same in Ireland as it is on average across OECD countries (91.3 and 92.8, respectively). There is considerable variation in the standard deviation among the five highest performing countries/ economies, ranging from 82.0 in Shanghai-China to 104.2 in Singapore. The standard deviation for science performance in Northern Ireland is 100.7, which is larger than the standard deviations for Ireland and for the OECD average.

Mean science scores achieved by students at key percentile markers, for Ireland, the OECD average and selected comparison countries/economies are presented in Table 4.10. The difference between the mean scores of students at 5th and 95th percentiles in Ireland is 300.2 score points, which is not significantly different from the OECD average differences of 304.5 points. The difference in Ireland does not differ significantly either from the differences in Finland (306.2 points), Poland (286.4 points), Germany (309.8 points) and the United States (308.5 points). The differences in Shanghai-China (268.9 points) and Korea (268.1 points) are significantly greater than the difference in Ireland, while New Zealand (343.4 points), the United Kingdom (327.5 points), France (327.9 points) and Northern Ireland (330.6 points) have significantly larger differences compared to Ireland.

Table 4.10. Scores of students at key percentile markers on the science scale in Ireland, in selected comparison countries/economies and on average across OECD countries

	5th		10th		25th		75th		90th		95th	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Finland	385.9	(5.66)	424.1	(3.94)	485.7	(2.83)	609.0	(2.43)	661.9	(2.88)	692.1	(2.65)
Korea	396.0	(6.30)	430.7	(4.88)	484.9	(4.00)	595.0	(4.11)	638.9	(4.28)	664.1	(5.29)
Poland	382.1	(4.65)	414.9	(3.99)	467.1	(3.29)	584.4	(4.04)	637.4	(4.98)	668.5	(4.89)
Germany	361.2	(5.60)	397.2	(4.80)	461.2	(3.84)	592.2	(3.09)	642.2	(3.92)	671.0	(3.67)
Ireland	366.2	(5.78)	403.9	(4.79)	462.0	(3.12)	586.0	(2.40)	636.6	(2.58)	666.4	(3.41)
New Zealand	339.1	(4.50)	377.1	(4.45)	443.9	(3.04)	590.6	(3.10)	649.4	(3.05)	682.5	(3.88)
United Kingdom	344.1	(5.76)	384.2	(4.95)	448.3	(4.60)	584.3	(3.53)	639.1	(3.85)	671.6	(4.98)
France	323.4	(7.84)	366.2	(6.01)	433.4	(3.38)	570.1	(2.97)	622.0	(4.07)	651.3	(4.67)
United States	343.7	(5.41)	377.3	(4.93)	431.2	(4.43)	562.7	(4.22)	619.1	(4.49)	652.2	(5.54)
OECD	344.0	(0.93)	379.8	(0.77)	438.9	(0.63)	566.3	(0.57)	618.8	(0.64)	648.4	(0.70)
Shanghai -China	435.1	(6.15)	471.7	(5.38)	526.6	(3.72)	638.8	(3.24)	680.7	(3.24)	704.0	(3.28)
Northern Ireland	338.4	(7.58)	374.7	(7.32)	438.1	(5.17)	577.9	(5.18)	635.2	(6.51)	669.0	(7.37)

At each percentile marker, Ireland's score is higher than the corresponding OECD average score. At both the 10th and 90th percentiles, students in Ireland achieve science scores that are significantly higher than on average across OECD countries (403.9 compared to 379.8 at the 10th percentile, and 636.6 compared to 618.8 at the 90th percentile). Students at the 10th percentile in Shanghai-China, Finland and Korea significantly outperform those at the 10th percentile in Ireland, while the corresponding students in New Zealand, the United Kingdom, France, the United States and Northern Ireland perform significantly less well than in Ireland. At the 90th percentile, students in Ireland perform significantly less well than their counterparts in Shanghai-China, Finland and New Zealand, but do not differ significantly from those in Korea, Poland, Germany, the United Kingdom and Northern Ireland.

4.11. Performance on Science Proficiency Levels

Six proficiency levels are described for science and the skills and competencies that students at each of these levels are expected to demonstrate are presented in Table 4.11. As with reading and mathematics, Level 2 is considered by the OECD as the baseline levels of proficiency needed to participate actively in scientific and technological situations. In Ireland, 11.1% of students achieved a science score below Level 2, which is considerably below the corresponding OECD average of 17.8%. The percentage of lower-performing students in Ireland is also considerably below the corresponding proportions in the United Kingdom, New Zealand, Northern Ireland, the United States and France, but is higher than the percentages in Shanghai-China, Korea, Finland and Poland (Figure 4.8).

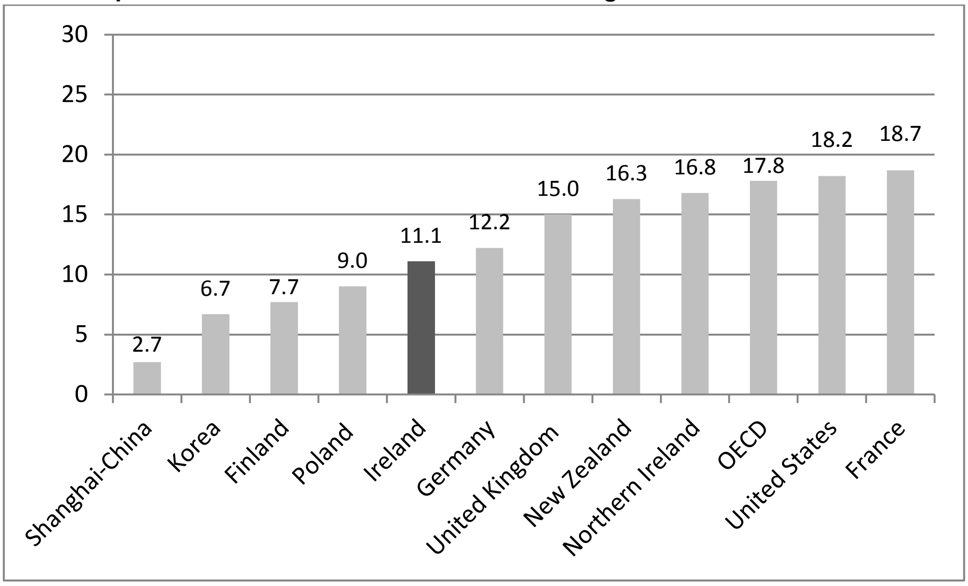
Table 4.11. Descriptions of the six levels of proficiency on the science scale and percentages of students achieving each level in Ireland and on average across OECD countries

Level *(Cut-point)*	Students at this level are capable of:	OECD		Ireland	
		%	SE	%	SE
6 *(>708)*	Consistently identifying, explaining and applying scientific knowledge and knowledge about science in a variety of complex life situations; using evidence from different sources to justify decisions and using advanced scientific thinking and reasoning to solve problems in unfamiliar scientific and technological situations.	1.2	(0.04)	1.5	(0.25)
5 *(>633 to ≤708)*	Identifying scientific components; applying both scientific concepts and *knowledge about science* to complex life situations; linking knowledge appropriately; bringing critical insights to situations; constructing evidence-based explanations.	7.2	(0.10)	9.3	(0.63)
4 *(>559 to ≤633)*	Using non-complex situations to make inferences about the role of science or technology; selecting and integrating explanations from different disciplines and applying them directly; reflecting on their actions and communicating decisions using scientific knowledge and evidence.	20.5	(0.15)	25.0	(0.94)
3 *(>484 to ≤559)*	Identifying clearly described scientific issues in a range of contexts; interpreting and using scientific concepts from different disciplines and applying them directly; developing short statements using facts and making decisions based on scientific knowledge.	28.8	(0.17)	31.1	(1.03)
2 *(>409 to ≤484)*	Providing possible explanations in familiar contexts; drawing conclusions based on simple investigations; engaging in direct reasoning and making literal interpretations of the results of scientific inquiry. Level 2 can be considered the basic level of proficiency needed to participate actively in scientific and technological situations.	24.5	(0.16)	22.0	(1.15)
1 *(>335 to ≤409)*	Applying a limited store of scientific knowledge to a few, familiar situations; and presenting scientific explanations that are obvious and follow explicitly from given evidence.	13.0	(0.14)	8.5	(0.76)
Below Level 1 *(≤335)*	Students at this level have a less than 50% chance of responding correctly to Level 1 tasks. Scientific literacy at this level is not assessed by PISA.	4.8	(0.09)	2.6	(0.40)

Source: OECD (2013b)

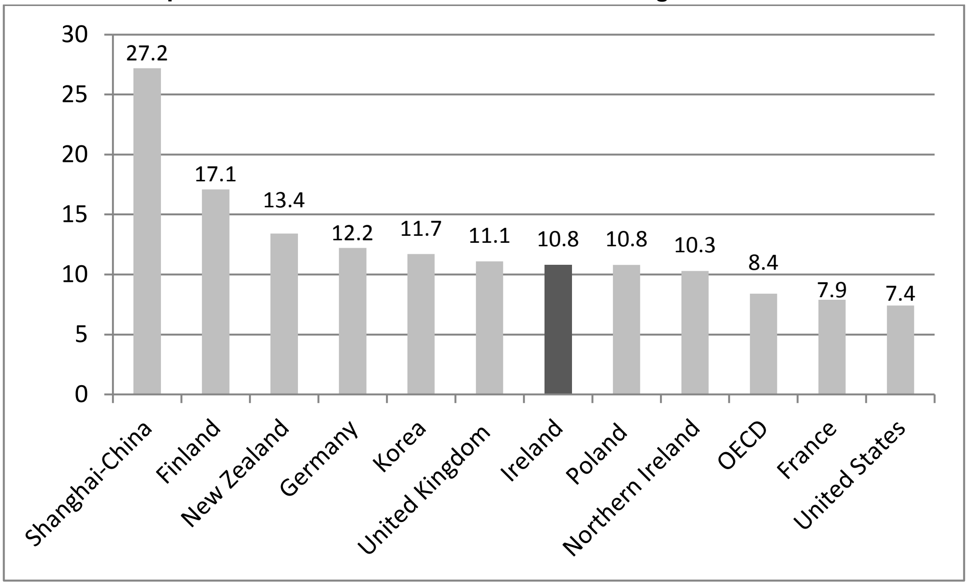
On the other hand, 10.8% of students in Ireland score at or above Level 5 on the science scale, which is similar to the corresponding OECD average of 8.4% and the percentages in Korea, the United Kingdom, Poland and Northern Ireland (Figure 4.9). Shanghai-China and Finland have considerably higher proportions of students scoring at Level 5 or above compared to Ireland, while France and the United States have somewhat lower proportions.

Figure 4.8. Percentage of students performing below Level 2 on the science scale in Ireland, in selected comparison countries/economies and on average across OECD countries



Note: See Table A4.6 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the print reading scale, in selected comparison countries and on average across OECD countries

Figure 4.9. Percentage of students performing at or above Level 5 on the science scale in Ireland, in selected comparison countries/economies and on average across OECD countries



Note: See Table A4.6 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of students (and standard errors) at each proficiency level in Ireland on the print reading scale, in selected comparison countries and on average across OECD countries

4.12. Gender Differences on Science

In Ireland, the mean science score of male students is marginally higher than, although not significantly different from, the mean score for female students (Table 4.12). The difference in science achievement between males and females across all OECD countries, though small, is narrower than in Ireland (1.3 points compared to 3.9 points), and is statistically significant. The difference in achievement between male and female students is also significant in Finland (in favour of female students) and the United Kingdom (in favour of male students). The size of the gender difference in Ireland does not differ significantly from that in any of the comparison countries/

economies, with the exception of Finland, which has a significantly larger gender difference than Ireland.

The mean science scores of both male and female students in Ireland are significantly higher than the corresponding OECD average scores. Both male and female students in Ireland perform significantly less well than their counterparts in Shanghai-China, Finland and Korea, but significantly outperform their counterparts in France and the United States. While male students in Ireland do not differ significantly in terms of science performance from males in the United Kingdom and Northern Ireland, female students in Ireland significantly outperform their counterparts in both Northern Ireland and the United Kingdom.

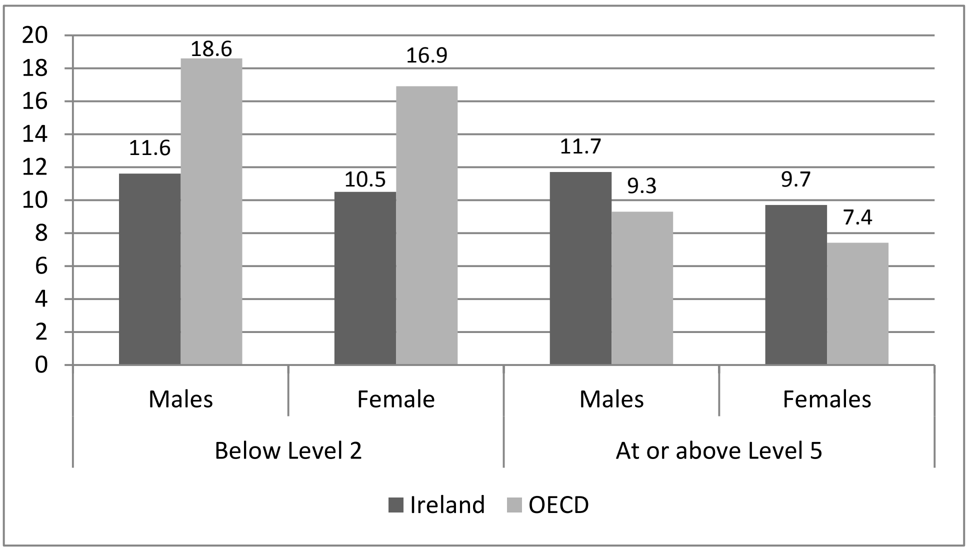
Table 4.12. Gender differences on the science scale in Ireland, in selected comparison countries/economies and on average across OECD countries

	Males		Females		Difference (Males-Females)	
	Mean	SE	Mean	SE	Score diff	SE
Finland	537.4	(2.98)	553.9	(2.28)	**-16.5**	(3.03)
Korea	539.4	(4.66)	535.9	(4.21)	3.5	(5.11)
Poland	524.4	(3.73)	527.1	(3.19)	-2.7	(3.03)
Germany	523.9	(3.10)	524.4	(3.52)	-0.5	(2.97)
Ireland	523.9	(3.45)	520.0	(3.14)	3.9	(4.41)
New Zealand	517.9	(3.19)	513.3	(3.33)	4.6	(4.90)
United Kingdom	520.6	(4.47)	507.9	(3.68)	**12.7**	(4.68)
France	497.7	(3.82)	500.2	(2.42)	-2.4	(3.73)
United States	496.5	(4.05)	498.3	(3.95)	-1.8	(2.68)
OECD	501.8	(0.62)	500.5	(0.53)	**1.3**	(0.62)
Shanghai-China	582.5	(3.52)	577.8	(3.14)	4.7	(2.73)
Northern Ireland	509.8	(6.25)	504.4	(5.80)	5.4	(9.18)

Note: Significant differences are in bold

In Ireland, the proportions of male and female students that score below Level 2 on the science scale are similar (11.6% and 10.5%, respectively) and significantly below the corresponding OECD average proportions (18.6% for males and 16.9% for females; Figure 4.10). On the other hand, slightly more male than female students in Ireland achieve a science score at or above Level 5 (11.7% and 9.7%, respectively). The proportions of male and female students performing at Level 5 or above in Ireland are higher than, but do not differ significantly from, the corresponding OECD averages (9.3% for males and 7.4% for females).

Figure 4.10. Percentages of male and female students achieving below proficiency level 2 and at or above proficiency level 5 on the science scale in Ireland and on average across OECD countries



Note: See Table A4.7 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for percentages of male and female students (and standard errors) at each proficiency level on the digital reading scale in Ireland, in selected comparison countries and on average across the 23-participating OECD countries

4.13. Summary

Print reading, digital reading and science were all minor assessment domains in PISA 2012. The mean score for Ireland on the print reading scale is 523.2, which is significantly above the corresponding OECD average (496.5). Other countries with similar mean print reading performance to Ireland's include Finland (524.0), Canada (523.1) and Poland (518.2). Students in Ireland significantly outperformed their counterparts in Northern Ireland, who have a mean score of 497.6 on print reading. In Ireland, students scoring at the 10th and 90th percentiles on the print reading scale have significantly higher scores than the corresponding averages across OECD countries (410.2 compared to 371.7 at the 10th percentile and 631.5 compared to 613.5 at the 90th percentile).

Fewer than 10% of students in Ireland perform below Level 2 on the assessment of print reading, compared to 18.0% across OECD countries. Ireland also has a somewhat higher proportion of students at or above Level 5 on the print reading scale compared to the OECD average (11.4% and 8.5%, respectively).

Female students significantly outperformed male students on the print reading scale, in Ireland (537.7 and 509.2, respectively) and on average across OECD countries (515.4 for females and 477.8 for males). Both male and female students in Ireland have significantly higher mean print reading scores than do students on average across OECD countries, although the difference is somewhat larger for males (+31.4 points) than for females (+22.3 points). In Ireland, over twice as many male as female students obtain print reading scores that are below proficiency Level 2 (13.0% compared to 6.0%), while the proportion of female students who have a print reading score at or above Level 5 is considerably larger than the corresponding proportion of male students (14.4% and 8.6%, respectively).

The performance of students in Ireland on the assessment of digital reading does not differ significantly from their performance on the print reading assessment (520.1 and 523.2, respectively). Ireland's mean score on the assessment of digital reading is significantly above the corresponding

23-country OECD average (496.9). As with mathematics, there is considerable variation in the performance of countries/economies on the print and digital assessments of reading (i.e. 17 countries/economies obtain significantly higher print reading than digital reading scores, while 15 countries/economies achieve significantly higher digital reading than print reading scores).

In Ireland, there is little difference between the scores of students at the 10th percentile on the digital and print reading assessments (411.6 and 410.2, respectively), while students at the 90 percentile performed less well on digital reading (621.6) than on print reading (631.5). Students at both the 10th and 90th percentiles in Ireland have significantly higher digital reading scores than the averages across the 23 OECD countries (372.8 at the 10th percentile and 611.4 at the 90th percentile).

The proportion of students below Level 2 on the digital reading assessment is similar to the corresponding proportion for print reading in Ireland (9.4% and 9.6%, respectively) but is considerably below the 23-country OECD average (17.6%). On the other hand, there are slightly fewer students at or above Level 5 on the assessment of digital reading compared to print reading in Ireland (9.0% compared to 11.4%). The proportion of students at or above Level 5 on the digital reading assessment in Ireland is similar to the 23-country OECD average (8.0%).

As with print reading, female students outperform male students on the assessment of digital reading, both in Ireland and on average across OECD countries. The size of the gender difference in Ireland is smaller for digital (25.3 points) than for print reading (28.5 points). Male students in Ireland have a significantly higher mean score on digital reading than male students on average across OECD countries (507.7 and 484.0, respectively). A similar outcome is evident for females (533.0 for Ireland and 510.0 on average across OECD countries). In Ireland, there are almost twice as many male students as female students performing below Level 2 on the digital reading assessment (12.2% compared to 6.5%), while there are fewer males than females scoring at or above Level 5 on this scale (7.0% and 11.2%, respectively).

Ireland’s mean science score is 522.0, which is also significantly above the corresponding OECD average (501.2). Ireland’s performance on the science assessment is similar to the performance of students in Poland (525.8), Germany (524.1), New Zealand (515.6) and the United Kingdom (514.1) but is significantly higher than in Northern Ireland (507.2). At both the 10th and 90th percentiles, students in Ireland have mean science scores that are significantly higher than on average across OECD countries (403.9 and 379.8 at the 10th percentile, and 636.6 and 618.8 at the 90th percentile).

Approximately one in nine students in Ireland (11%) is performing below Level 2 on the science scale, which is considerably lower than the corresponding OECD average (17.8%). The proportion of students at or above Level 5 in Ireland is slightly above the corresponding OECD average (10.8% and 8.4%, respectively). There is no significant difference between male and female students in Ireland in terms of science performance (523.9 and 520.0, respectively), while there is a significant gender difference in favour of males across OECD countries (1.3 points). The mean science scores of both male and female students in Ireland are significantly higher than the corresponding OECD average scores (501.8 for males and 500.5 for females). The proportions of male and female students performing below Level 2 on the science scale are similar in Ireland (11.6 and 10.5, respectively), while slightly more male than female students obtain science scores at or above Level 5 (11.7% and 9.7, respectively).

5. Student- and School-level Associations with Achievement

Chapters 3 and 4 provide a detailed analysis of the achievement of students in Ireland on mathematics (print and computer-based), reading (print and digital) and science. The purpose of this chapter is to examine the context of those achievement results with reference to a range of school and student factors. As mathematics is the major assessment domain in PISA 2012, results for print and computer-based mathematics are reported throughout this chapter, with some references to the other domains. Further information on contextual factors associated with print and digital reading and with science can be found in the *PISA 2012 E-appendix,* available at www.erc.ie/p12eappendix. Where appropriate, comparisons with the OECD average and with other countries in PISA 2012 are drawn.

Box 5.1 Student Characteristics Examined in Chapter 5

Student social and home background

Economic Social and Cultural Status (ESCS)

- *Parental occupation*
- *Parental education*
- *Cultural possessions*
- *Material possessions*
- *Home educational resources*
- *Number of books in the home*

Family structure

Immigrant and language status

Membership of the Traveller community*

Time spent in paid work during term time*

*Parental interaction**

Student educational background

Preschool attendance

Grade level

Student participation in education

Leaving Certificate syllabus level*

Early school-leaving risk*

Absence from school and lateness

Note: Variables in *italics* are continuous and the others are categorical.
* Variable is nationally-derived

Box 5.2. A Note on the Analyses

Bivariate analysis examines the relationship between two variables, and most of the analyses presented in this chapter are of the relationship between academic achievement and another variable related to student personal or school background. These analyses are useful for identifying patterns in the data but do not account for mediating factors. For example, there may be differences in achievement between students attending fee-paying and non-fee-paying schools, but these could relate to differences in family socio-economic status rather than the type of school students attend, or some other variables which have not been considered. Bivariate analysis is less powerful than multivariate analysis, which can take the combined impact of several variables into account.

The student and school variables analysed are either categorical or continuous. Categorical variables describe discrete groups, such as student gender or grade level. Continuous variables are on a scale with equal differences between the units and are either ratio, like the number of books in the home where zero means there are no books, or interval, where zero is just another point on the scale. Interval scales have been constructed as composites of a series of related questions and have been standardised so that 0 is the mean across all OECD countries and the standard deviation is 1, unless otherwise stated.

Differences in achievement between groups are analysed by comparing each group's mean score with that of a designated reference group. For continuous variables, correlations are calculated based on 80 degrees of freedom (the number of variance strata in the BRR variance estimation method used in PISA). It is important to note that a significant correlation between two variables does not imply a direct causal relationship. Furthermore, not all significant correlations indicate a strong relationship; owing to the large sample in PISA and to the small standard error in calculations, even weak correlations can be significant. In this report, strong correlations are $r>\pm.56$, moderate-to-strong are in the range $r=\pm.41$ to $r=\pm.55$, moderate between $r=\pm.26$ and $r=\pm.40$, weak-to-moderate between $=\pm.11$ and $r=\pm.25$, and weak correlations $r<\pm.10$ (Cosgrove et al., 2005). Unless otherwise stated, significant differences are at the $p\leq.05$ level of probability.

5.1. Student Characteristics

Students were asked questions about their family and personal circumstances, including questions on their participation in education (see Box 5.1). The characteristics reported in this section are those which have previously been found to have a significant bearing on achievement and which are relevant to policy development. All of the information reported in this section is based on the responses of students themselves. In the context of an international comparative study, cultural differences, for example in how material possessions in the home are valued, may influence the patterns of responses.

5.1.1. Student Social and Home Background

Socio-economic status (SES) is consistently related to achievement in PISA. PISA's index of SES is called Economic, Social, and Cultural Status (ESCS). This section reports on this index and on the demographic variables of family structure, immigrant and language status, and membership of the Traveller community, as well as on aspects of students' lifestyles including interaction with their parents and engagement in paid employment.

Economic, Social, and Cultural Status (ESCS)

ESCS is derived from six variables including parents' education, parents' occupation, cultural possessions; material possessions, home educational resources and the number of books available in the home (see Table 5.1). An index of parental occupation is generated from students' descriptions of their parents' occupations and types of work, which are coded according to the International Standard Classification of Occupation index (ISCO)[36] to give scores on the International Socio-Economic Index (ISEI), with the higher of the two scores used for two-parent families. Similarly, parental education is indexed based on students' reports of their parents' highest level of

[36] www.ilo.org/public/english/bureau/stat/isco

educational attainment and qualifications converted to years of education. Home educational resources about which students were asked include a desk, a quiet place to study, access to reference books, a dictionary, other books to help with schoolwork, and the use of a computer with educational software. Cultural possessions include classic literature, poetry books, and works of art. The material (wealth) items were a student's own bedroom, internet access, a dishwasher, a DVD player, the number of mobile phones, televisions, computer, cars, and bathrooms. Three nationally-specific items were also included to measure students' level of material possessions. In Ireland, these were a flat-screen television, a bedroom with an en-suite bathroom, and a premium cable television package. Finally, students were asked to estimate the number of books in their home, excluding magazines, newspapers, and schoolbooks on a scale from 0-10 books to more than 500 books[37].

The index of ESCS is significantly positively correlated with performance on both mathematics domains (Table 5.2) and with the other achievement domains (see Table A5.1 in the *PISA 2012 E-appendix*). The amount of variance in mathematics performance scores attributable to ESCS is 15% for students in Ireland, which is the same as the OECD average (OECD, 2013c). A one-point (one standard deviation) increase on the ESCS index is associated with a 38 score-point difference in mathematics performance in Ireland, which is similar to the average across OECD countries (39 points). Students in Ireland have a significantly higher level of ESCS than the average across OECD countries.

Table 5.1. Mean scores on Economic, Social, and Cultural Status, in Ireland and on average across OECD countries

	Ireland			*OECD Mean*			*Difference*	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
ESCS	0.13	(0.02)	0.85	0.00	(0.0)	0.90	**0.13**	(0.02)
Parental occupation	52.5	(0.42)	21.0	50.6	(0.09)	20.8	**1.90**	(0.43)
Parental education (years)	13.6	(0.05)	2.3	13.5	(0.01)	2.7	0.1	0.05
Home educational resources	-0.12	(0.02)	0.97	0.0	(0.0)	0.94	**-0.12**	(0.02)
Cultural possessions	-0.16	(0.02)	0.93	0.0	(0.0)	0.97	**-0.16**	(0.02)
Material possessions	0.45	(0.02)	0.86	0.0	(0.0)	0.89	**0.45**	(0.02)
Number of books in home[37]	155.5	(4.26)	197.3	156.1	(0.75)	198.53	-0.6	(4.33)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

The variables from which ESCS is derived give a more detailed picture of how socio-economic circumstances are associated with achievement. All indices have significant positive correlations with mathematics performance (Table 5.2). The variable with the highest correlations with performance in the two mathematics domains is the number of books in the home (*r*=.45 with print mathematics and *r*=.38 with computer-based mathematics). The parental education and parental occupation variables have moderate correlations with the mathematics performance domains, ranging from *r*=.26 for parental education and computer-based mathematics to *r*=.32 for parental occupation and print mathematics. Students in Ireland report significantly higher levels of parental occupation and

[37] Students were asked to estimate the number of books in their home, whether 0-10, 11-25, 26-100, 101-200, 201-500, or more than 500. These data were recoded to generate the national averages as follows: 0-10 books was coded 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.

material possessions, but significantly lower levels of home educational resources and cultural possessions, compared to the OECD average.

Table 5.2. Correlations between ESCS and its component indices and the print and computer-based mathematics in Ireland

	Print mathematics			Computer-based mathematics		
	r	*t*	*p*	*r*	*t*	*p*
ESCS	.382	23.4	< .001	.345	19.0	< .001
Parental occupation	.324	18.9	< .001	.282	15.6	< .001
Parental education (years)	.271	18.2	< .001	.257	15.3	< .001
Home educational resources	.191	10.4	< .001	.191	11.9	< .001
Cultural possessions	.203	12.6	< .001	.159	9.3	< .001
Wealth	.145	7.5	< .001	.140	7.3	< .001
Number of books in home[2]	.350	24.7	< .001	.282	17.5	< .001

Family Structure

Based on students' responses to questions on their family, the analysis distinguishes between one-parent families and other family types, including two-parent families. Ireland has a slightly but significantly lower proportion of one-parent families (11.0%) than on average across OECD countries (13.3%). In Ireland, children in one-parent families have significantly lower mean scores on print mathematics (485.0) than students in other family types (509.0) (Table 5.3). Achievement differences of a similar magnitude are observed for other domains (Table 5.3 and Table A5.2 in the *PISA 2012 E-appendix*). One-parent families have significantly lower ESCS (-0.20 in Ireland and -0.21 across OECD countries) than other family types (0.21 in Ireland and 0.06 across OECD countries) (see Table A5.3 in the *PISA 2012 E-appendix*).

Table 5.3. Mean print and computer-based mathematics scores by family structure, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
One-parent families (Ref)	11.0	485.0	(4.05)	79.3	477.0	(4.73)	76.2
Other family types	89.0	**509.9**	(2.13)	82.2	**500.9**	(2.77)	77.7

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Immigrant and Language Status

Ireland has experienced high levels of immigration in recent years and the number of students in PISA categorised as immigrants increased from 3.4% in 2003 to 8.0% in 2009 and again to 9.6% in 2012[38]; similar increases are observed in Italy and Spain between PISA 2003 and 2012 (OECD, 2013c). The proportion of immigrant students in Ireland in 2012 is not significantly different from the OECD average of 10.5%[39]. Taking immigrant and language status together, just over half of immigrant students in Ireland speak English or Irish at home and the rest speak some other language

[38] Students were excluded for whom no information was available on language or ESCS. The OECD also reports on immigrant status only, regardless of language data (OECD, 2013c) and on this basis the proportion of immigrant students in Ireland is reported as 10.1%.

[39] In PISA, students are categorised as 'native' if they were born in the country where they took the test and had one parent born in that country and as 'immigrant' if the student was born in the test country and both parents were born elsewhere or if the student and their parents were all born outside the test country.

(Table 5.4). In general, the three groups do not differ significantly in mean achievement, with the exception of print reading where other language-speaking immigrant students score significantly lower than the other two groups (Table 5.4 and Table A5.4 in the *PISA 2012 E-appendix*). However, because of the relatively small numbers of students in the immigrant groups, large standard errors could render large differences as insignificant. English- or Irish-speaking immigrants have significantly higher average ESCS (0.33) than either native (0.12) or other language-speaking immigrants (0.05) (Table A5.3 in the *PISA 2012 E-appendix*). Patterns of achievement by immigrant status vary widely in the OECD, due at least in part to large differences across countries in the composition of the immigrant population. In New Zealand, the large immigrant populations perform quite differently, with those who speak the language of the test scoring above the OECD average, about the same as native students, and immigrants who speak other languages scoring below the OECD average; in Australia immigrants significantly outperform native students, with the highest scores among the other language-speaking group. On the other hand, in France, Sweden, and the Netherlands, immigrant students as a group have significantly lower mean achievement scores than native students (OECD, 2013c). On average across OECD countries, native students speaking the language of the test achieve a score of 502.7 in print mathematics and native students who speak another language score 467.0, while immigrants score significantly lower, at 473.4 for those speaking the language of the test and 462.5 for other language-speakers (OECD, 2013c).

Table 5.4. Mean print and computer-based mathematics scores by immigrant and language background, in Ireland[40]

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Native (Ref)	90.4	503.5	(2.29)	84.3	494.4	(2.89)	79.8
Immigrant with Eng/ Irish	5.1	508.4	(6.13)	79.4	489.9	(7.22)	83.8
Immigrant with other language	4.5	499.0	(6.92)	81.4	507.9	(6.68)	71.9

Note: Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Traveller Community

Less than 2% of students participating in PISA in Ireland indicated that they are members of the Traveller community. These students' families have significantly lower ESCS (-0.36) than their peers' (0.14) (Table A5.3 in the *PISA 2012 E-appendix*), and they have significantly lower average mean scores on all domains (Table 5.5 and Table A5.5 in the *PISA 2012 E-appendix*). For Traveller students, average scores on both the print and computer-based mathematics and on digital reading are approximately two-thirds of a standard deviation lower, while print reading and science scores are around one standard deviation lower (see Table A5.5 in the *PISA 2012 E-appendix*). In terms of proficiency levels on print mathematics, Traveller students have an average score at Level 2, which is below the overall average at Level 3.

Table 5.5. Mean print and computer-based mathematics scores by Traveller status, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Traveller (Ref)	1.7	425.6	(8.88)	73.0	423.4	(9.55)	74.7
Settled	98.3	**504.0**	(2.12)	83.7	**495.3**	(2.81)	79.7

Note: Significant differences in bold (in comparison to ref group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

[40] Native students speaking a language other than English or Irish accounted for 0.3% of the sample and achievement scores for all native students are reported together.

Time Spent in Paid Work during Term Time

Fewer than one in six students in Ireland report that they engage in paid work during term time (Table 5.6). Among all students, 9.0% work less than four hours per week, 3.9% for between four and eight hours, and 3.3% for more than eight hours. Significantly more boys (5.2%) than girls (1.5%) work for eight or more hours per week (Table A5.6 in the *PISA 2012 E-appendix*). On average, pupils who report engaging in paid work during term time for more than 8 hours per week have significantly lower mean scores on print and computer-based mathematics (Table 5.6) and in the other achievement domains (Table A5.7 in the *PISA 2012 E-appendix*), compared with those who do not engage in paid work during term time.

Table 5.6. Mean print and computer-based mathematics scores by time spent in paid work during term time, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
None (Ref)	83.8	507.0	(2.29)	83.9	498.6	(2.69)	78.9
Up to 4 hours a week	9.0	497.0	(4.80)	81.5	486.4	(5.23)	77.4
4 to 8 hours a week	3.9	495.3	(6.82)	78.0	491.2	(6.91)	73.4
More than 8 hours a week	3.3	**478.4**	(6.90)	82.3	**473.1**	(8.23)	82.6

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Parental Interaction

Students in Ireland were also asked how often they discuss topics such as political and social issues, school, or books, films, and television with their parents, as well as how often they eat dinner together and spend time just chatting. Based on their responses, a national scale of parental interaction was constructed. Significant positive correlations are observed across all the domains (Table 5.7 and Table A5.8 in the *PISA 2012 E-appendix*). The index of parental interaction is also significantly correlated with ESCS (r=.23) (Table A5.9 in the *PISA 2012 E-appendix*).

Table 5.7. Correlation achievement scales by level of parental interaction, in Ireland

	Print mathematics			Computer-based mathematics		
	r	*t*	*p*	*r*	*t*	*p*
Parental interaction	.210	13.9	< .001	.265	16.2	< .001

Note: Significant correlations are highlighted in bold. Df=80 (number of variance strata associated with balanced repeated replication (BRR) method of variance estimation.

5.1.2. Student Educational Background

Aspects of students' educational background are also investigated in PISA 2012. The participants in PISA were all aged between 15 and 16 years[41] at the time of the assessment but not all were in the same year at school so the association between grade level and achievement is considered. There is also variation in attendance at preschool and its association with achievement.

[41] The PISA population in a country is defined as all students enrolled in educational programmes aged between 15 years and 3 months to 16 years and 2 months (OECD, 2013b).

Preschool Attendance

Preschool attendance is comparatively low among students in PISA 2012 in Ireland than on average across OECD countries: 74.0% of students across OECD countries report attending for more than one year compared to 42.8% in Ireland. Students in Ireland are also more likely never to have attended preschool (13.6%) than students on average across OECD countries (7.2%).[42] However, the lack of attendance at preschool in Ireland should be considered in conjunction with the age at which students start school. In Ireland, more than half of students (56.0%) started school at age four compared to fewer than 20% across the OECD, where the modal age is six.

There is an association between ESCS and preschool attendance in Ireland such that those who have never attended have lower average ESCS (-0.17) than those who attended for one year or less (0.09) and for more than one year (0.26) (see Table A5.3 in the *PISA 2012 E-appendix*). Across OECD countries, preschool attendance is associated with significantly higher achievement in print mathematics such that students who spent any time in preschool score higher than those who have never attended while those with more than one year at preschool have the highest scores. PISA students in Ireland who attended preschool score slightly but significantly higher in print mathematics than those who did not, though the advantage of longer attendance is not evident (Table 5.8 and Table A5.10 in the *PISA 2012 E-appendix*). Similar patterns are observed for the other achievement domains, with the exception of computer-based mathematics performance, where no significant differences are found between those who attended or did not attend preschool.

Table 5.8. Mean print and computer-based mathematics scores by duration of preschool attendance, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
No preschool (Ref)	13.3	490.7	(4.18)	87.9	488.5	(4.33)	81.4
1 year or less	43.6	**505.5**	(2.83)	83.7	493.8	(3.40)	79.8
More than 1 year	42.8	**502.3**	(2.72)	83.5	494.6	(3.28)	80.6

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Grade Level

The majority of students in PISA 2012 in Ireland are in Third Year (60.5%) with a further quarter in Transition Year (24.3%) and 13.3% in Fifth Year. The rest are in Second Year (1.9%) or First Year (0.03%) and these last two groups are combined for ease of analysis. Compared to those in Third Year, Transition Year students have significantly higher scores on all the achievement domains, while Second Years have significantly lower scores. Students in Fifth Year do not differ significantly from Third Year students in terms of performance on any domain (Table 5.9 and Table A5.11 in the *PISA 2012 E-appendix*). Second Years students have an average score at proficiency level 2, one level below the other years, which average at proficiency level 3. Year groupings also vary with respect to ESCS: Second and Fifth Years have lower average ESCS (-0.21 and -0.11 respectively) than Third Years

[42]The Early Childhood Care and Education Scheme was established in 2010 and provides 2 hours and 15 minutes per day of free care for 50 weeks prior to school entry. Children in PISA 2012 did not benefit from this initiative as they were too old but it may have an impact in future cycles.
see http://www.citizensinformation.ie/en/education/pre_school_education_and_childcare/early_childhood_care_and_education_scheme.html

(0.13) while Transition Year students have the highest average levels (0.27) (Table A5.3 in the *PISA 2012 E-appendix*).

Table 5.9. Mean print and computer-based mathematics scores by student grade (year) level, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Second Year	1.9	**444.9**	(10.58)	83.4	**457.8**	(12.00)	86.2
Third Year (Ref)	60.5	494.8	(2.34)	84.0	488.7	(3.10)	81.2
Transition Year	24.3	**522.7**	(3.95)	80.8	**509.8**	(3.91)	75.1
Fifth Year	13.3	501.6	(5.48)	85.2	487.6	(5.92)	80.8

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

5.1.3. Student Participation in Education

To examine student participation in education, questions on absence from school and on intentions regarding the Leaving Certificate were asked of PISA students. With regard to the Leaving Certificate, those who did not plan to complete the exam or were unsure are considered at risk of early school-leaving. Where relevant, students indicated which syllabus level they intended to study for mathematics and for English at Leaving Certificate.

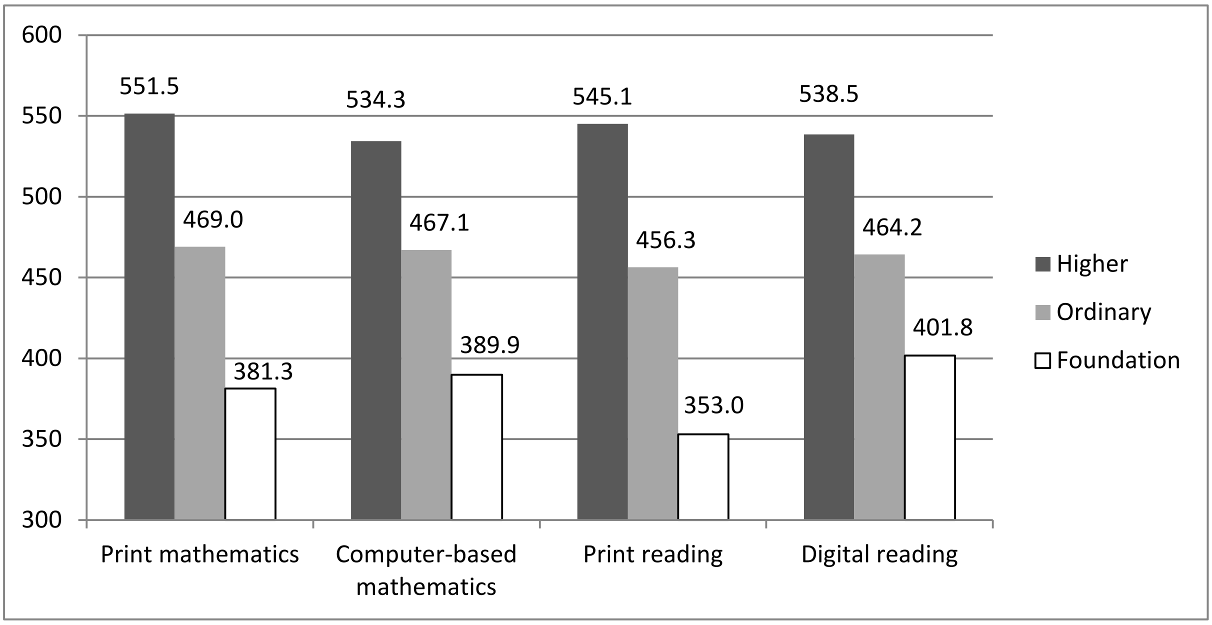
Early School-leaving Risk

The vast majority of students (93.5%) were deemed not to be at risk of early school leaving, as they indicated an intention to stay at school until they took the Leaving Certificate. The remaining 6.5% comprised 0.6% who did not plan to stay on and 5.9% who were unsure. These students achieve significantly lower scores on all five achievement domains, 63.2 points lower in the case of print mathematics and 57.2 points on computer-based mathematics (Table A5.12 in the *PISA 2012 E-appendix*). The difference is largest on print reading where the average score for the at-risk group is 462.1 compared to 530.8 among those not at risk (Table A5.12 in the *PISA 2012 E-appendix*). The at-risk group also have a lower average ESCS (-0.32) than the other students (0.17) (Table A5.3 in the *PISA 2012 E-appendix*).

Intended Leaving Certificate Syllabus Level

Looking ahead to the Leaving Certificate, students were asked about the syllabus levels they intended to study for mathematics and English. For mathematics, 46.2% intended to pursue Higher Level and these have a mean score of 551.5 on print mathematics and 534.3 on computer-based mathematics in PISA (see Figure 5.1). More than half (51.2%) indicated that they would opt for Ordinary Level and they have scores of 469.0 and 467.1 respectively on print and computer-based mathematics, while the 2.6% who intended to sit Foundation Level have a score of 381.3 for print mathematics and 389.9 for computer-based mathematics; the large standard errors for Foundation Level should be noted (see Tables A5.13 and A5.14 in the *PISA 2012 E-appendix*). Likewise, those who intended to study Higher Level English (79.4%) have higher scores in print and digital reading (545.1 for print reading and 538.5 for digital reading) than those planning to take Ordinary (20.3%) (456.3 and 464.2) or Foundation Levels (0.3%) (353.0and 401.8) (Tables A5.13 and A5.14 in the *PISA 2012 E-appendix*).

Figure 5.1. Average mathematics and reading (print and computer-based) scores by intended Leaving Certificate syllabus level for mathematics and English, in Ireland



Absence from School and Lateness

Several items addressed attendance at school: frequency of arriving late in the two weeks prior to PISA testing, of missing classes, and of missing full days due to illness or by skipping school for a whole day. The largest difference in achievement is apparent on frequency of skipping school for a whole day, with those who did not skip any days in the previous two weeks significantly outperforming those who skipped school for one or two days, and those who skipped school for three or more days, on both print and computer-based mathematics (Table 5.10 and Table A5.15in the *PISA 2012 E-appendix*). It should be noted that the numbers of students who report skipping at least one whole day is small (4.0%). Students in SSP schools are more likely than students in schools in general to miss one or two days (χ^2 (2) = 21.4, *p*< .001)[43] and those in Community and Comprehensive schools are more likely to miss one or two days and three or more days (χ^2 (8) = 87.6, *p*< .001).

Table 5.10. Mean print and computer-based mathematics scores by frequency of skipping school in the previous two weeks, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
None (Ref)	96.0	503.1	(2.23)	84.0	494.7	(2.84)	79.9
1 or 2 days	3.3	**479.7**	(8.39)	88.5	**461.8**	(8.54)	84.0
3 or more days	0.7	**428.6**	(19.51)	97.5	**433.3**	(17.51)	87.5

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

A similar pattern of achievement differences is apparent when comparing scores according to how often students are late for school (Table 5.11 and Table A5.16 in the *PISA 2012 E-appendix*) or absent due to illness (Table 5.12 and Table A5.17 in the *PISA 2012 E-appendix*). Rates of skipping school in

[43] The chi-square tests reported in this chapter do not take account of sampling error so results should be interpreted cautiously.

Ireland are below the OECD average with 4.0% of students skipping at least one day compared to the OECD average of 14.5% (OECD, 2013d). In Ireland, students in SSP schools are more likely to be late for school than students in schools in general (χ^2 (2) = 1079.9, p< .001). Students in community and comprehensive schools are also more likely to be late while students in girls' secondary schools are least likely to be late compared to students in schools in general (χ^2 (8) = 205.3, p< .001). All of these aspects of educational participation are significantly related to ESCS across the OECD (OECD, 2013d).

Table 5.11. Mean print and computer-based mathematics scores by frequency of arriving late for school in the previous two weeks, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
None (Ref)	72.6	510.0	(1.90)	81.9	499.7	(2.71)	78.2
1 or 2 days	20.1	**485.2**	(3.66)	85.2	**478.8**	(3.91)	81.6
3 or more days	7.2	**465.7**	(6.25)	91.3	**468.3**	(6.58)	88.8

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Table 5.12. Mean print and computer-based mathematics scores by frequency of being absent due to illness in the previous two weeks, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
None (Ref)	53.7	509.8	(2.56)	83.1	500.6	(3.08)	78.9
1 or 2 days	38.8	**496.3**	(2.83)	84.5	**487.4**	(3.35)	80.9
3 or more days	7.5	**471.9**	(5.40)	86.2	**470.5**	(5.90)	82.7

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

5.2. School Characteristics

This section reports on the relationship between students' achievement and the characteristics of their school (see Box 5.3). Schools vary in their gender composition, location, average ESCS, and funding, whether fee-paying, or in the School Support Programme under DEIS. Information on these characteristics was gathered from the student and school principal questionnaires, and from Department of Education and Skills' databases. All results are reported at the student level; for school-level data, all students in a school are assigned the value corresponding to their school. It should be noted that this approach can result in over-estimates of the significance of statistical tests, so results of tests that use school aggregates in this section should be interpreted cautiously.

Box 5.3: School Characteristics Examined in Chapter 5

School-related variation in ESCS and in achievement

School average ESCS

Between-school variation in achievement

Within-school variation in achievement

School Support Programme (SSP) under DEIS*

School structure

School sector and gender composition*

Fee-paying status*

School location

Proximity to other schools locally

School climate

Disciplinary climate

Student-teacher relations

Teacher morale

Student factors affecting school climate

Teacher factors affecting school climate

Parental pressure

School policies on organisation of mathematics*

Ability-grouping

Policies regarding mathematics lessons*

Small-group teaching*

Mathematics-related activities

Mathematics extracurricular activities

Mathematics extension activities

Characteristics of mathematics lessons

Teacher support

Classroom management

Teacher intentions

Mathematics teacher practices

Formative assessment

Teacher-directed instruction

Cognitive activation

Student orientation

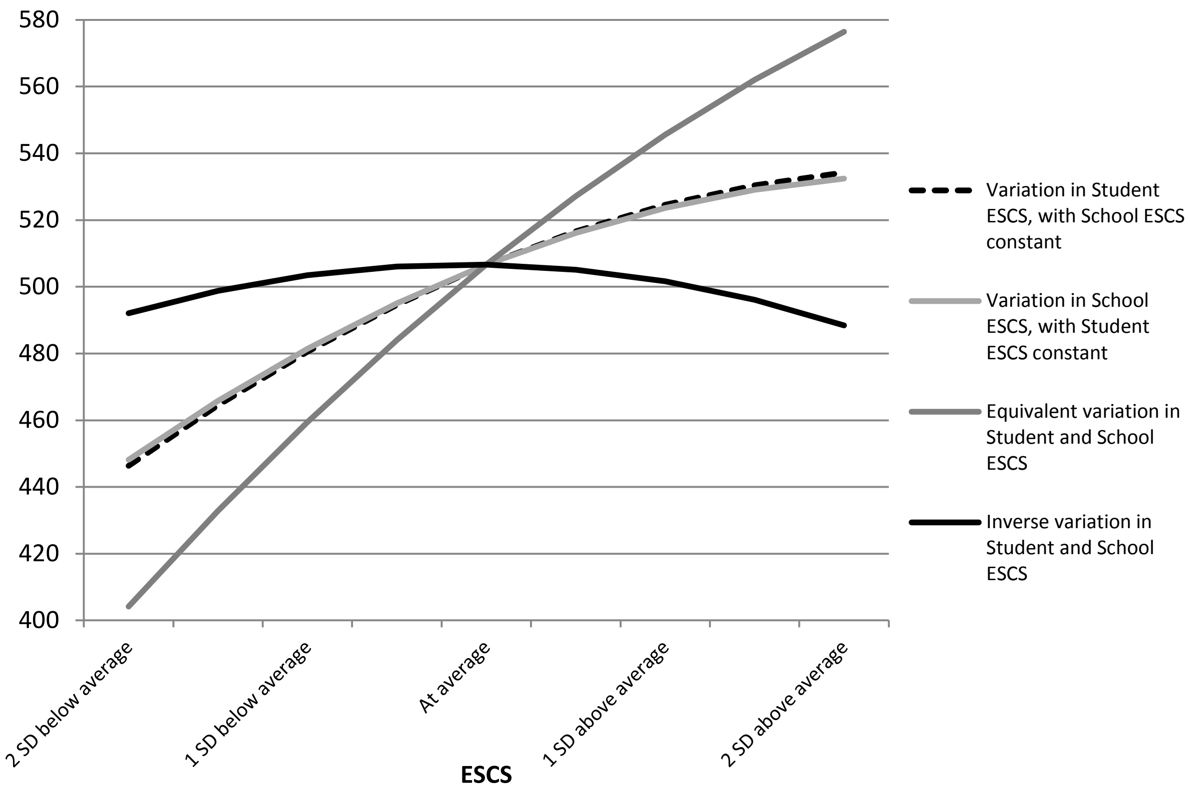
Use of ICT in mathematics lessons

Note: Variables in *italics* are continuous and the others are categorical.* Variable is nationally-derived

5.2.1. School-related Variation in ESCS and in Achievement

Average school ESCS is related to performance in mathematics. Significant positive correlations are observed with print mathematics (r=.38) and computer-based mathematics (r=.33) and for the other domains (see Table A5.18in the *PISA 2012 E-appendix*). However, the relationship between school mean ESCS, student ESCS, and achievement is complex (Figure 5.2). When school mean ESCS is held constant, students with lower ESCS perform below average and those with higher ESCS perform above average (the broken black curve); a similar relationship is observed for school mean ESCS when student ESCS is constant (the light grey curve). The context effect is clear from the interaction between the two. For students with high ESCS attending schools with a high mean ESCS, the positive association with performance is compounded, and for low-ESCS students at low-ESCS schools the negative association is also stronger (the steep grey curve in Figure 5.2). Interestingly, the positive influence of high-ESCS schools can raise the achievement scores of low-ESCS students to close to the national mean score, but the opposite effect is also apparent: scores of high-ESCS students attending low-ESCS schools are below the national average (the solid black curve in Figure 5.2).

Figure 5.2: Relationship between school mean ESCS, student ESCS and print mathematics achievement, in Ireland



In Ireland, the difference in mathematics performance between students attending socio-economically advantaged and disadvantaged schools (as defined by the OECD)[44] is 97 points and on average in OECD countries it is 104 (OECD, 2013c). The correlation between school mean ESCS and student ESCS is in the moderate-to-strong range (*r*=.48). However, between-school differences in ESCS in Ireland account for less than 25% of differences in performance in print mathematics compared to more than half in countries like Germany, Italy, and Japan and more than two-thirds in the Netherlands and Turkey (OECD, 2013c). Since between-school variance in ESCS is low in Ireland, within-school variance is quite high. This means that quite large differences in ESCS can be found within schools.

Differences between students attending schools in the School Support Programme (SSP) under DEIS and those at other schools are also apparent on all five achievement domains, ranging from a 48.1 points advantage for students in non-SSP schools on digital reading to 64.7 on print reading (Table A5.19 in the *PISA 2012 E-appendix*). Students in SSP schools have significantly lower average ESCS (-0.29) than their peers in non-SSP schools (0.24) (see Figure 5.3 and Table A5.3 in the *PISA 2012 E-appendix*).

[44]Advantaged schools are those where the typical student in the school is above the country mean ESCS, while disadvantaged schools are those below the country mean ESCS. This is separate from the School Support Programme under DEIS or the earlier Designated Disadvantaged status.

5.2.2. School Structure

Several aspects of school structure, location, and funding are addressed next. Sector and gender composition are examined together, followed by fee-paying status. Two variables related to school location are also reported: rural, town, or city location and the availability of other schools locally.

Sector and Gender Composition and Fee-paying Status

The sector and gender composition of schools is also related to performance, with schools categorised as community and comprehensive, vocational, boys' secondary, girls' secondary, and mixed secondary. Comparisons between students in vocational schools and the other school types indicate significantly lower achievement scores on both print and computer-based mathematics for students in vocational schools compared with boys' secondary schools (Table 5.13), significantly lower print reading, science, and digital reading scores than those in girls' secondary schools, and significantly lower print reading and science scores than students in mixed secondary schools (Table A5.20 in the *PISA 2012 E-appendix*). The only significant difference in mean student ESCS shows that students in girls' secondary schools (0.19) have higher average ESCS than students in vocational schools (0.00) (Table A5.3 in the *PISA 2012 E-appendix*). The gender differences reported in Chapters 3 and 4, where male students outperform female students on print and computer-based mathematics and females outperform males on print and digital reading, are evident again in comparisons between boys' and girls' secondary schools.

Table 5.13. Mean print and computer-based mathematics scores by school sector and gender composition, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Girls' Secondary	21.6	501.7	(5.27)	83.4	494.5	(3.43)	70.8
Boys' Secondary	16.2	**520.7**	(7.02)	85.1	**512.7**	(7.63)	79.7
Community/Comprehensive	16.8	491.7	(4.23)	84.3	495.8	(7.01)	79.4
Mixed Secondary	20.3	505.5	(4.59)	78.9	492.4	(6.34)	77.6
Vocational (Ref)	25.1	492.2	(5.86)	87.4	477.9	(7.76)	88.5

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Students in fee-paying schools[45] have significantly higher scores on all domains, over half a standard deviation on the three print domains and on digital reading (Table 5.14; Table A5.21in the *PISA 2012 E-appendix*). Students at fee-paying schools have significantly higher ESCS (0.88) than students at non-fee-paying schools (0.06) (see Figure 5.3).

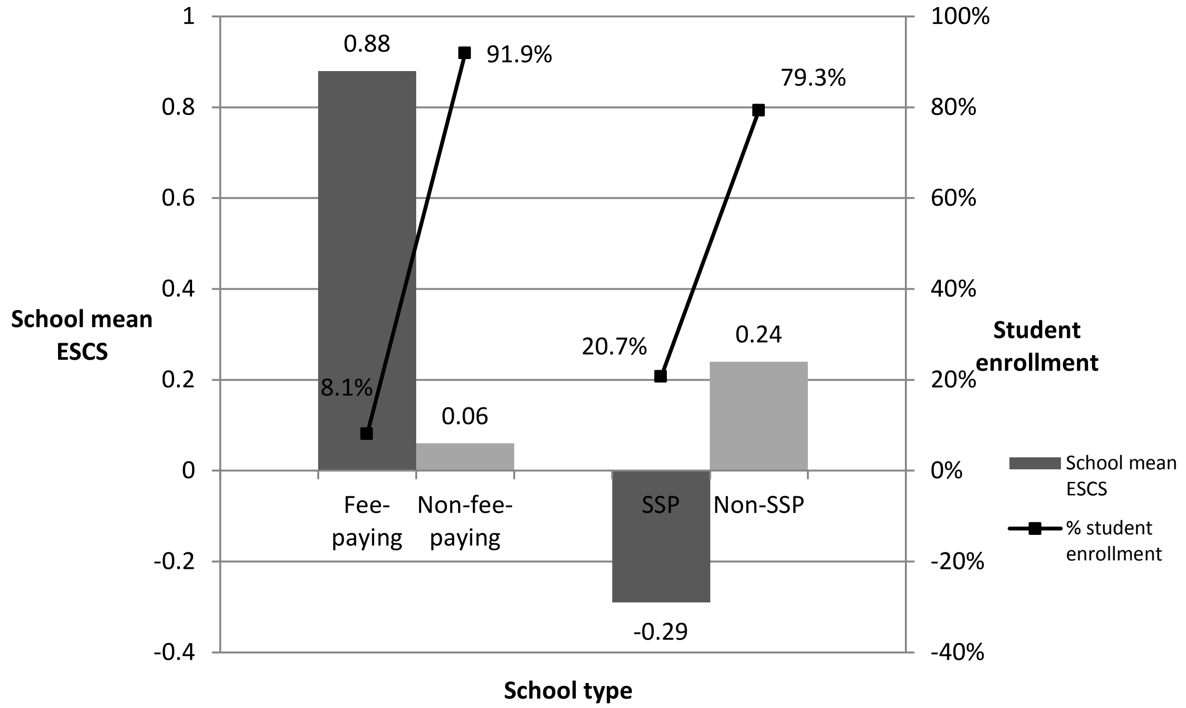
Table 5.14. Mean print and computer-based mathematics scores by school fee-paying status (Ireland)

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Non-fee-paying (Ref)	91.9	496.9	(2.42)	84.0	490.0	(3.18)	80.8
Fee-paying	8.1	**554.1**	(5.59)	72.2	**528.2**	(8.42)	67.8

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

[45] The OECD report (2013d) makes reference to 'public' and 'private' schools, a distinction based on the governance of schools rather than their funding. Of more interest here is whether students pay fees or not.

Figure 5.3. School mean ESCS by Fee-paying status and SSP status, in Ireland



School Location and Proximity to Other Schools Locally

Other school-related variables include location and proximity to schools in the area. In Ireland, 22.6% of students attend Rural schools (including those in villages), while 50.7% of students attend Town schools and 26.7% City schools[46]. The majority of students (74.8%) attend schools that are close to at least two others, with 11.6% near one other, and 13.6% of students' principals reporting that there are no other schools in the area. No significant differences are observed on the achievement domains when comparing school location (Table A5.22 in the *PISA 2012 E-appendix*) or the proximity to other schools locally (Table A5.23 in the *PISA 2012 E-appendix*). On average across OECD countries, however, the pattern is for students in rural areas to have the lowest average scores with those in towns higher, and those in cities the highest, when ESCS is taken into account.

5.2.3. School Climate

In PISA, school climate refers to aspects of the management and culture of the school which could affect student achievement. Six factors are considered in this section: disciplinary climate, student-teacher relations, student- and teacher-related factors affecting school climate, teacher morale, and parental pressure. Disciplinary climate and student-teacher relations are indices derived from the student questionnaire and the others are based on responses to the school questionnaire (i.e. based on information provided by school principals). As with other indices, these have an OECD mean of 0 and a standard deviation of 1. Apart from parental pressure, higher scores indicate a more positive perception.

[46] Rural areas including villages are in areas with a population of fewer than 3,000 people while Towns have populations up to 100,000 and Cities up more than 100,000 people.

Disciplinary climate refers to the frequency of interruptions during mathematics lessons. Students were asked how often the following happen in their mathematics classes: students do not listen to what the teacher says; there is noise and disorder; the teacher has to wait a long time for students to quieten down; students cannot work well; and students do not start working for a long time after the lesson begins. The questions on student-teacher relations concern whether students get along well with the teachers at their school, whether teachers are interested and listen to students, and whether teachers treat students fairly and help them when necessary. The student-related factors affecting school climate are the extent to which learning is hindered by disruptive student behaviour such as truancy, skipping classes, arriving late for school, not attending compulsory events or excursions, lacking respect for teachers, disrupting classes, using alcohol or illegal drugs, and intimidating or bullying other students. Principals were asked about teacher-related factors affecting school climate, including whether teachers' behaviour could hinder learning by not encouraging students to achieve their full potential, being too strict, poor teacher-student relations, demonstrating low expectations of students, being late, absent, or under-prepared, or offering resistance to change; perceptions of teachers' work circumstances were also addressed here, such as teachers having to teach students of heterogeneous ability levels within the same class and having to teach students of diverse ethnic backgrounds within the same class. Teacher morale was explored with questions about whether teachers work with enthusiasm, take pride in the school, and value academic achievement. The measure of parental pressure is described later.

Compared to the OECD average values, Ireland has a significantly more positive disciplinary climate in mathematics classes as well as higher teacher morale and more positive teacher behaviours (Table 5.15). On average across OECD countries, rates of agreement on the teacher morale items exceed 90% (OECD, 2013e). All five school climate factors are significantly positively correlated with performance in all of the achievement domains (Table 5.16 and Table A5.24 in the *PISA 2012 E-appendix*). Both teacher morale and student-teacher relations have weak associations while student and teacher factors affecting climate have correlations in the weak-to-moderate range. The strongest correlation is with disciplinary climate, though in Ireland and on average across OECD countries most of the variation in disciplinary climate is within schools (84.5 and 86.0%, respectively) (OECD, 2013e), suggesting that individual teachers influence the climate rather than the school as a whole. Student ESCS is not consistently associated with the other school characteristics described here: Correlations range from r=.01 for student-teacher relations to r=.20 for student behaviour (Table A5.9 in the *PISA 2012 E-appendix*).

Table 5.15. Mean scores on the indices measuring school climate in Ireland and on average across OECD countries

	Ireland			OECD Mean			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Disciplinary climate	0.13	(0.03)	1.10	0.00	(0.00)	1.0	**0.13**	(0.03)
Student-teacher relations	0.03	(0.02)	0.95	0.00	(0.00)	1.0	0.03	(0.02)
Student factors affecting climate	-0.09	(0.06)	0.91	-0.08	(0.01)	0.95	-0.01	(0.06)
Teacher factors affecting climate	0.10	(0.08)	0.99	-0.09	(0.01)	0.96	**0.19**	(0.08)
Teacher morale	0.49	(0.08)	0.96	0.00	(0.01)	0.98	**0.49**	(0.08)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Table 5.16. Correlations between the indices measuring school climate and print and computer-based mathematics, in Ireland

	Print mathematics			Computer-based mathematics		
	r	*t*	*p*	*r*	*t*	*p*
Disciplinary climate	.255	11.7	< .001	.222	9.2	< .001
Student-teacher relations	.070	3.3	< .001	.072	3.6	< .001
Student factors affecting climate	.214	7.5	< .001	.244	7.6	< .001
Teacher factors affecting climate	.130	3.4	< .001	.177	4.3	< .001
Teacher morale	.069	1.7	< .05	.143	3.1	< .01

Parental Pressure

A question on parental pressure concerned whether principals thought there was pressure on the school to achieve high academic standards from many parents, a minority of parents, or was largely absent. Students in schools where principals perceived pressure from many parents have significantly higher achievement scores across all domains than students in other schools, again with differences of more than 50 points in some domains (Table 5.17 and Table A5.25 in the *PISA 2012 E-appendix*). Pressure from many parents is greater in boys' and girls' secondary schools than in other school types, while it is more likely to be largely absent in community and comprehensive schools (χ^2 (8) = 1981.68, *p*< .001. Over nine in ten pupils (92.1%) attending fee-paying schools have principals who believe that many parents exert pressure, compared to 44.3% of pupils attending non-fee-paying schools. On average across OECD countries, 21% of pupils attend schools where the principal reported pressure from many parents, 46% where the principal perceived there to be pressure from a from a minority of parents, and 33% where such pressure was perceived to be largely absent. Hence, principals in Ireland report comparatively greater levels of pressure. Other countries with above-average levels of perceived pressure are Australia, New Zealand, Sweden, the United Kingdom, and the United States.

Table 5.17. Mean print and computer-based mathematics scores by level of parental pressure, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Many parents (Ref)	48.1	523.0	(2.57)	78.5	508.3	(3.91)	75.4
Minority of parents	36.1	**492.3**	(5.05)	83.5	**486.4**	(5.70)	81.4
Largely absent	15.8	**462.3**	(7.07)	86.3	**462.3**	(9.04)	83.8

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

5.2.4. School Policies on Organisation of Mathematics

Policies and practices on mathematics teaching in schools can also have an impact on achievement. This section focuses on the issues of ability-grouping, policies on mathematics education, and the frequency of working in small groups in mathematics classes.

Ability-grouping

Students of similar strengths are sometimes in the same class with the aim of creating a more homogenous learning environment and facilitating instruction for both more- and less-able students (OECD, 2013e). In Ireland, almost all students are grouped by ability for mathematics classes, 50.4% for all classes and 47.2% for some classes. Other countries in which the vast majority of students are grouped by ability for at least some mathematics classes include Australia, Austria, New Zealand, and the United Kingdom (OECD, 2013e). Mean scores on computer-based mathematics among students in Ireland are related to ability-grouping such that the 2.4% of students who are not in ability-grouped classes score significantly lower than the 50.4% in the 'all classes' group (478.5 and 500.8 respectively); scores on print mathematics do not differ significantly (Table A5.26 in the *PISA 2012 E-appendix*). The time at which ability-grouping was introduced is also associated with significant differences in both print and computer-based mathematics (Table 5.18), with significantly lower scores for those grouped from First Year.

Table 5.18. Mean print and computer-based mathematics scores by time point when streaming of mathematics classes begins, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Beginning of First Year	11.5	**466.6**	(11.54)	91.8	**451.4**	(12.72)	89.1
Beginning of Second Year (Ref)	76.7	506.7	(2.69)	82.2	498.0	(3.66)	77.9
Beginning of Third Year	9.5	502.6	(10.25)	80.9	497.2	(9.00)	74.2
Other	2.3	528.7	(17.42)	87.8	497.1	(6.51)	71.3

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Policies Regarding Mathematics Education

Principals were also asked about policies on the use of computers in mathematics lessons and 13.7% of students are at schools that had such policies in place, though there is no significant difference in either print or computer-based mathematics achievement among pupils attending schools with or without policies (Table A5.27 in the *PISA 2012 E-appendix*). More than two-thirds of students' schools have a policy of using the same mathematics book in all Third Year classes (68.1%), though again there is no significant association with achievement (Table A5.28 in the *PISA 2012 E-appendix*). The final policy question concerned the use of a standardised curriculum and 91.5% of students' principals report that this policy is in place, again with no significant effect on mathematics scores (Table A5.29 in the *PISA 2012 E-appendix*).

Small-group Teaching

Students in Ireland were also asked about the frequency with which they work in small groups in mathematics class. The majority of students (69.1%) report never working in this way and the use of small-group teaching every day is associated with lower achievement (Table 5.19). However, students in SSP school are more likely to report working in small groups every day and a few times a week than students in schools in general (χ^2 (3) = 512.9, p< .001) so the difference here may reflect the SSP and non-SSP achievement differences described earlier in this chapter and may be linked to the involvement of resource teachers.

Table 5.19. Mean print and computer-based mathematics scores by frequency of working in small groups in mathematics classes, in Ireland

		Print mathematics			Computer-based mathematics		
	%	Mean	SE	SD	Mean	SE	SD
Every day (Ref)	3.8	454.6	(8.24)	95.4	454.1	(9.22)	94.3
A few times a week	9.0	**492.6**	(5.30)	86.6	**488.6**	(5.36)	81.0
A few times a month	18.1	**506.7**	(3.66)	81.6	**498.2**	(3.68)	78.8
Rarely/never	69.1	**505.6**	(2.36)	82.9	**496.1**	(3.04)	78.8

Note: Significant differences in bold (in comparison to reference group). Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

5.2.5. Mathematics-related Activities

The extent to which schools offer mathematics-related activities was also covered in the school questionnaire and OECD indices on extra-curricular activities and extension courses were generated. Ireland is below the OECD average in the provision of both forms of mathematics activities, significantly so in the case of extra-curricular activities (Table 5.20). Across the countries participating in PISA 2012, there are examples of cultural practices which underlie participation in mathematics activities, as in Turkey and Qatar where 37% of students regularly play chess and Jordan and the UAE where more than 40% regularly programme computers (OECD, 2013d); the corresponding figures for Ireland are 9.7% and 12.5%. In Ireland, neither the mathematics extra-curricular scale nor the mathematics extension courses scale are significantly associated with achievement on print mathematics (r=.06 for extra-curricular activities and r=.03 for extension courses) or on computer-based mathematics (r=.05 and r=-.02 respectively) (see Table A5.30 in the *PISA 2012 E-appendix*).

Table 5.20. Mean scores on the indices measuring mathematics activities in school, in Ireland and on average across OECD countries

	Ireland			OECD Mean			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Mathematics extra-curricular activities	1.81	(0.11)	1.31	2.36	(0.01)	1.5	**-0.55**	(0.11)
Mathematics extension courses	2.44	(0.07)	0.53	2.46	(0.01)	0.59	-0.02	(0.07)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

5.2.6. Characteristics of Mathematics Lessons

This section deals with the practices employed in mathematics lessons in schools. It reports on students' perceptions of the level of support received from mathematics teachers in lessons, their perception of their mathematics teachers' classroom management, and principals' perceptions of mathematics teachers' intentions to use different practices in the classroom. The information was gathered from the student and school questionnaires and OECD indices were developed.

The items used to formulate the index of teacher support asked whether students agree that their mathematics teachers let them know when they have to work hard, help them with learning, provide extra help when needed, and give students opportunities to express their opinions. Classroom management refers to students' views on whether the teacher starts on time, waits a long time for the class to quieten down, keeps the class orderly, and whether students listen. Finally, the teacher intentions index is based on principals' perceptions regarding whether teachers try new methods or stay with well-known methods, try to maximise achievement, adapt standards to the students' levels and needs, and take into account students' social and emotional development and their mathematical skills and knowledge during mathematics classes.

For all of the indices of mathematics teachers' characteristics, Ireland scores significantly above the OECD average (Table 5.21). In the case of teacher support, students in Ireland indicated that their teachers offer more support and help than students on average across OECD countries. Similarly, students in Ireland rate their teachers' classroom organisation and management higher than the OECD average. The largest difference is in teacher intentions, suggesting that principals report positive efforts on the part of teachers to maintain their own development and to be responsive to their students' needs. However, only one of these indices of teacher characteristics, classroom management, is significantly, though weakly, correlated with performance on print mathematics (Table 5.22).

Table 5.21. Mean scores on the indices measuring mathematics teachers' characteristics, in Ireland and on average across OECD countries

	Ireland			OECD Mean			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Teacher support	0.08	(0.02)	1.04	0.00	(0.00)	1.00	**0.08**	(0.02)
Mathematics teacher classroom management	0.15	(0.03)	1.11	0.00	(0.00)	1.00	**0.15**	(0.03)
Teacher intentions	0.21	(0.09)	1.02	-0.13	(0.01)	0.94	**0.34**	(0.09)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Table 5.22. Correlations between indices measuring mathematics teachers' characteristics and print and computer-based mathematics, in Ireland

	Print mathematics			Computer-based mathematics		
	r	*t*	*p*	*r*	*t*	*p*
Teacher support	0.031	1.5	NS	0.044	2.0	< .05
Mathematics teacher classroom management	0.141	6.9	< .001	0.1	5.1	< .001
Teacher intentions	0.024	0.6	NS	0.005	0.1	NS

Note: Significant correlations are highlighted in bold. Df=80 (number of variance strata associated with balanced repeated replication (BRR) method of variance estimation.

5.2.7. Mathematics Teachers' Practices

Teachers' practices in mathematics classes examined in PISA included the use of formative assessment, teacher-directed instruction, cognitive activation strategies, and ICT, as well as teachers' student orientation. An index with an OECD average of 0 and a standard deviation of 1 was constructed for each one. Formative assessment refers to teachers' frequency of use of assessment for learning and the nature and frequency of feedback given to students. Student orientation refers to differentiation or the extent to which teachers give different tasks to students depending on their abilities as well as teachers' use of small-group teaching and project work. The index of teacher-directed instruction consists of items on setting goals, checking that students understand a topic, and summarising what has been learned.

Among the participating school systems in PISA 2012, there are large differences both between schools and within schools on these indices of teacher practices. Ireland scores below the OECD average on all but one of the indices, and significantly below on use of formative assessment and on student orientation (Table 5.23). This suggests that teachers in Ireland use formative assessment and student orientation strategies such as differentiation less often than teachers in other countries. Again there are some significant correlations with mathematics performance, with weak-to-moderate negative associations between mathematics performance and both formative assessment and student orientation (Table 5.24). The negative correlations may reflect greater use of approaches such as formative assessment and student orientation (differentiation) with lower-achieving students. Overall, however, there is little evidence to indicate the teacher practices as measured in PISA are strongly associated with achievement.

Table 5.23. Mean scores on the indices measuring mathematics teachers' practices, in Ireland and on average across OECD countries

	Ireland			OECD Mean			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Formative assessment	-0.07	(0.02)	0.93	0.00	(0.00)	1.00	**-0.07**	(0.02)
Student orientation	-0.58	(0.03)	0.94	0.00	(0.00)	1.00	**-0.58**	(0.03)
Teacher-directed instruction	-0.08	(0.02)	0.98	0.00	(0.00)	1.00	-0.08	(0.02)
Cognitive activation	0.13	(0.02)	1.00	0.00	(0.00)	1.00	0.13	(0.02)
Use of ICT in mathematics lessons	-0.15	(0.02)	0.85	0.00	(0.00)	1.00	-0.15	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

Table 5.24. Correlations between for indices measuring mathematics teachers' practices and print and computer-based mathematics, in Ireland

	Print mathematics			Computer-based mathematics		
	r	*t*	*p*	*r*	*t*	*p*
Formative assessment	-0.142	-6.2	< .001	-0.133	-6.0	< .001
Student orientation	-0.213	-9.9	< .001	-0.181	-8.2	< .001
Teacher-directed instruction	-0.055	-2.4	< .01	-0.061	-2.9	< .05
Cognitive activation	0.049	2.6	< .01	0.029	1.5	NS
Use of ICT in mathematics lessons	-0.066	-3.1	< .01	-0.086	-3.8	< .001

Note: Significant correlations are highlighted in bold. Df=80 (number of variance strata associated with balanced repeated replication (BRR) method of variance estimation.

5.3. Summary

PISA 2012 asked students and their principals about a wide range of factors that could influence their achievement and the results presented here describe a complex system of inter-connected student- and school-related variables. Measures come from the international PISA questions, national questions administered as part of PISA, and publicly available DES data.

There is evidence that student demographic characteristics are associated with achievement: students in one-parent families performed almost 25 points lower on print mathematics than students in other family types, while students who are members of the Travelling community have print mathematics scores that are almost 75 points lower than the scores of other students. However, these differences are partially attributable to socio-economic status, which is low for both groups (-0.20 for one parent families and -0.36 for members of the Travelling community). Other aspects of the students' background that are related to achievement are their interactions with parents (*r*=.21 for print mathematics) and whether or not they engage in paid work, with students who work for more than eight hours a week during term time performing over 28 points lower on print mathematics than those who do not engage in paid work during term time. Both of these showed significant relationships with ESCS.

The percentage of immigrant students in Ireland is about the same as the OECD average, just over 1 in 10, and Ireland's immigrants appear to be well integrated at school, at least on the basis that there are no significant differences in mathematics achievement between the groups. However, this conclusion is tempered by the fact that large standard errors are associated with scores of students in the relatively small immigrant groups.

Several aspects of student's educational background are associated with achievement, particularly whether they have attended preschool; once again, students from higher ESCS families are more likely to have had at least one year of preschool education and this is associated with print mathematics scores that are 15 points higher than students who have never attended preschool. Similar patterns emerge in the analysis of participation in education, as measured by risk of early school-leaving, and by frequency of arriving late or skipping school, with 20- to 70-point differences in mathematics achievement between groups.

School characteristics are also associated with some differences in achievement. Students attending fee-paying schools have higher average scores than those at non-fee-paying school by up to 63 points or two-thirds of a standard deviation; likewise, those at schools in the SSP score 59 points lower on print mathematics than their peers. However, comparing schools by sector and gender composition appears to account for some of that variation and the patterns of results appear to replicate gender differences at the individual student level. As for school climate and policies, there are few significant associations with achievement. However, students in Ireland attend school with more positive disciplinary climate than on average across OECD countries and are taught by teachers who use more positive teaching strategies and have higher morale, as perceived by school principals.

Socio-economic status, as measured by the PISA ESCS, is usually a strong predictor of achievement and is significantly correlated with achievement scores in Ireland, explaining 15% of the variance in mathematics achievement. Likewise, average school ESCS is significantly positively correlated with achievement.

The context of the achievement results of students is comprised of the students' family and educational background, their participation in education, and their schools' climate, policies, and practices. No single factor explains achievement in isolation; rather it is the complex interaction of the components of educational life. Chapter 6 looks at some more specific aspects of students' attitudes towards school in general and towards mathematics in particular in an effort to better understand how students achieve. Chapter7 examines trends in achievement over time.

Chapter 6. Students' Attitudes towards and Engagement with School and Mathematics

Consistent with its focus on mathematical literacy and engagement, PISA 2012 examined students' attitudes towards school, their motivation for learning mathematics, their self-beliefs about mathematics, their attributions of failure and openness to problem solving, and their behaviours, intentions and subjective norms as they relate to mathematics. Data were obtained by asking questions on the student questionnaire, and, where appropriate, grouping item responses to form indices, each of which was scaled to have an OECD mean of 0 and a standard deviation of 1. This chapter considers student responses to individual items and relates selected indices to student performance on print and computer-based mathematics. While the main focus is on the responses of students in Ireland as they relate to corresponding OECD averages, reference is also made to outcomes in other countries with high or low scores on the indices. First, the chapter looks at students' general attitudes and behaviour towards school. Second, intrinsic and instrumental motivation to learn mathematics, and perseverance are considered. Third, students' mathematics self-beliefs are considered. Fourth, students' attributions of failure in mathematics, and their openness to problem solving are described. Fifth, mathematics' students' behaviours, their intentions to study mathematics further, and their subjective norms are examined (Box 6.1). Supplementary tables are provided in the *PISA 2012 E-appendix,* available at www.erc.ie/p12eappendix.

Box 6.1 Variables Relating to Students' Attitudes, Motivations, Self-beliefs, Behaviours and Intentions

Attitudes towards School

- Attitudes towards school – learning activities at school
- *Attitudes towards school – learning outcomes from school
- *Sense of belonging to school

Motivation to Learn Mathematics

- *Intrinsic motivation to learn mathematics
- *Instrumental motivation to learn mathematics
- Perseverance

Mathematics Self-beliefs, Attributions and Perseverance

- *Mathematics self-efficacy
- *Mathematics self-concept
- *Mathematics anxiety

Mathematics Attributions and Openness to Problem Solving

- Self-responsibility for failure in mathematics
- Openness to problem solving

Mathematics Behaviours, Intentions and Subjective Norms

- Behaviours
- Intentions
- Subjective Norms

* Indicates that trend data are available in Chapter 7

6.1 Attitudes towards School

Three measures of attitudes and behaviour towards school are considered: attitudes towards school – learning activities (perceived benefits of schooling); attitudes towards school – learning outcomes (perceived outcomes of schooling); and sense of belonging to school.

Attitudes towards school – learning activities at school was also assessed by asking students to indicate their levels of agreement with four statements, though, in this case, all were positively worded: "Trying hard at school will help get me into college" (98.1% of students in Ireland strongly agree or agree); "I enjoy receiving good grades" (98.1%); "Trying hard at school is important" (96.1%); and "Trying hard at school will help me get a good job" (95.2%) (see Table A6.1 in the *PISA 2012 E-appendix*). Hence, most students in Ireland strongly endorsed all of the statements associated with attitudes towards school – learning activities.

Attitude towards school – learning outcomes from school was assessed by asking students to indicate their levels of agreement (strongly agree, agree, disagree, strongly disagree) with two positively worded statements: "School has taught me things which could be useful in a job" (88.4% of students in Ireland strongly agree or agree) and "School has helped give me confidence to make decisions" (83.6%) – and with two negatively-worded statements: "School has done little to prepare me for adult life when I leave school" (26.2%) and "School has been a waste of time" (9.4%) (see Table A6.2 in the *PISA 2012 E-appendix*).

Sense of belonging to school was assessed by asking students to indicate their levels of agreement with eight statements. Positively-worded statements included "I make friends easily at school" (89.5% of students in Ireland strongly agree or agree) and "Things are ideal in my school" (66.0%). Negatively-worded statements included "I feel awkward and out of place in my school" (10.2%) and "I feel lonely at school" (6.7%) (see Table A6.3 in the *PISA 2012 E-appendix*).

Indices based on these clusters of items were constructed to have an OECD mean of zero, and a standard deviation of 1. Students in Ireland achieved scores that are significantly higher than the corresponding OECD average on the indices of attitudes towards school – learning activities (by one-fifth of a standard deviation) and attitudes towards school – learning outcomes (by one-tenth) (Table 6.1). Although the mean score for students in Ireland on the index of sense of belonging to school is slightly below the OECD average (-0.03), the difference is not statistically significant.

Table 6.1. Mean scores on indices of students' attitudes towards school and sense of belonging, in Ireland and on average across OECD countries

	Ireland			OECD			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Learning activities	0.20	(0.02)	0.96	0.00	(0.00)	0.97	**0.20***	(0.02)
Learning outcomes	0.11	(0.02)	1.03	0.00	(0.00)	0.98	**0.11***	(0.02)
Sense of belonging to school	-0.03	(0.02)	0.96	0.00	(0.00)	0.97	-0.03	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

High-scoring countries on attitudes towards school – learning activities included Costa Rica (0.54), Albania (0.52) and Iceland (0.39), while low-scoring countries included Vietnam (-0.52) and Japan (-0.56) (OECD, 2013d, Table III.2.5b). High-scoring countries on attitudes towards school – learning outcomes include Costa Rica (0.47) and Lithuania (0.45), while low-scoring countries include Macao-

China (-0.47) and Qatar (-0.48) (OECD, 2013d, Table III.2.4b). High-scoring countries on sense of belonging include Switzerland (0.40) and Austria (0.38), while low-scorers included Hong-Kong China (-0.47) and Macao-China (-0.58) (OECD, 2013c, Table III.2.3b).

In Ireland, female students have significantly higher mean scores than male students on attitudes towards school – learning activities and attitudes towards school – learning outcomes (Table 6.2). There are no significant differences on any of the three attitudes scales between native and immigrant students who speak English/Irish, or between native students and immigrants who speak another language. Students attending schools in SPP under DEIS achieve scores on the three attitude indices that are not significantly different from the scores of students attending non-SSP schools. There are no significant differences in attitudes across school types, except in the case of students attending girls' secondary schools, who have a significantly higher mean score on attitudes towards school – learning activities than students attending mixed secondary schools (see Table A6.7 in the *PISA 2012 E-appendix*). Correlations between attitudes towards school – learning activities and performance, and those between attitudes towards school – learning outcomes and performance are weak but statistically significant across all domains (Table 6.2, see Table A6.8 in the *PISA 2012 E-appendix*). For example, the strongest correlation (0.12) is between attitudes towards school – learning outcomes and computer-based mathematics. There are no statistically significant correlations between sense of belonging to school and achievement.

Table 6.2. Attitudes towards school indices – summary of gender differences, differences by immigrant/language status, and by SSP/ DEIS status, and correlations with mathematics performance, in Ireland

Scale	Gender (Male – Female)	Native – Immigrant (Eng/Irish)	Native – Immigrant (Other)	SSP – non-SSP	Correlation - print mathematics	Correlation – computer mathematics
Learning activities	**M < F**	N = I	N = I	SSP = n-SSP	**0.093**	**0.096**
Learning outcomes	**M < F**	N = I	N = I	SSP = n-SSP	**0.079**	**0.115**
Sense of belonging	M = F	N = I	N = I	SSP = n-SSP	0.010	0.011

Statistically significant differences and correlations shown in bold. See Tables A6.4, A6.5, A6.6, and A6.8 in the *PISA 2012 E-appendix* for details.

6.2 Motivation to Learn Mathematics

Three clusters of items were administered to assess students' motivation to learning mathematics – those relating to intrinsic and instrumental motivation and to perseverance in solving problems. Intrinsic motivation was assessed using four items: "I enjoy reading about mathematics" (33.3% of students in Ireland strongly agreed or agreed); "I look forward to my mathematics lesson" (40.2%), "I do mathematics because I enjoy it" (37.0%), and " I am interested in the things I learn in mathematics" (49.6%) (Table A6.9 in the *PISA 2012 E-appendix*).

Instrumental motivation was also assessed using four items: "Making an effort in mathematics is worth it because it will help me in the work that I will do later on" (79.9% of students in Ireland strongly agreed or agreed); '"Learning mathematics is worthwhile for me because it will improve my career prospects and chances" (88.3%); "Mathematics is an important subject for me because I need it for what I want to study later on" (66.2%); and "I will learn many things in mathematics that will help me get a job" (75.6%) (see Table A6.10 in the *PISA 2012 E-appendix*). Scales (indices) were constructed for both intrinsic and instrumental motivation, each with an OECD average of 0 and a standard deviation of 1.

To obtain a measure of perseverance, students were asked to indicate how well each of five statements related to them. Three of the statements were positively worded: "I remain interested in the tasks that I start" (55.4% of students in Ireland indicated it was very much like them or mostly like them indicating positive perseverance); "I continue working on tasks until everything is perfect" (47.8%); and "When confronted with a problem I do more than is expected of me" (33.3%) (see Table A6.11 in the *PISA 2012 E-appendix*). Two statements were negatively worded: "When confronted with a problem, I give up easily" (61.2% said it was not like me at all or not like me); and "I put off difficult problems" (45.4%). The individual items were combined to form an index of perseverance, with an OECD mean of 0 and a standard deviation of 1.

In Ireland, the mean score for intrinsic motivation related to mathematics is 0.06, which is significantly above the OECD average of 0.0 (Table 6.3). The mean score for instrumental motivation is 0.13, while that for perseverance is 0.14. All three are significantly above the OECD average of 0.0.

Table 6.3. Mean scores on indices exploring students' intrinsic motivation, instrumental motivation and perseverance, in Ireland and on average across OECD countries

	Ireland			OECD			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Intrinsic motivation	0.06	(0.02)	0.97	0.00	(0.00)	0.97	**0.06**	(0.02)
Instrumental motivation	0.13	(0.02)	0.93	0.00	(0.00)	0.96	**0.13**	(0.02)
Perseverance	0.14	(0.02)	1.01	0.00	(0.0)	0.96	**0.14**	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

High-scoring countries on intrinsic motivation include Tunisia (0.53), Mexico (0.50) and Denmark (0.49). Among the lowest-scoring countries are Austria (-0.24), Korea (-0.39) and Japan (-0.52) (OECD, 2013d, Table III.3.4d). High-scoring countries on instrumental motivation are Peru (0.56), Albania (0.55) and Malaysia (0.53). Low-scoring countries included Austria (-0.41), Japan (-0.50) and Romania (-0.57) (OECD, 2013d, Table III.3.5c). The highest-scoring countries on perseverance are Kazakhstan (0.77), Albania (0.65) and Bulgaria (0.57), with Turkey (0.45) the highest OECD country (OECD , 2013d, Table III.3.1d). Low-scoring countries are France (0.45), Slovak Republic (-0.49) and Japan (-0.59).

In Ireland, male students (0.21) have a significantly higher score than females (0.04) on instrumental motivation, while there is no difference between males and females on intrinsic motivation (Table 6.4, Table A6.12 in the *PISA 2012 E-appendix*). Male students (0.21) also have a significantly higher mean score on perseverance than females (0.07).

For both intrinsic and instrumental motivation, immigrant students who are speakers of English or Irish have significantly higher mean scores than native students, while immigrant students who speak other languages have a significantly higher mean score than native students on intrinsic but not instrumental motivation. Differences in favour of immigrant students are large, ranging from one-third of a standard deviation (intrinsic motivation, in favour of immigrant speakers of English or Irish) to one-quarter of a standard deviation (instrumental motivation, in favour of immigrant speakers of other languages). Although immigrant speakers of English/Irish and immigrant speakers of other languages have higher scores on perseverance than native students, differences are not statistically significant.

Students attending SSP schools have a significantly higher mean score (0.23) than students attending non-SSP schools (0.10) on instrumental motivation but they did not differ in terms of intrinsic motivation (Table 6.4; see Table A6.14 in the *PISA 2012 E-appendix*). No significant differences are found on either intrinsic or instrumental motivation between students attending schools in different gender/sector categories (Table A6.15 in the *PISA 2012 E-appendix*). Students attending girls' secondary schools have significantly lower perseverance than students attending boys' secondary schools and mixed secondary schools (Table A6.15 in the *PISA 2012 E-appendix*).

Correlations between motivation to learn mathematics and performance on PISA mathematics are all weak to moderate, ranging from 0.237 (intrinsic motivation and print mathematics) to 0.126 (instrumental motivation and computer-based mathematics) (Table 6.4; see Table A6.16 in the *PISA 2012 E-appendix*). Correlations between perseverance and mathematics are stronger: 0.257 in the case of print mathematics, and 0.215 in the case of computer-based mathematics.

Table 6.4. Indices of motivation to learn mathematics – summary of gender differences, differences by immigrant/language status, and by SSP/ DEIS status, and correlations with mathematics performance, in Ireland

Scale	Gender (Male – Female)	Native – Immigrant (Eng/Irish)	Native – Immigrant (Other)	SSP – non-SSP	Correlation - print mathematics	Correlation – computer mathematics
Intrinsic motivation	M = F	**N < I**	**N < I**	SSP < n-SSP	**0.237**	**0.208**
Instrumental motivation	**M > F**	**N < I**	N = I	**SSP > n-SSP**	**0.138**	**0.126**
Perseverance	**M > F**	N = I	N = I	**SSS < n-SSP**	**0.257**	**0.215**

Statistically significant differences and correlations shown in bold. See Tables A6.12, A6.13, A6.14, and A6.16 in the *PISA 2012 E-appendix* for details.

6.3 Mathematics Self-beliefs

Three clusters of items were administered to students to assess their mathematics self-beliefs – those relating to mathematics self-efficacy, mathematics self-concept, and mathematics anxiety. Mathematics self-efficacy was assessed by asking students to indicate their level of confidence (ranging from very confident to not at all confident) in completing eight tasks in mathematics. For example, in Ireland, 85.9% of students indicated that they are either very confident or confident in "Using a train timetable to work out how long it would take to get from one place to another"; 80.2% that they could solve an equation like 3x = 5 = 17; 53.0% that they could calculate the petrol consumption rate of a car; and 48.7% that they could find the actual distance between places on a map with a 1:10 000 scale (Table A6.17 in the *PISA 2012 E-appendix*). Mathematics self-concept was assessed by asking students to indicate their level of agreement with five statements. Positively-worded statements included "I get good grades in mathematics" (in Ireland, 61.4% strongly agree or agree) and "I learn mathematics quickly" (46.5%), while negatively-worded statements included "I am just not good at mathematics" (39.9%) (Table A6.18 in the *PISA 2012 E-appendix*). Anxiety about mathematics was assessed by asking students to indicate their agreement with five statements, all of which were negatively worded. These included "I get very tense when I have to do mathematics homework" (in Ireland, 36.0% strongly agreed or agreed), "I get very nervous doing mathematics problems" (29.7%) and "I worry that I will get poor grades in mathematics" (62.1%) (Table A6.19 in the *PISA 2012 E-appendix*). Indices were constructed for the three aspects of self-belief about mathematics, each with a mean of 0 and a standard deviation of 1 across OECD countries.

In Ireland, the mean scores of students on the self-efficacy and self-concept indices are not significantly different from the corresponding OECD average scores (Table 6.5). This indicates that students in Ireland have similar levels confidence in their ability to solve a range of mathematics tasks (self-efficacy) and similar levels of confidence in their mathematical abilities as the average student across OECD countries. Anxiety about mathematics is significantly higher in Ireland – by just over one-tenth of a standard deviation – than on average across OECD countries. This indicates that students in Ireland are somewhat more likely than students on average across OECD countries to be anxious about engaging in mathematics tasks.

Table 6.5. Mean scores on indices of students' mathematics related self-, in Ireland and on average across OECD countries

	Ireland			OECD			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Self-efficacy	0.01	(0.02)	0.97	0.0	(0.0)	0.98	0.01	(0.02)
Self-concept	-0.04	(0.02)	0.94	0.0	(0.0)	0.98	-0.04	(0.02)
Anxiety	0.11	(0.02)	0.91	0.0	(0.0)	0.97	**0.11**	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

High-scoring countries on the self-efficacy index include Shanghai-China (0.94), Liechtenstein (0.49) and Singapore (0.33), while Germany (0.33) and Slovenia (0.33) are the highest-scoring OECD countries (OECD, 2013d, Table III.4.1c). Low-scoring countries on self-efficacy include Japan (-0.41), Colombia (-0.44) and Brazil (-0.45). High-scoring countries on self-concept are the United Arab Emirates (0.44), Jordan (0.43) and Kazakhstan (0.39), while the highest-scoring OECD countries are the United States (0.30), Iceland (0.24) and Denmark (0.23) (OECD, 2013d, Table III.4.2b). Low-scoring countries include Korea (-0.38), Chinese Taipei (-0.45) and Japan (-0.52). The countries with the highest levels of mathematics anxiety are Tunisia (0.65), Argentina (0.54) and Brazil (-0.51) (OECD, 2013d, Table III.4.3b). The OECD countries with the highest levels of mathematics anxiety are Mexico (0.45), Chile (0.42) and Japan (0.36). Countries with the lowest levels are Sweden (-0.35), Denmark (-0.37) and the Netherlands (-0.39).

In Ireland, male students report significantly higher mean scores than females on self-efficacy (0.32 scale points higher) and self-concept (0.26). Females have a significantly higher mean score on anxiety (0.32) (Table 6.6; see Table A6.20 in the *PISA 2012 E-appendix*). Immigrant speakers of English or Irish have a significantly higher mean score on self-efficacy (by 0.30 points) than native students, while immigrant speakers of other languages also have a higher mean score (by 0.14) than native speakers (Table 6.6; see Table A6.21 in the *PISA 2012 E-appendix*). Native speakers have a higher score on anxiety (by 0.27) compared with immigrants who speak a language other than English or Irish. A small difference on mathematical anxiety in favour of native students over immigrant speakers of English or Irish is not statistically significant. Students attending SSP schools have significantly lower mean scores on self-efficacy (by 0.26 points) and on self-concept (0.10) and a significantly higher mean score on anxiety about mathematics (by 0.27) compared with students in non-SSP schools (Table 6.6, see Table A6.22 in the *PISA 2012 E-appendix*). Students attending girls' secondary schools have significantly lower self-efficacy (by 0.34 points) and self-concept (by 0.19) than students attending boys' secondary schools (Table A6.23 in the *PISA 2012 E-appendix*).

Students attending girls' secondary schools also have higher levels of mathematical anxiety than students attending boys' secondary schools, mixed secondary schools and vocational schools. The differences are 0.32, 0.17 and 0.18 respectively.

Correlations between mathematics self-efficacy and performances on mathematics are in the moderate to strong range, while those between self-concept and performance are in the moderate range (Table 6.6, see Table A6.24 in the *PISA 2012 E-appendix*). Correlations between anxiety and performance, which are uniformly negative, are at the upper end of the moderate range. Particular care should be exercised in interpreting the moderate-to-strong correlations between self-efficacy and mathematics – whether print- or computer-based – since the self-efficacy questions could be interpreted as proxies for mathematical performance.

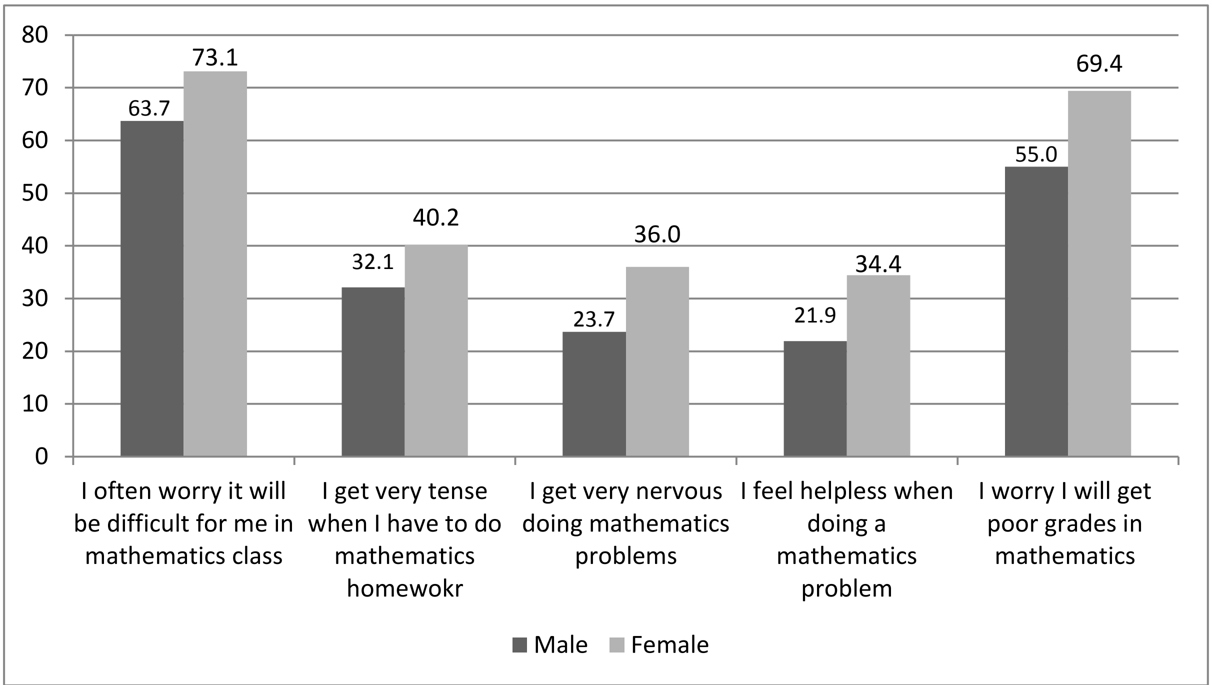
Table 6.6. Students' mathematics-related self-belief indices – summary of gender differences, differences by immigrant/language status, and by SSP/ DEIS status, and correlations with mathematics performance, in Ireland

Scale	Gender (Male – Female)	Native – Immigrant (Eng/Irish)	Native – Immigrant (Other)	SSP – non-SSP	Correlation - print mathematics	Correlation – computer mathematics
Self-efficacy	**M > F**	**N < I**	N = I	**SSP < n-SSP**	**0.551**	**0.465**
Self-concept	**M > F**	N = I	**N < I**	**SSP < n-SSP**	**0.403**	**0.342**
Anxiety	**M < F**	N = I	**N > I**	**SSP > n-SSP**	**-0.380**	**-0.313**

Statistically significant differences and correlations shown in bold. See Tables A6.20, A6.21, A6.22, and A6.24 in the *PISA 2012 E-appendix* for details.

Figure 6.2 illustrates the gender differences on component items on the mathematics anxiety scale. For example, 63.7% of male students and 73.1% of female students report that they "often worry it will be difficult for them in mathematics classes", while 55% of males and almost 70% of females report that they "worry they will get poor grades in mathematics".

Figure 6.2. Percentages of male and female students indicating strong agreement or agreement with various statement contributing to the mathematics anxiety scale, in Ireland



6.4 Self-responsibility for Failure in Mathematics and Openness to Problem Solving

PISA 2012 also asked students about their attributions of failure in mathematics and their openness to problem solving.

To measure their perceived self-responsibility for failure in mathematics, students were asked to consider the following situation “Each week your mathematics teacher gives a short quiz. Recently you have done badly on these quizzes. Today you are trying to figure out why”. They were then asked to indicate how likely they are to have the following thoughts or feelings in this situation: “to think or feel that they are not very good at solving mathematics problems” (in Ireland, 53.9% of students responded that they are likely or very likely to feel this way); that “their teacher did not explain the concepts well this week” (45.4%), that ”this week they made bad guesses on the quiz” (41.0%); “that sometimes the course material is too hard” (71.8%); that “ the teacher did not get the students’ interested in the material” (51.0%); and that sometimes they are just unlucky (37.6%) (Table A6.25 in the *PISA 2012 E-appendix*). An index based on these responses was constructed to have an OECD average of 0 and a standard deviation of 1. Students with high values on this index tend to attribute the responsibility for failure in solving mathematics problems to themselves, while students with low values on the index are more likely to see other individuals or factors as responsible

Openness to problem solving was assessed by asking students to indicate their levels of agreement with five general statements (all positively worded): “I can handle a lot of information” (52.4% of students in Ireland strongly agree or agree); “I am quick to understand things” (55.3%), “I seek explanations for things” (66.2%), “I can easily link facts together” (56.8%), and “I like to solve complex problems” (29.8%). Again, a scale with an OECD mean of 0 and a standard deviation of 1 was constructed (Table A6.26 in the *PISA 2012 E-appendix*). The openness to problem solving scale is not mathematics-specific, since the underlying questions refer to problem-solving in general.

The mean score for students in Ireland on the self-responsibility for failure in mathematics index is -0.10, which is significantly below the OECD average. This indicates that students in Ireland are more likely than on average across OECD countries to attribute failure in mathematics to others rather than to themselves. The difference between the mean score for students in Ireland on openness to problem solving (-0.02) and the corresponding OECD average is not statistically significant (Table 6.7).

Table 6.7. Mean scores on the index of self-responsibility for failure in mathematics and openness to problem solving, in Ireland and on average across OECD countries

	Ireland			OECD			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Self-responsibility for failure	-0.10	(0.02)	0.96	0.0	(0.0)	0.97	**-0.10***	(0.02)
Openness to problem solving	-0.02	(0.02)	0.96	0.0	(0.0)	0.97	-0.02	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

The countries with the highest mean scores on the index of self-responsibility for failure in mathematics are Bulgaria (0.47), Croatia (0.42) and Greece (0.35) (OECD, 2013d, Table III.3.3b). Students in these countries are more likely to blame themselves rather than others for poor performance in mathematics. Low scoring countries (where students are less likely to blame themselves for poor performance, and are more likely to blame others) are Shanghai-China (-0.49), Kazakhstan (-0.67) and Japan -0.68. The highest scoring countries on openness to problem solving are Jordan (0.62), Montenegro (0.62) and Albania (0.51), with Poland (0.36) as the highest OECD country. Low-scoring countries are Korea (-0.37), Vietnam (-0.60), and Japan (-0.73) (OECD, 2013D, Table III.3.2d).

In Ireland, female students (-0.01) have a significantly higher mean score than male students (-0.20) on self-responsibility for failure in mathematics. This indicates that females are more likely than males to blame themselves for poor performance in mathematics. Males (0.05) have a significantly higher mean score than females (-0.10) on openness to problem solving (Table 6.8; Table A6.27 in the *PISA 2012 E-appendix*).

Immigrant speakers of English or Irish and other immigrants had significantly lower mean scores on the index of self-responsibility for failure in mathematics than native students, indicating that, compared with native students, they were less likely to blame others for poor performance in mathematics and more likely to blame themselves (Table 6.8; Table A6.28 in the *PISA 2012 E-appendix*). Differences between native and immigrant students are not statistically significant for openness to problem-solving. There are no differences on either self-responsibility for failure in mathematics or on openness to problem solving between students attending schools in SSP under DEIS or non-SSP schools (Table 6.8; Table A6.29 in the *PISA 2012 E-appendix*). However, students attending girls' schools have a higher score on self-responsibility for failure than students attending boys' schools or vocational schools (Table A6.30 in the *PISA 2012 E-appendix*). This is broadly consistent with the earlier finding that females were less likely than males to blame others for poor performance in mathematics.

Table 6.8. Students' mathematics-related self-belief indices– summary of gender differences, differences by immigrant/language status, and by SSP/ DEIS status, and correlations with mathematics performance, in Ireland

Scale	Gender (Male – Female)	Native – Immigrant (Eng/Irish)	Native – Immigrant (Other)	SSP – non-SSP	Correlation - print mathematics	Correlation – computer mathematics
Self-responsibility for failure	**M < F**	**N > I**	**N > I**	SSP = n-SSP	**-0.191**	**-0.160**
Openness to problem solving	**M > F**	N = I	N = I	SSP = n-SSP	**0.404**	**0.362**

Statistically significant differences and correlations shown in bold. See Tables A6.27, A6.28, A6.29, and A6.31 in the *PISA 2012 E-appendix* for details.

The correlations between self-responsibility for failure in mathematics and mathematics performance are in the weak-to-moderate range, and are negative for both print (-0.191) and computer-based mathematics (-0.160) (Table 6.8; Table A6.31 in the *PISA 2012 E-appendix*). These correlations indicate that students with higher performance in mathematics tend to attribute failure in mathematics to others rather than to themselves. Correlations between openness to problem-solving and mathematics performance are positive, significant and in the moderate range with a slightly stronger correlation for print mathematics (0.404) than for print mathematics (0.362).

6.5 Mathematics Behaviours, Intentions and Subjective Norms

Three further item clusters that also formed indices are considered in this section: mathematics-related behaviours, mathematics-related intentions, and subjective norms. As noted in Chapter 5, students were asked about the frequency with which they engaged in eight mathematics-related activities and behaviours. These included: "I participate in a mathematics club" (0.9% of students in Ireland said they do so always or almost always); "I take part in mathematics competitions" (2.4%); "I programme computers" (12.5%) and "I help my friends with mathematics" (19.1%) (Table A6.32 in the *PISA 2012 E-appendix*). Students' mathematics-related intentions were assessed using four items. For each item, students had to indicate which of two statements best described them. For example, they were asked to choose between whether they "Intend to take additional mathematics courses after school finishes" (47.3% of students in Ireland) or "Intend to take additional English courses after school finishes" (52.7%) (Table A6.33 in the *PISA 2012 E-appendix*). Students' mathematics-related subjective norms were assessed by asking them to indicate their level of agreement with six statements such as "Most of my friends do well in mathematics" (67.5% of students in Ireland strongly agree or agree), and "My parents like mathematics" (62.2%) (Table A6.34 in the *PISA 2012 E-appendix*). Indices were constructed for each of these clusters such that the OECD average was set at 0 and the standard deviation at 1.

The mean score of students in Ireland on the index of mathematics-related behaviours was -0.43, while for mathematics intentions, it is -0.12. Both scores are significantly below the corresponding OECD averages (Table 6.9). The first indicates that students in Ireland are, on average, significantly less likely than their counterparts across OECD countries to participate in activities that might be expected to support performance in mathematics, such as doing mathematics as an extra-curricular activity, or taking part in mathematics activities. The second indicates that, on average, students in Ireland are somewhat less likely, than on average across OECD countries, to indicate an intention to engage in mathematics-related activities or courses as part of their future education or careers. On the index of students' subjective norms for mathematics, the mean score for students in Ireland was 0.13, which was significantly above the OECD average. This indicates that students in Ireland are somewhat more likely than their counterparts in other OECD countries to report that significant others, including their parents and friends, expect them to do well in mathematics, and that those persons like mathematics themselves.

Table 6.9. Mean scores on indices of students' behaviours, intentions and subjective norms related to mathematics, in Ireland and on average across OECD countries

	Ireland			OECD			Difference	
	Mean	SE	SD	Mean	SE	SD	IRL-OECD	SE Diff
Mathematics behaviours	-0.43	(0.02)	0.98	0.0	(0.0)	0.97	**-0.43**	(0.02)
Mathematics intentions	-0.12	(0.02)	0.96	0.0	(0.0)	0.99	**-0.12**	(0.02)
Mathematics subjective norms	0.13	(0.02)	0.89	0.0	(0.0)	0.95	**0.13**	(0.02)

Note: Significant differences in bold. Percentages and mean scores were computed using normalised population weights. Standard errors (SE) were computed using a balanced repeated replication (BRR) method of variance estimation.

The highest-scoring countries on the index of mathematics behaviours are Jordan (1.48), Qatar (1.21) and Kazakhstan (1.13), while Turkey (0.55) and Israel (0.38) are the highest-scoring OECD countries (OECD, 2013d, Table III.4.4b). In addition to Ireland (-0.42), low-scoring countries include Norway (-0.45) and the Netherlands (-0.49). The highest-scoring countries on the index of mathematics intentions are Sweden (0.35), Denmark (0.35) and Vietnam (0.32) (OECD, 2013d, Table III.4.5b). Low-scoring countries include Romania (-0.34), Serbia (-0.42), and Montenegro (-0.45). Korea (-0.21) is the lowest-scoring OECD country. The highest-scoring countries on the subjective norms index are Albania (1.08), Malaysia (1.05) and Kazakhstan (0.97) (OECD, 2013d, Table III.4.6b). The highest scoring OECD countries are Israel (0.47) and Mexico (0.44). The lowest-scoring countries are Croatia (-0.45), the Czech Republic (-0.50) and Japan (-0.58).

In Ireland, male students have a significantly higher mean score than females on mathematics intentions (Table 6.10; Table A6.35 in the *PISA 2012 E-appendix*). There is no difference between males and females on either mathematics behaviours or subjective norms related to mathematics. Native student have a significantly lower score than immigrant students who speak English/Irish and immigrant students who speak another language on mathematics behaviours and subjective norms, while there are no differences on mathematics intentions (Table 6.10; Table A6.36 in the *PISA 2012 E-appendix*). Students in SSP schools have a higher mean score than students in non-SSP schools on mathematics intentions, while there is no difference between students attending the two school types on mathematics behaviours or on subjective norms related to mathematics (Table 6.10; Table A6.37 in the *PISA 2012 E-appendix*). Students attending girls' secondary schools have a significantly lower mean score on mathematics intentions than students attending boys' secondary schools, mixed secondary schools, vocational schools and community/comprehensive schools (Table A6.38 in the *PISA 2012 E-appendix*).

Table 6.10. Students' behaviours, intentions and subjective norms related to mathematics – summary of gender differences, differences by immigrant/language status, and by SSP/ DEIS status, and correlations with mathematics performance, in Ireland

Scale	Gender (Male – Female)	Native – Immigrant (Eng/Irish)	Native – Immigrant (Other)	SSP – non-SSP	Correlation - print mathematics	Correlation – computer mathematics
Mathematics behaviours	M = F	**N < I**	**N < I**	SSP = n-SSP	**0.142**	**0.129**
Mathematics Intentions	**M > F**	N = I	N = I	**SSP > n-SSP**	**0.069**	0.029
Subjective norms	M = F	**N < I**	**N < I**	SSP = n-SSP	0.003	0.038

Statistically significant differences and correlations shown in bold. See Tables A6.35, A6.36, A6.37, and A6.39 in the *PISA 2012 E-appendix* for details.

There are weak to moderate correlations that are statistically significant between mathematics behaviours and performance on both the print (0.142) and computer-based (0.129) mathematics tests (Table 6.10. Table A6.39 in the *PISA 2012 E-appendix*). There is a weak but non-significant correlation between mathematics intentions and performance on the print mathematics test. Correlations between the subjective norms related to mathematics index and performance on the print and computer-based mathematics tests are not statistically significant.

6.6 Correlations among Indices

A significant challenge in making inferences about the importance of various indices of behaviour, motivation, self-beliefs and intentions is that many of them correlate significantly with one another, and with other variables considered in this chapter, such as gender and immigrant status.

Table 6.11 gives correlations among the indices considered in this chapter. One observation is that there tends to be moderate to strong correlations among variables that are conceptually related. Thus, the correlation between mathematical self-efficacy and self-concept is 0.578, while that between mathematical self-concept and anxiety about mathematics is -0.753. Similarly, the correlation between intrinsic and instrumental motivation is 0.576.

In general, correlations between the indices and individual student ESCS are weak. The strongest is that between mathematics self-efficacy and ESCS (0.280), while the correlation between mathematics intention and ESCS (-0.022) is not statistically significant.

Table 6.11. Correlations among indices of students' attitudes towards and behaviour in school, their motivation to learn mathematics, their self-beliefs about mathematics, and their attribution of failure in mathematics, in Ireland

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Learning outcomes	-	.479	.502	.286	.391	.199	.248	.191	-.174	-.191	.192	.196	.114	.302	.077
2. Learning activities	.479	-	.350	.281	.397	.218	.273	.164	-.089	-.125	.244	.208	.117	.297	.137
3. Sense of belonging to school	.502	.350	-	.243	.307	.190	.265	.171	-.192	-.163	.230	.137	.128	.256	.043
4. Intrinsic motivation	.286	.281	.243	-	.576	.349	.450	.690	-.492	-.366	.360	.408	.422	.425	.075
5. Instrumental motivation	.391	.397	.307	.576	-	.269	.342	.459	-.318	-.225	.260	.298	.423	.523	.045
6. Perseverance	.199	.218	.190	.349	.269	-	.402	.451	-.381	-.221	.476	.290	.106	.195	.141
7. Self-efficacy	.248	.273	.265	.450	.342	.402	-	.578	-.466	-.302	.510	0.33	.221	.239	.280
8. Self-concept	.191	.164	.171	.690	.459	.451	.578	-	-.753	-.441	.465	.317	.400	.282	.147
9. Anxiety	-.174	-.089	-.192	-.492	-.318	-.381	-.466	-.753	-	.441	-.340	-.158	-.286	-.125	-.123
10. Responsibility for failure	-.191	-.125	-.163	-.366	-.225	-.221	-.302	-.441	.441	-	-.201	-.134	-.223	-.177	-.046
11. Openness to problem-solving	.192	.244	.230	.360	.260	.476	.510	.465	-.340	-.201	-	.331	.101	.194	.201
12. Mathematics behaviours	.196	.208	.137	.408	.298	.290	0.33	.317	-.158	-.134	.331	-	.152	.315	.133
13. Mathematics intentions	.114	.117	.128	.422	.423	.106	.221	.400	-.286	-.223	.101	.152	-	.241	-.022
14. Mathematics subjective norms	.302	.297	.256	.425	.523	.195	.239	.282	-.125	-.177	.194	.315	.241	-	.102
15. ESCS	.077	.137	.043	.075	.045	.141	.280	.147	-.123	-.046	.201	.133	-.022	.102	-

Note: All correlations are statistically significant except that between mathematics intentions and ESCS.

6.7 Summary

This chapter examined the responses of students in Ireland to items designed to assess attitudes towards and engagement with school and mathematics. In addition to responses to individual questionnaire items, the chapter looked at indices constructed from clusters of items. The purpose of the chapter was to gain insights into some of the behavioural, motivational and confidence-related factors associated with students' performance on mathematics – both print and computer-based.

Students' attitudes towards school were considered with reference to activities (for example, the view that trying hard at school will lead to a good job) and outcomes (for example, students' perceptions that school taught them things that could be useful in getting a job). On both indices, students in Ireland have mean scores that were significantly higher than the corresponding OECD average, indicating that, in general, students in Ireland are satisfied that school is beneficial to them. Students in Ireland have a mean score on sense of belonging to school that is not significantly different from the corresponding OECD average. Correlations between students' attitudes to school and performance in mathematics are significant but low, while the correlation between sense of belonging and performance is not statistically significant.

Students in Ireland achieved mean scores on indices of intrinsic and instrumental motivation in mathematics that are above the corresponding OECD averages, while their mean score on perseverance (on problem solving in general) is also above the corresponding OECD average. Male students have higher levels of instrumental (but not intrinsic) motivation than females, while males also have higher average perseverance. Correlations between the motivation indices, perseverance and mathematics performance are in the weak to moderate range.

The mean scores for students in Ireland on self-efficacy and self-concept are not significantly different from the OECD average scores. However, students in Ireland have a significantly higher level of anxiety about mathematics. While male students in Ireland have higher levels of mathematical self-efficacy and self-concept than females, they have lower levels of anxiety. Correlations between measures of mathematics-related self-beliefs and mathematics performance are moderate to strong, with the strongest being that between self-efficacy and print mathematics (.551).

Students in Ireland have a mean score on the index of self-responsibility for failure in mathematics that is significantly below the corresponding OECD average, indicating that they are less likely to attribute mathematics failure to themselves, and more likely to attribute it to others. Ireland's mean score on openness to problem solving is about the same as the corresponding OECD average. Male students have a significantly lower score than females on self-responsibility for failure in mathematics and a significantly higher score on openness to problem solving. Correlations between self-responsibility for failure and mathematics performance are negative, meaning that those who attribute their failure in mathematics to others tend to do better than those who attribute their failure to themselves.

Students in Ireland have the third-lowest mean score among participating countries in PISA 2012 on mathematics behaviours, indicating that they do not engage in activities related to mathematics such as chess, mathematics clubs or computer-programming with any great frequency. The mean score of students in Ireland is also low on the index of mathematics intentions, indicating that students in Ireland are less likely than students on average across OECD countries to indicate an intention to study mathematics courses in college or pursue a career in mathematics. Students in Ireland have a score that is above the OECD average on the subjective norms in mathematics index, indicating that the views about mathematics of their parents and friends, and how they evaluate the mathematical abilities of these significant others influence how they think about mathematics. Male students in Ireland have a significantly higher mean score than females on mathematics intentions. Correlations between mathematical behaviour, mathematical intentions and performance are weak, while those between subjective norms and mathematics performance are not statistically significant.

7. Trends in Student Performance, Characteristics Attitudes and Beliefs

PISA 2012 is the fifth cycle of the assessment since it began in 2000. This chapter describes changes that have occurred in the performance, characteristics, attitudes and beliefs of students in Ireland across PISA cycles and examines factors which may have contributed to observed changes in performance across cycles. Supplementary tables are provided in the *PISA 2012 E-appendix,* available at www.erc.ie/p12eappendix. Some issues around trends in PISA are also documented in national publications on PISA 2009 (La Roche & Cartwright, 2010; Cartwright, 2011; Cosgrove, Shiel, Perkins & Moran, 2010; Cosgrove, 2011).

7.1. Trends in Student Performance

PISA assesses student performance in mathematical, reading and scientific literacy. In each cycle, one domain becomes the main focus (or 'major domain') of the assessment, meaning that the majority of test items are from that domain and lesser focus is placed on the other, 'minor', domains. In 2000 and 2009, reading was assessed as the major domain, in 2003 and 2012 it was mathematics; and in 2006 science was the main focus of the assessment. The results for each domain in 2012 are compared back to results for that domain when it was assessed as a major domain (i.e., in the case of mathematics, results are compared back to 2003, while for reading results are compared to 2000 and 2009). Where data are available, comparisons are also be made between 2012 and cycles when a particular domain was assessed as a minor domain.

There have been changes in the number of countries participating in PISA, as well as the number of countries that form the OECD, across PISA cycles. The results between 2000 and 2012 can only be compared for 38 countries that have valid data for both cycles, 39 countries for comparisons between 2003 and 2012, 55 countries for comparisons between 2006 and 2012, and 62 countries for comparisons between 2009 and 2012 (Table 7.1). The number of OECD countries that have participated in PISA has also varied, from 28 in 2000 (25 of which have valid data for 2000 and 2012) to 34 in 2012.

Table 7.1: Number of participating countries that have valid data for comparison between cycles

	2000 & 2012	2003 & 2012	2006 & 2012	2009 & 2012
All participating countries	38	39	55	62
OECD countries	25	29	30	33

Note: see Table A7.1 in the PISA 2012 E-appendix (www.erc.ie/p12eappendix) for a list of countries that have valid data for comparisons between cycles

Digital reading was introduced as a minor domain in 2009 and was also assessed in 2012; therefore comparisons can be made between these two cycles for digital reading (among the 17 countries that participated in the assessment in both cycles). Computer-based mathematics was assessed for the first time in 2012; therefore, no trend information is available for this assessment.

In 2003 and 2012, an additional minor domain, problem solving, was also assessed (as a print assessment in 2003 and a computer-based assessment in 2012). Results of the problem-solving assessment will be presented in a subsequent report that will be released by the OECD in spring 2014.

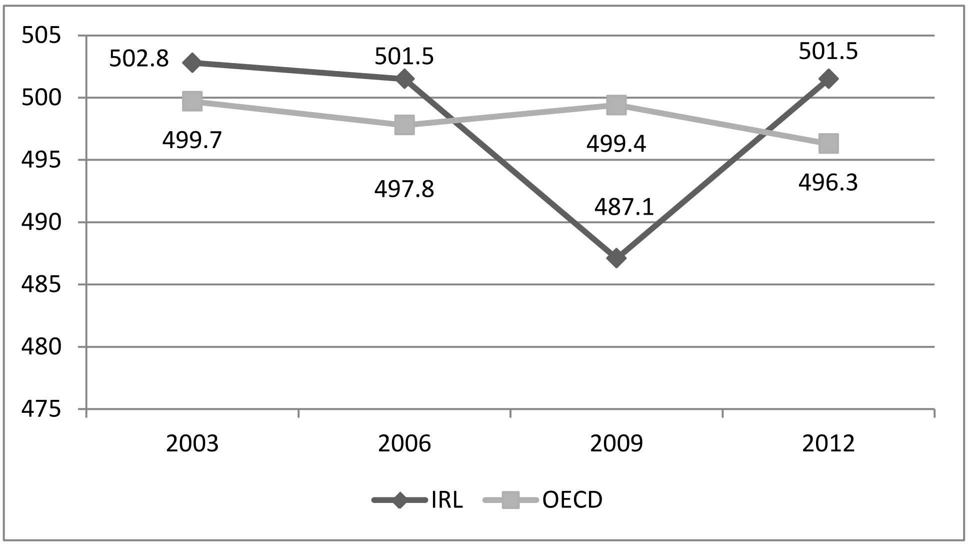
In this chapter, to allow for valid comparisons of the OECD average over time, the OECD average reported for each domain across cycles is restricted to the number of OECD countries that participated in PISA when the domain was first assessed as a major domain. For example, for mathematics, the OECD average is based on the 29 OECD countries that have valid data for both 2003 and 2012 (the OECD averages reported for mathematics in 2006 and 2009 are also based on these 29 countries). For reading, the OECD averages for each cycle are based on the 25 OECD countries that have valid data for both 2000 and 2012, while for science the OECD averages are based on the 30 OECD countries that have valid data for 2006 and 2012 (see Table A7.1 in the *PISA 2012 E-appendix* for a list of OECD countries that have valid data for each cycle). This means that some of the OECD averages reported in this chapter differ slightly from those reported in earlier chapters.

As well as examining changes in mean scores over time, this chapter describes changes in the proportions of lower- and higher-achieving students. As student performance and assessment items are placed on the same scale in PISA, each domain scale can be divided into proficiency levels and the skills of students at each level described (see Inset 1.1. in Chapter 1 for a description of proficiency levels). For each domain, Level 2 is considered the basic level of proficiency needed to participate effectively and productively in society and in future learning, while at or above Level 5 is considered as a benchmark for high achievement (OECD, 2013b).

7.1.1. Trends in Print Mathematics Performance since 2003

Ireland's mean print mathematics score in 2012 is 501.5, which does not differ significantly from the mean print mathematics scores for Ireland in 2003 (502.8) and 2006 (501.5), but is significantly above the mean score in 2009 (487.1; Figure 7.1). In 2003 and 2006, Ireland's mean print mathematics scores were above, but did not differ significantly from, the corresponding OECD average scores (499.7 and 497.8, respectively), whereas in 2009, Ireland's mean score was significantly below the corresponding OECD average score (499.4). In 2012, the mean print mathematics score for Ireland is significantly above the corresponding OECD average (496.3).

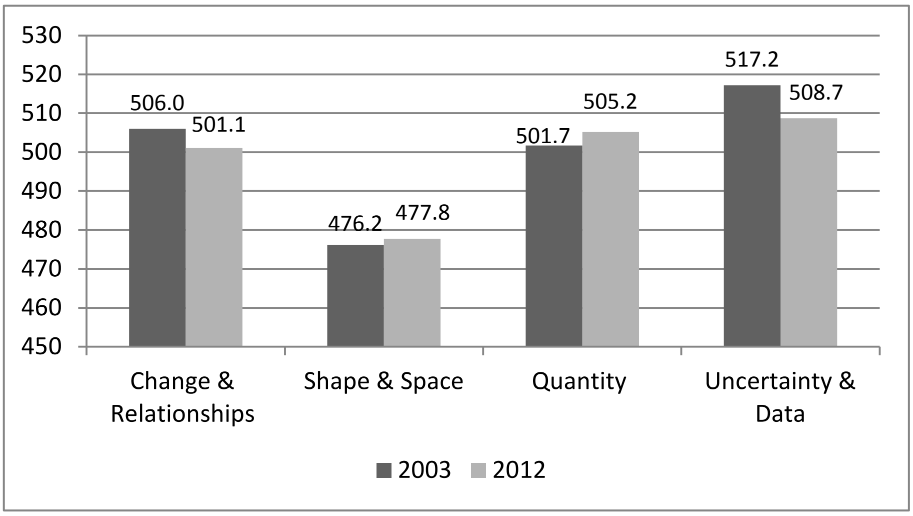
Figure 7.1. Mean scores on the overall mathematics scale for Ireland and the average across OECD countries, 2003 to 2012



Note: See Table A7.2 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean mathematics scores for Ireland and the average across OECD countries across PISA cycles, as well as analysis of difference.

As mathematics was assessed as the major domain in both 2003 and 2012, it was possible to measure student performance on four mathematics content area subscales (Change & Relationships, Space & Shape, Quantity and Uncertainty & Data) in both cycles.[47] Figure 7.2 presents the mean scores of students in Ireland on the four content area subscales for 2003 and 2012. There is little variation in the mean scores of students on the content area subscales across the two cycles, with the exception of the Uncertainty & Data subscale. Although performance is highest on the Uncertainty & Data subscale in both cycles, students in Ireland perform significantly less well on this subscale in 2012 than in 2003 (508.7 versus 517.2; see Table A7.3 in the *PISA 2012 E-appendix*). There has also been little change in the position of Ireland's mean scores on the content area subscales relative to the corresponding OECD average scores: students in Ireland have significantly higher mean scores on the Change & Relationships and Uncertainty & Data subscales compared to the OECD average scores, but have significantly lower mean scores on the Space & Shape subscale in both cycles. The mean score of students in Ireland on the Quantity subscale is not significantly different from the OECD average in 2003, but is significantly above it in 2012.

Figure 7.2. Mean scores on the four mathematics content scales for Ireland in 2003 and 2012

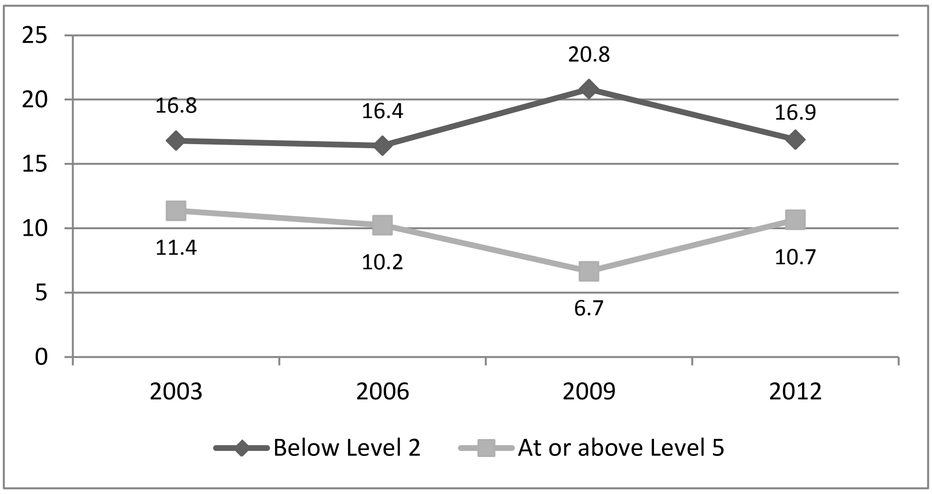


Note: See Table A7.3 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores for each of the mathematical content areas for Ireland across PISA cycles, as well as analyses of differences.

With the exception of 2009, there has been little change in the proportions of higher- and lower-achieving students in Ireland since 2003 (i.e. those scoring below Level 2, and those scoring at or above Level 5, respectively) (Figure 7.3). In both 2003 and 2012, the proportions of lower achieving students in Ireland are below the corresponding OECD averages (21.5% in 2003 and 23.0% in 2012). The proportions of higher-achieving students in Ireland are also below the corresponding OECD averages in both cycles (14.6% in 2003 and 12.6% in 2012).

[47] Performance on content area subscales was not reported on in 2006 and 2009 as mathematics was a minor domain.

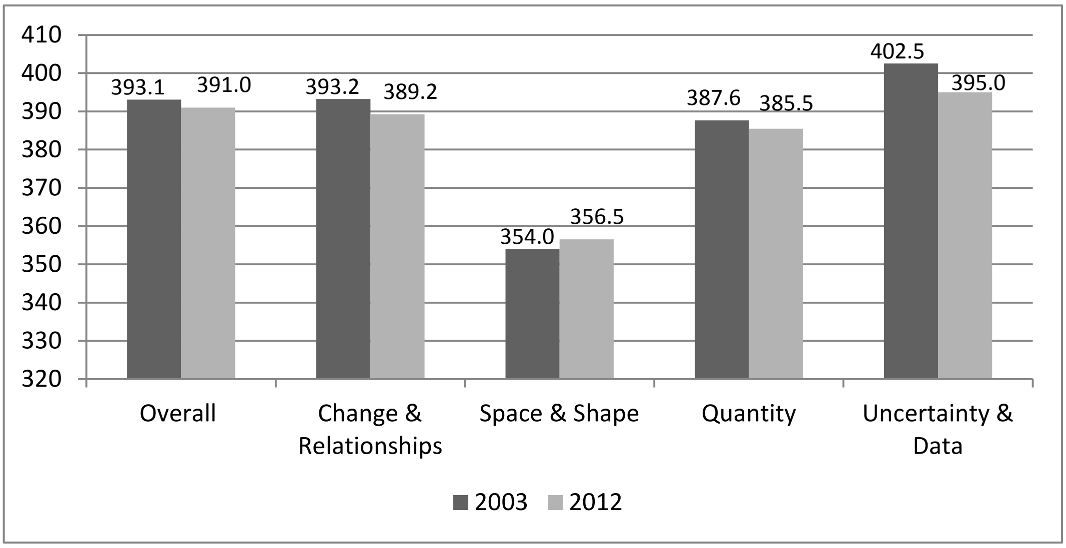
Figure 7.3. Percentage of students below proficiency level 2 and at or above proficiency level 5 on the overall mathematics scale in Ireland, 2003 to 2012



Note: See Table A7.4 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentage of students below Level 2 and at or above Level 5 on the print mathematics scale in Ireland across PISA cycles, as well as analyses of differences.

Similarly, in Ireland, there are no significant differences in the scores of students at the 10th percentile on the overall print mathematics scale and on any of the content area subscales between 2003 and 2012 (Figure 7.4). The score of students at the 10th percentile on the overall mathematics scale in Ireland is higher than the corresponding OECD average in 2003 and 2012.

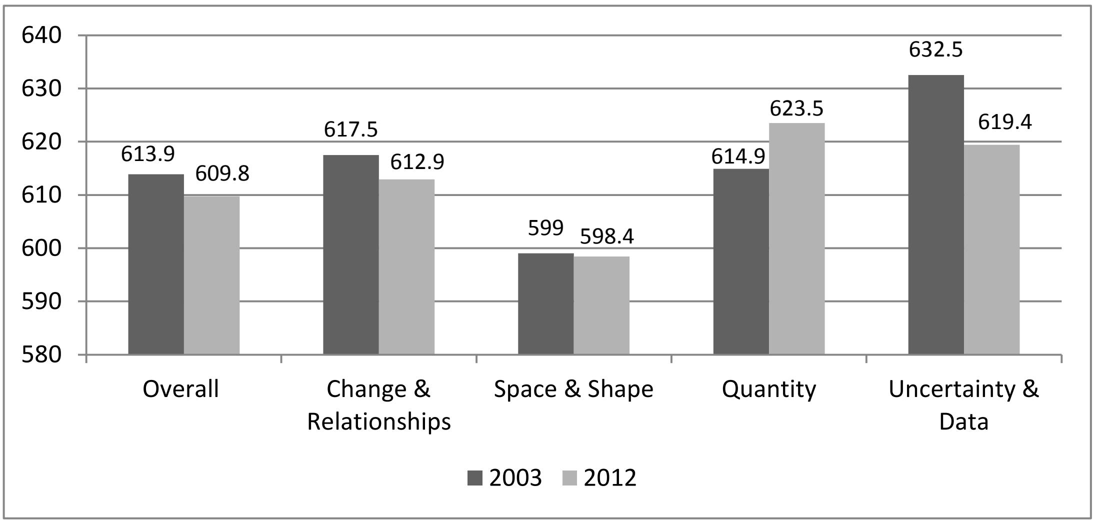
Figure 7.4. Scores of students at the 10th percentile on the overall mathematics scale and four content subscales in Ireland, in 2003 and 2012



Note: See Table A7.5 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the scores of students at the 10th percentile in Ireland in 2003 and 2012, as well as analyses of differences.

There is also little variation in the score of students at the 90th percentile on the overall mathematics scale and the content area subscales in Ireland, between 2003 and 2012 (Figure 7.5). There has been, however, a significant drop on the Uncertainty & Data subscale among higher-achieving students between 2003 and 2012 (from 632.5 to 619.4). In 2003, the score of students performing at the 90th percentile on the overall mathematics scale in Ireland was similar to the OECD average. However, in 2012, students at the 90th percentile in Ireland perform less well than the average across OECD countries

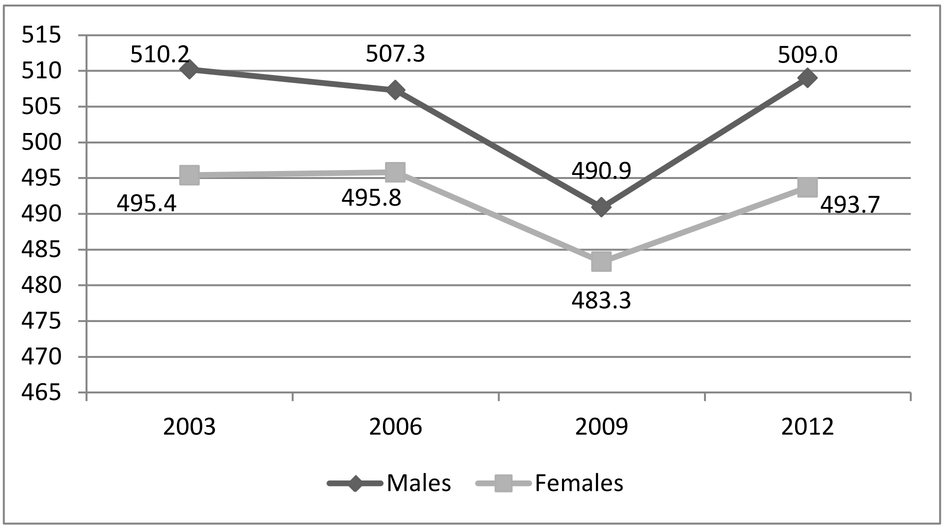
Figure 7.5. Scores of students at the 90th percentile on the overall mathematics scale and four content subscales in Ireland, in 2003 and 2012



Note: See Table A7.6 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the scores of students at the 90th percentile in Ireland in 2003 and 2012, as well as analyses of differences.

In Ireland, the mean print mathematics score of male students in 2012 (509.0) does not differ significantly from the mean scores of males in 2003 or 2006 (510.2 and 507.3, respectively), but is significantly above the score in 2009 (490.9; Figure 7.6). Similarly, the mean score of female students in 2012 is significantly higher than in 2009 (493.7 and 483.3, respectively), but does not differ significantly from the mean scores in 2003 or 2006 (495.4 and 495.8, respectively). The gender difference in 2012 (15.3 points) is about the same as in 2003 (14.8 points) and is significant in both cycles. In 2003, both male and female students in Ireland had higher mean scores than the corresponding OECD averages (505.1 for males and 494.4 for females); although the differences were not significant (see Table A7.7 in the *PISA 2012 E-appendix*). However, in 2012, the mean score of male students in Ireland is significantly higher than the OECD average for males (501.5), while there is no significant difference for female students (490.9). In both cycles, the gender difference is larger in Ireland compared to the OECD averages (10.6 points in 2003 and 2012), although not significantly so.

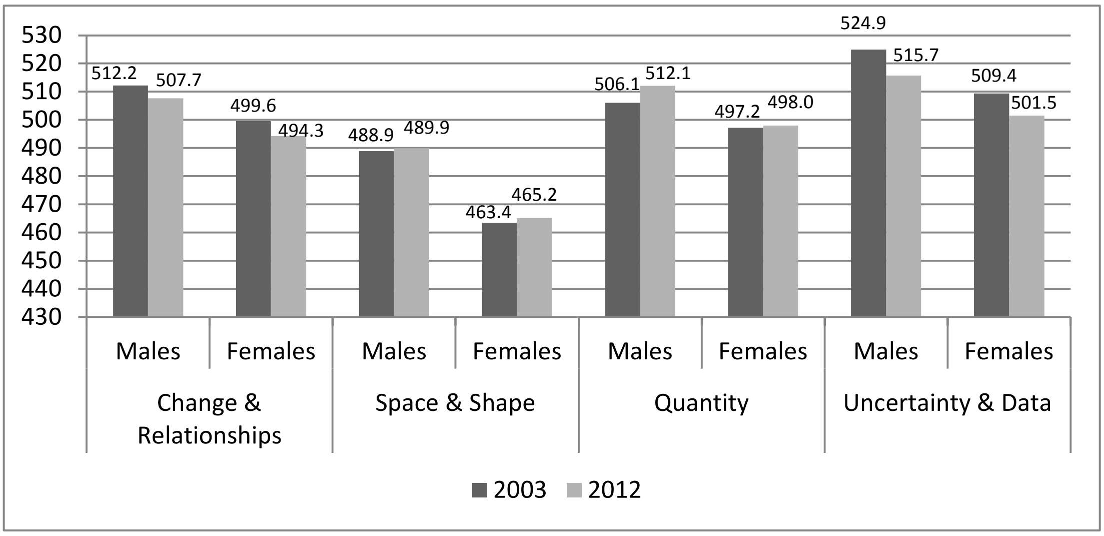
Figure 7.6. Mean scores of male and female students on the overall mathematics scale in Ireland, 2003 to 2012



Note: See Table A7.8 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean mathematics scores of male and female students in Ireland across cycles, as well as analyses of differences.

There has been some variation in the mean scores of male and female students on the content area subscales between 2003 and 2012. For example, both male and female students have lower mean scores on the Change & Relationships and Uncertainty & Data subscales in 2012 compared to 2003, while males have seen an increase in their mean score on the Quantity subscale since 2003 (Figure 7.7). However, none of these differences are statistically significant.

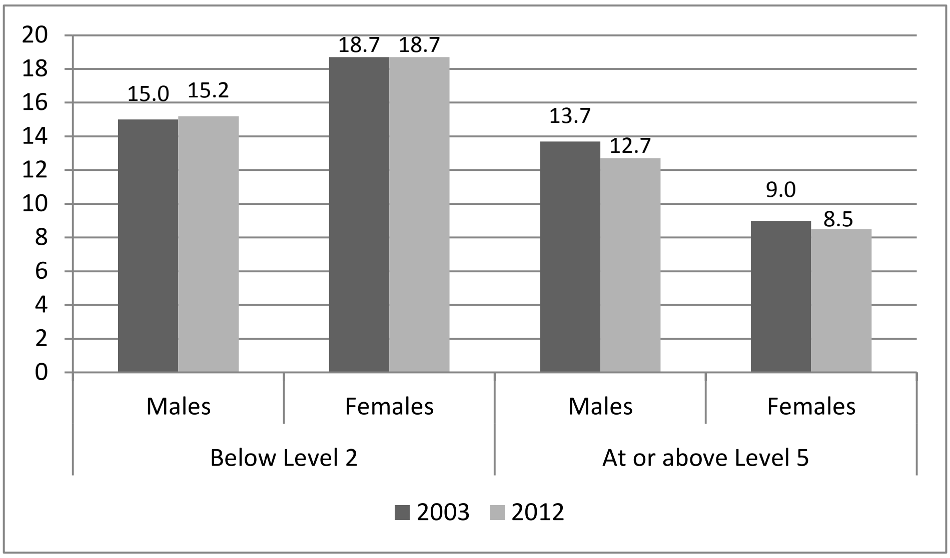
Figure 7.7. Mean scores of male and female students on the four mathematics content scales in Ireland, in 2003 and 2012



Note: see Table A7.9 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean mathematics scores of male and female students on each of the content area subscales in 2003 and 2012, as well as analyses of differences.

In Ireland, the proportions of male and female students performing below Level 2 and at or above Level 5 on the overall mathematics scale has changed very little between 2003 and 2012 (Figure 7.8). Ireland has lower proportions of both lower- and higher-achieving males and females compared to the corresponding OECD averages in both 2003 and 2012 (see tables A7.10 and A7.11 in the *PISA 2012 E-appendix*).

Figure 7.8. Percentages of male and female students below proficiency level 2 and at or above proficiency level 5 on the overall print mathematics scale in Ireland, in 2003 and 2012

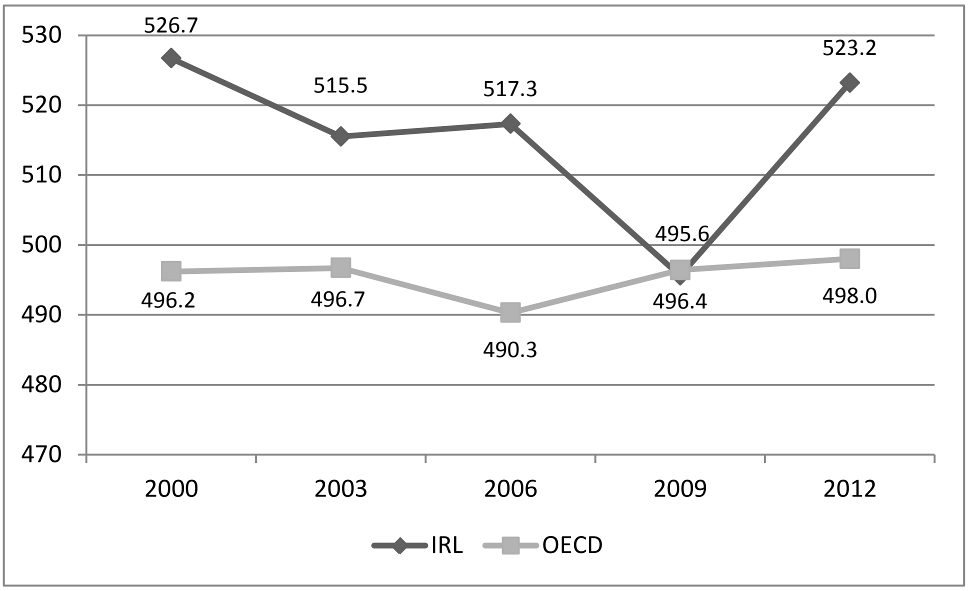


Note: see Table A7.12 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentages of male and female students below Level 2 and at or above Level 5 in Ireland in 2003 and 2012, as well as analyses of differences.

7.1.2. Trends in Print Reading Performance Since 2000

The mean print reading score of students in Ireland in 2012 is 523.2, which is significantly higher than the mean score in 2009 (495.6), but not significantly different from the mean scores in 2000, 2003 or 2006 (526.7, 515.5 and 517.3, respectively). Ireland's mean print reading scores in 2000, 2003, 2006 and 2012 are significantly above the corresponding OECD averages (496.2, 496.7, 490.3 and 498.0), while the difference between Ireland and the OECD average (496.4) in 2009 was not significantly different (Figure 7.9).

Figure 7.9 Mean scores on the overall print reading scale for Ireland and the average across OECD countries, 2000 to 2012

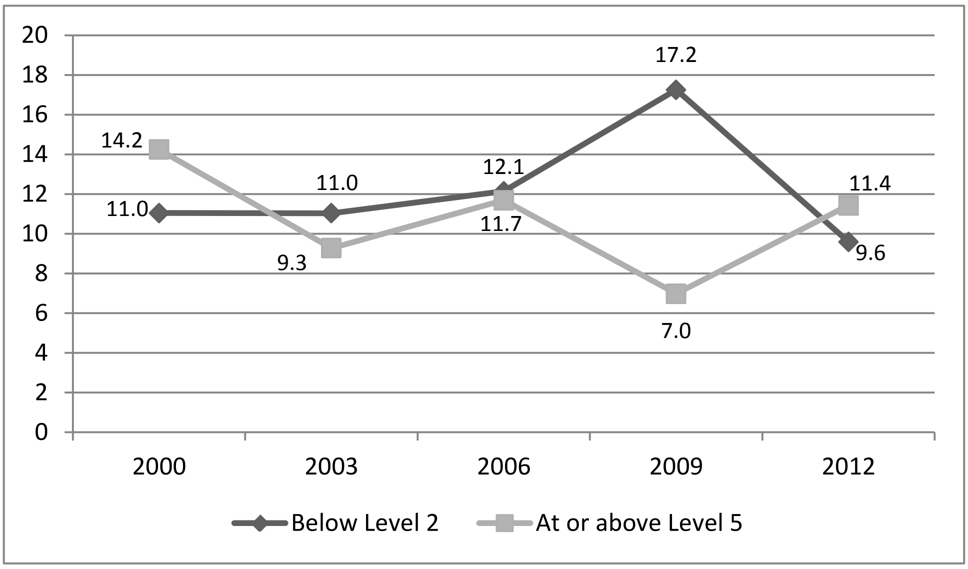


Note: See Table A7.13 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean reading scores for Ireland and the average across OECD countries across PISA cycles, as well as analyses of differences.

Although two new proficiency levels were introduced for print reading in 2009 (Level 1b at the lower end of proficiency and Level 6 at the upper end), the same cut points are used for levels 2 and 5 in all cycles; therefore, the proportion of students performing below Level 2 (i.e., lower-achieving students) and at or above Level 5 (i.e., higher-achieving students) can be compared for all cycles. The proportion of lower-achieving students in Ireland in 2012 (9.6%) is marginally lower than in 2000, 2003 and 2006 (11.0% in 2000 and 2003, and 12.1% in 2006), but is considerably lower than the proportion in 2009 (17.2%, Figure 7.10). On the other hand, the proportion of higher-achieving students in 2012 (11.4%) is higher than in 2003 and 2009 (9.3% and 7.0%, respectively), but is lower than the proportion in 2000 (14.2%).

In all cycles except 2009, the proportions of lower-achieving students in Ireland are considerably below the corresponding OECD averages and there are somewhat higher proportions of higher-achieving students than on average across OECD countries. In Ireland in 2009, the percentages of lower- and higher-achieving students are very similar to the corresponding OECD averages (see Table A7.14 in the *PISA 2012 E-appendix* for Irish and OECD percentages).

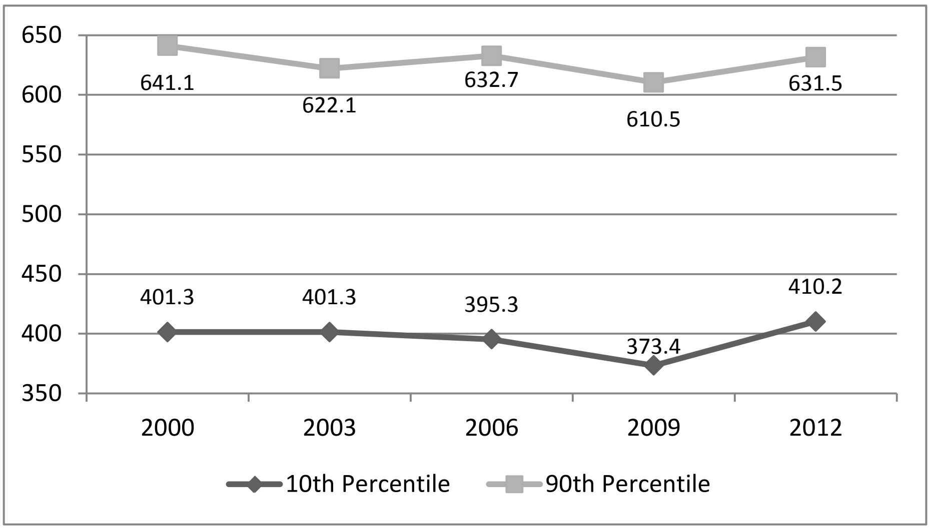
Figure 7.10. Percentage of students below proficiency level 2 and at or above proficiency level 5 on the overall print reading scale in Ireland, 2000 to 2012



Note: See Table A7.14 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentage of students below Level 2 and at or above Level 5 on the print reading scale in Ireland across PISA cycles.

Figure 7.11 presents the scores for students at the 10th and 90th percentiles on the print reading scale in Ireland for all cycles. The performance of students at the 10th percentile is higher in 2012 than in previous cycles, but the difference is only significant with respect to 2009. On the other hand, the score of students at the 90th percentile is considerably (though not significantly) below the corresponding score in 2000, and is significantly higher than the score in 2009. In Ireland, students at both the 10th and 90th percentiles have significantly higher scores than the corresponding averages across OECD countries in all cycles, with the exception of 2009, where the differences were not significant (see Table A7.15 in the *PISA 2012 E-appendix*).

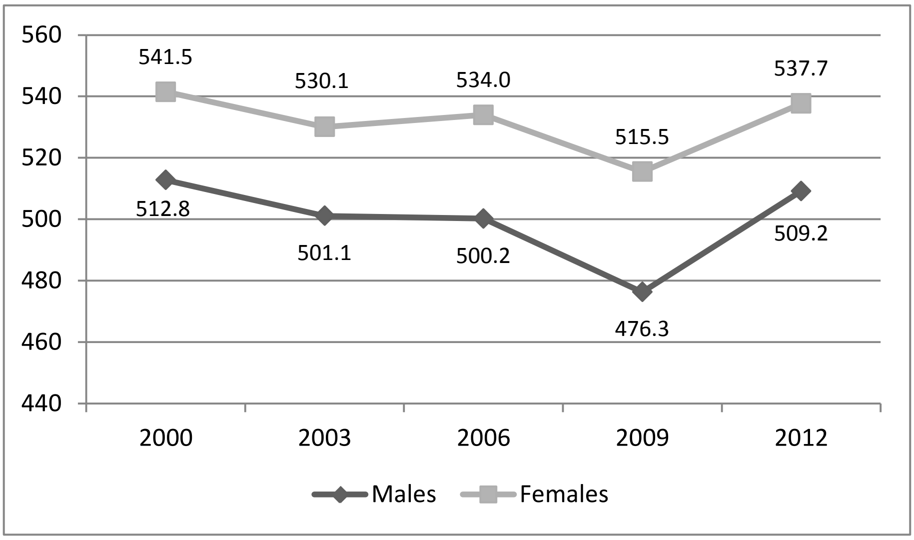
Figure 7.11. Scores of students at the 10th and 90th percentile on the overall print reading scale in Ireland, 2000 to 2012



Note: See Table A7.15 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the scores of students at the 10th and 90th percentiles on the print reading scale in Ireland across PISA cycles, as well as analyses of differences.

In Ireland, the mean scores of male and female students on the print reading scale in 2012 do not differ significantly from the corresponding scores in 2000, 2003 or 2006, but are significantly higher than the scores in 2009 (Figure 7.12). The gender gap in Ireland in 2012 (28.5 points) is about the same as it was in 2000 and 2003 (28.7 points and 29.0 points, respectively), but is smaller than in 2006 and 2009 (33.8 points and 39.2 points, respectively). For 2000 and 2012, the mean scores of male and female students in Ireland are significantly above the corresponding OECD average scores (see Table A7.16 in the *PISA 2012 E-appendix*).

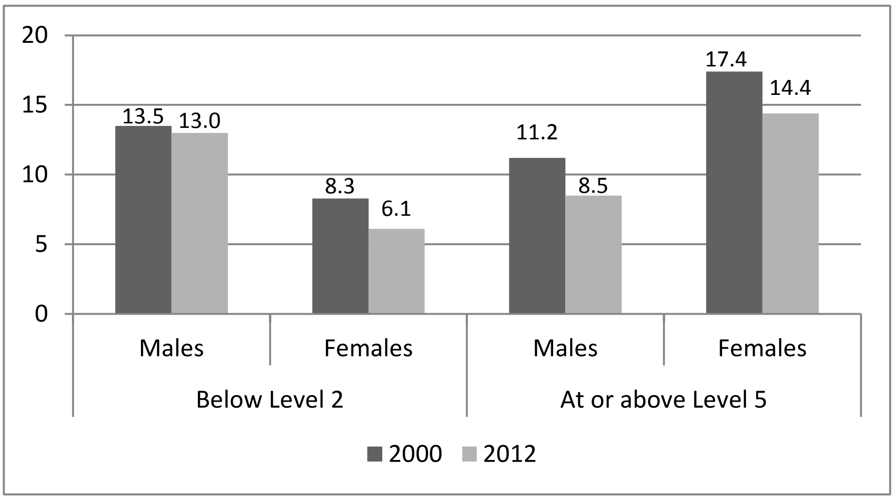
Figure 7.12. Mean scores of male and female students on the print reading scale in Ireland, 2000 to 2012



Note: See Table A7.17 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean print reading scores of male and female students in Ireland across cycles, as well as analyses of differences.

In Ireland, there has been little change in the proportions of male students performing below Level 2 since 2000 (13.5% in 2000 and 13.0% in 2012), while the proportion of lower-performing female students has decreased slightly, from 8.3% in 2000 to 6.1% in 2012. On the other hand, the proportions of male and female students performing at or above Level 5 on the print reading scale have decreased somewhat since 2000 (-2.7% for males and -3.0% for females; Figure 7.13). Ireland has lower proportions males and females performing below Level 2, and higher proportions of males and females performing at Level 5 or higher, compared to the corresponding OECD averages in both 2000 and 2012 (see Tables A7.18 and A7.19 in the *PISA 2012 E-appendix*).

Figure 7.13. Percentages of male and female students below proficiency level 2 and at or above proficiency level 5 on the overall print reading scale in Ireland, in 2000 and 2012

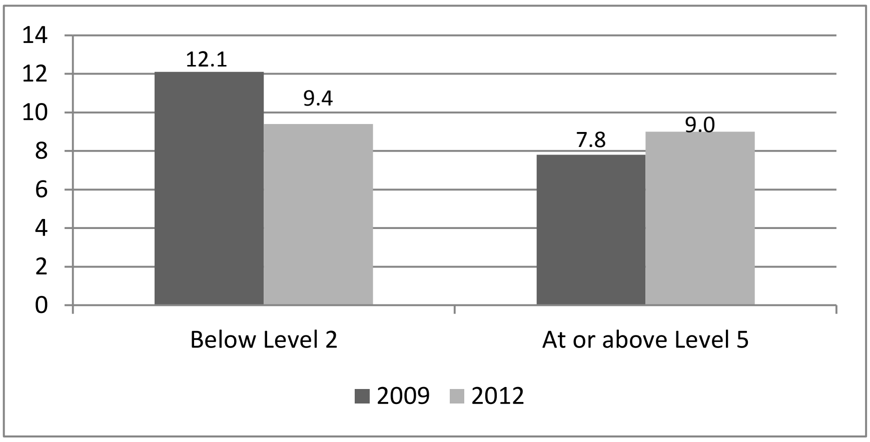


Note: see Table A7.20 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentages of male and female students below Level 2 and at or above Level 5 in Ireland in 2000 and 2012.

7.1.3. Trends in Digital Reading Performance Since 2009

Ireland's mean score on the digital reading scale in 2012 is 520.1, which is significantly higher than the mean score in 2009 (508.9). In both cycles, Ireland's mean score is significantly above the corresponding OECD average scores (see Table A7.21 in the *PISA 2012 E-appendix*).[48] Five proficiency levels were used to describe performance on digital reading in both 2009 and 2012. In Ireland, the proportion of lower-performing students (i.e., those below Level 2) on the digital reading scale dropped from 12.1% in 2009 to 9.4% in 2012. On the other hand, the proportion of higher-achieving students increased slightly since 2009, from 7.8% to 9.0% (Figure 7.14).

Figure 7.14. Percentage of students below proficiency level 2 and at or above proficiency level 5 on the digital reading scale in Ireland, in 2009 and 2012

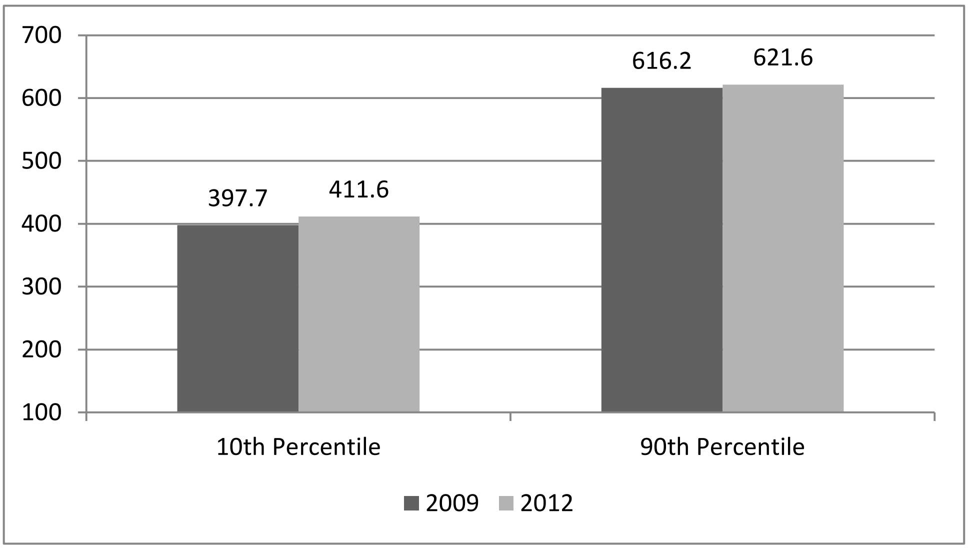


Note: See Table A7.22 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentage of students below Level 2 and at or above Level 5 on the digital reading scale in Ireland across PISA cycles.

Figure 7.15 shows the scores for students at the 10th and 90th percentiles on the digital reading scale in Ireland for 2009 and 2012. The performance of students at both the 10th and 90th percentiles increased, although not significantly, between the two cycles (from 397.7 to 411.6 for students at the 10th percentile and from 616.2 to 621.6 for students at the 90th percentile). In Ireland, students at both the 10th and 90th percentiles have significantly higher scores than the corresponding averages across OECD countries in both cycles.

[48] The OECD average for the 2009 digital reading assessment is based on the 16 OECD countries that participated in the assessment. The OECD average for 2012 is based on the 23 OECD countries that participated in the assessment. Fourteen OECD countries participated in the digital reading assessment in both 2009 and 2012.

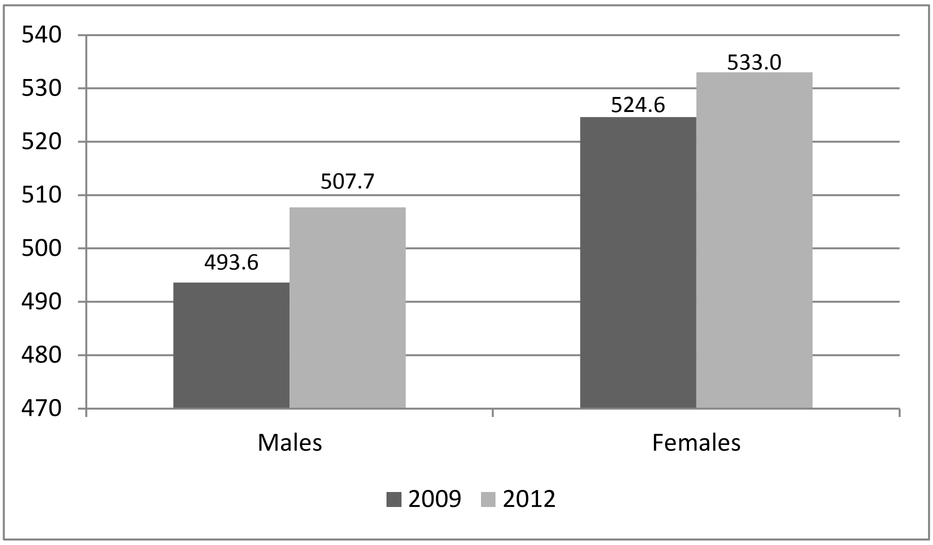
Figure 7.15. Scores of students at the 10th and 90th percentile on the digital reading scale in Ireland, in 2009 and 2012



Note: See Table A7.23 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the scores of students at the 10th and 90th percentiles on the digital reading scale in Ireland across PISA cycles, as well as analyses of differences.

The mean digital reading scores of both male and female students in Ireland also increased between 2009 and 2012, although the difference was larger (and significant) for males (+14.1 points) than for females (8.4 points; Figure 7.16). Female students significantly outperformed males in both cycles, although the gender difference has decreased from 31.1 points to 25.3 points. Both male and female students significantly outperformed their OECD counterparts in 2009 and 2012 (see Table A7.24 in the *PISA 2012 E-appendix*).

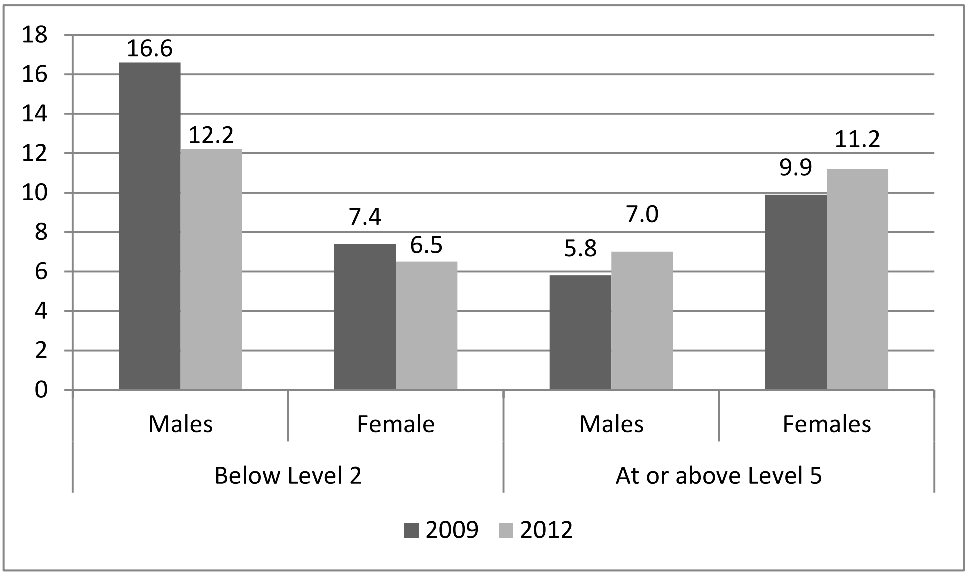
Figure 7.16. Mean scores of male and female students on the digital reading scale in Ireland, in 2009 and 2012



Note: See Table A7.25 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean digital reading scores of male and female students in Ireland across cycles.

Figure 7.17 presents the proportions of lower- (i.e., those below Level 2) and higher-achieving (i.e., those at or above Level 5) male and female students in Ireland in 2009 and 2012. The proportion of lower-achieving male students has decreased from 16.6% to 12.2% since 2009, while the proportion of lower-achieving female students has remained stable (7.4% in 2009 and 6.5% in 2012). The proportions of higher-achieving male and female students in Ireland has increased, although only slightly, between 2009 and 2012 (+1.2% for males and +1.3% for females). In both 2009 and 2012, the proportions of males and females below Level 2 in Ireland are lower than the corresponding OECD averages. In 2009, the proportions of males and females in Ireland at or above Level 5 were similar to the corresponding OECD averages. In 2012, the proportion of males at or above Level 5 in Ireland is similar to the OECD average, while the corresponding proportion of female students is higher in Ireland than on average across OECD countries (see Tables A7.26 and A7.27 in the *PISA 2012 E-appendix*).

Figure 7.17. Percentages of male and female students below proficiency level 2 and at or above proficiency level 5 on the digital reading scale in Ireland, in 2009 and 2012

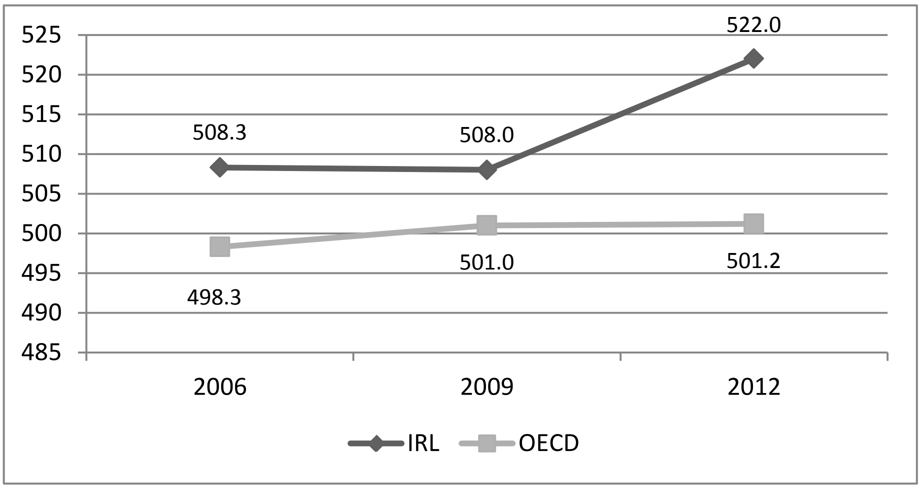


Note: see Table A7.28 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentages of male and females students below Level 2 and at or above Level 5 on the digital reading scale in Ireland in 2009 and 2012

7.1.4. Trends in Science Performance Since 2006

Ireland's mean science score in 2012 is 522.0, which is significantly above the mean scores for Ireland in 2006 (508.3) and 2009 (508.0; Figure 7.18). Ireland's mean science performance is significantly above the corresponding OECD averages in 2006 (498.3), 2009 (501.0) and 2012 (501.2).

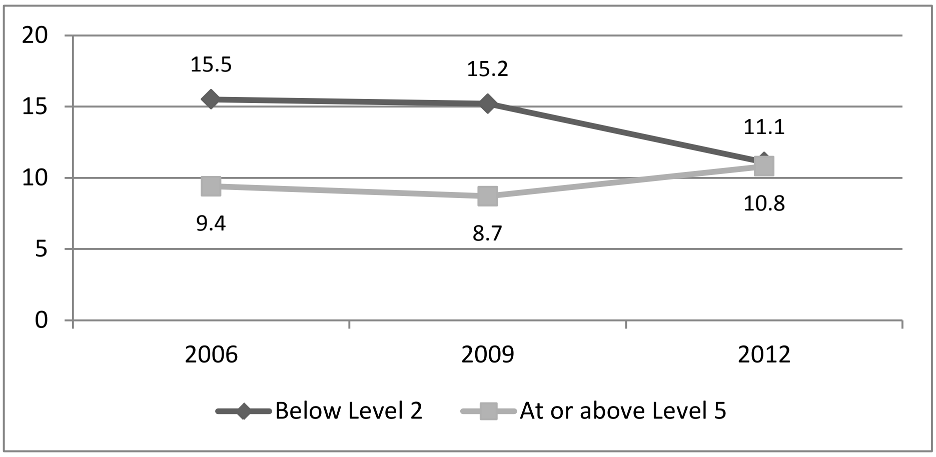
Figure 7.18. Mean scores on the overall science scale for Ireland and the average across OECD countries, 2006 to 2012



Note: See Table A7.29 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean science scores for Ireland and the average across OECD countries across PISA cycles, as well as analyses of differences.

Figure 7.19 presents the percentages of students in Ireland scoring below proficiency level 2 and at or above proficiency level 5 on the science scale. There is little difference in the proportions of lower- (i.e., below Level 2) and higher- (i.e., at or above Level 5) achieving students in Ireland between 2006 and 2009. However, in 2012, the proportion of lower-performing students dropped considerably, while the percentage of higher-achieving students increased. In each cycle, the proportions of students below Level 2 in Ireland are smaller than on average across OECD countries, while the proportions of students at or above Level 5 are slightly above (see Table A7.30 in the *PISA 2012 E-appendix*).

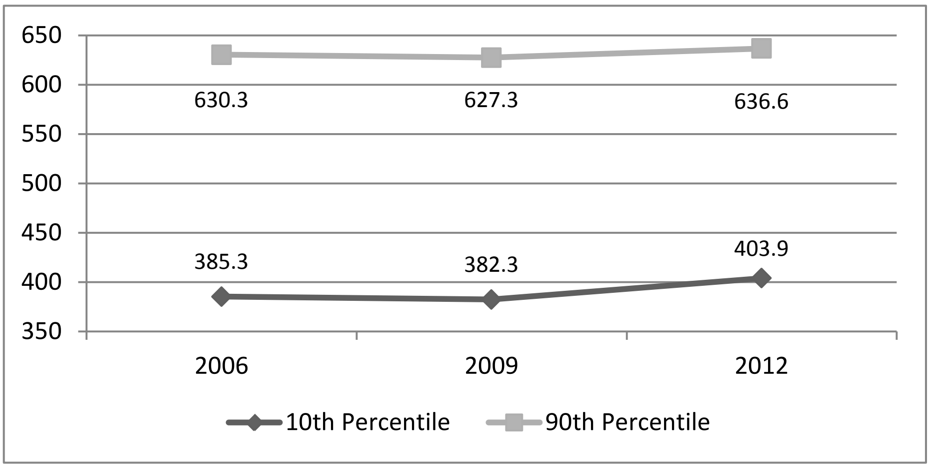
Figure 7.19. Percentage of students at below proficiency level 2 and at or above proficiency level 5 on the science scale in Ireland, 2006 to 2012



Note: See Table A7.30 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentage of students below Level 2 and at or above Level 5 on the science scale in Ireland across PISA cycles.

In Ireland, the scores of students at the 10th and 90th percentiles on the science scale are significantly higher in 2012 than in 2009 and 2006 (Figure 7.20). Students performing at the 10th percentile in Ireland are significantly above the corresponding OECD average scores in 2006 and 2012, but do not differ significantly in 2009. On the other hand, students at the 90th percentile perform significantly above the corresponding OECD average score in all cycles since 2006 (see Table A7.31 in the *PISA 2012 E-appendix*).

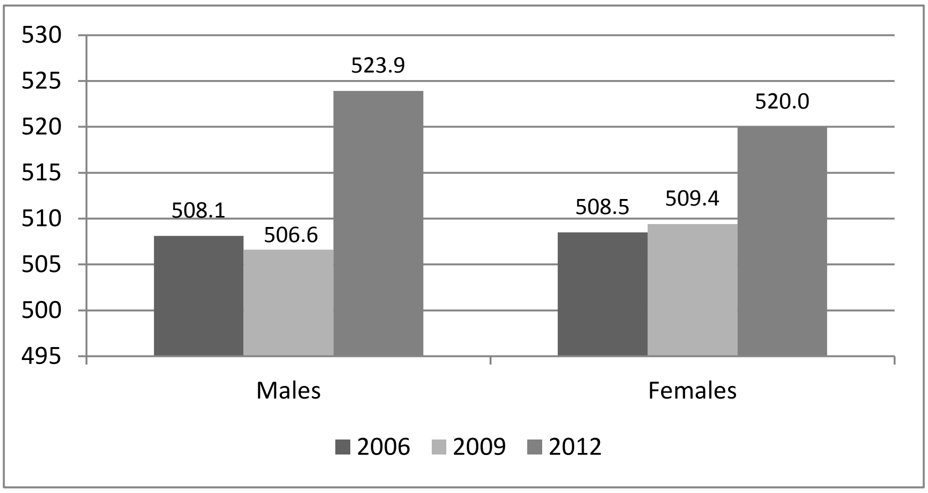
Figure 7.20. Scores of students at the 10th and 90th percentiles on the science scale in Ireland, 2006 to 2012



Note: See Table A7.31 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the scores of students at the 10th and 90th percentiles on the science scale in Ireland across PISA cycles, as well as analyses of differences.

The mean scores of male and female students in Ireland are significantly higher in 2012 than in 2006 and 2009 (Figure 7.21) and the increase since 2009 is greater among male students (+17.3 points) than among female students (+10.6 points). The gender difference has also changed somewhat since 2006, from 0.4 points in favour of females in 2006 to 3.9 points in favour of males in 2012, although these differences are not statistically significant in either cycle. The mean scores of both males and females in Ireland are significantly higher than the corresponding OECD average scores in 2006 and 2012 (see Table A7.32 in the *PISA 2012 E-appendix*).

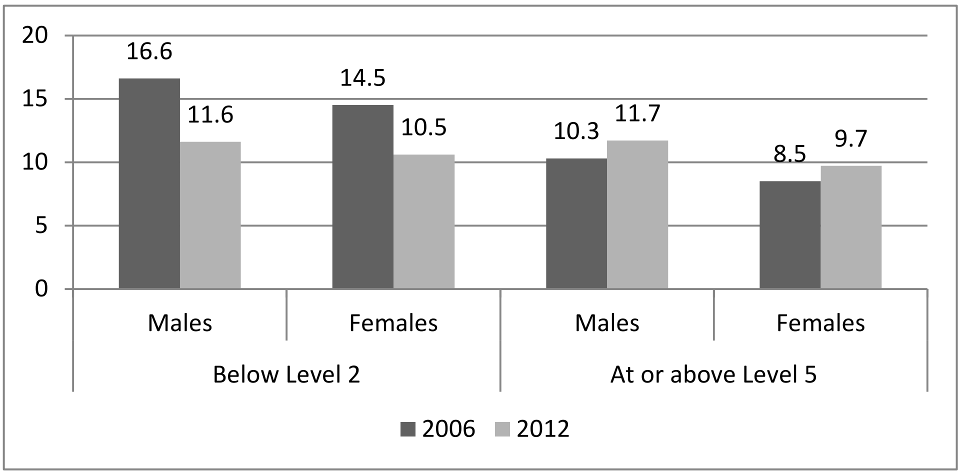
Figure 7.21. Mean scores of male and female students on the overall science scale in Ireland, 2006 to 2012



Note: See Table A7.33 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the mean science scores of male and female students in Ireland across cycles.

The proportions of male and female students performing below Level 2 have decreased considerably since 2006 (-5.0 percentage points for males and -4.0 percentage points for females), while the proportions at or above Level 5 have increased slightly (+1.4 percentage points for males and +1.2 percentage points for females; Figure 7.22). In Ireland, the percentages of lower-achieving males and females are lower than the corresponding OECD averages in both 2006 and 2012, while the proportions of higher-achieving males and females are higher in Ireland than on average across OECD countries in both cycles (see tables A7.34 and A7.35 in the *PISA 2012 E-appendix*).

Figure 7.22. Percentages of male and female students below proficiency level 2 and at or above proficiency level 5 on the science scale in Ireland, in 2006 and 2012



Note: see Table A7.36 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for the percentages of male and females students below Level 2 and at or above Level 5 on the science scale in Ireland in 2009 and 2012

7.2. Trends in Student and School Characteristics Since 2003

In order to better understand the comparisons between achievement scores over time, it is helpful to examine how the characteristics of students and schools have changed across PISA cycles. Building on the results presented in Chapter 5, this section looks at changing demographic patterns (including ESCS, family structure and immigrant and language status), associations between school-level variables and achievement (including between- and within-school variation, school sector and gender composition and the School Support Programme under DEIS) as well as other factors including grade (year level), early school leaving risk, frequency of arriving late for school and student reported disciplinary climate. Since mathematics was assessed as the major domain in both 2003 and 2012, the characteristics listed in Box 7.1 will be compared to 2003 and only associations with print mathematics achievement will be presented.

Box 7.1 Student and School Characteristics Examined in Section 7.2

Student Characteristics	**School Characteristics**
ESCS	Between-school variation in achievement
Family structure	Within-school variation in achievement
Immigrant and language status	School sector and gender composition
Grade level (year)	School Support Programme (SSP) under DEIS
Early school-leaving risk	
Frequency of arriving late for school	
Student reported disciplinary climate	

7.2.1. Student characteristics

ESCS was calculated slightly differently in 2003 and 2012 as the International Standard Classification of Occupations (ISCO) was revised in 2007. For comparison between the 2003 and 2012 cycles, 2003 student ESCS was re-calculated using the revised ISCO 08 index. Students in Ireland and on average across OECD countries have significantly higher mean ESCS in 2012 than in 2003 (Table 7.2). The overall effect of ESCS on mathematics achievement is significant for Ireland and the OECD average in both cycles but does not differ significantly between cycles.

The between-school effect of ESCS on print mathematics performance in schools increased for Ireland and on average across OECD countries, but the change is only significant for the OECD average. The within-school effect ESCS on print mathematics performance in Ireland has remained relatively stable over time.

Table 7.2. Comparison of mean ESCS and its effects on print mathematics in Ireland and on average across OECD countries, in 2003 and 2012

	2003				2012				Difference 2012-2003			
	IRL		OECD		IRL		OECD		IRL		OECD	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
ESCS	-0.26	(0.03)	-0.22	(0.01)	0.13	(0.02)	0.0	(0.0)	**0.39**	(0.04)	**0.22**	(0.01)
Overall effect of ESCS[1]	36.2	(1.74)	38.7	(0.41)	38.0	(1.82)	39.0	(0.40)	1.7	(2.51)	0.3	(0.57)
Between-schools effect of ESCS[2]	39.6	(5.10)	59.0	(1.07)	52.3	(4.71)	71.3	(1.20)	12.8	(6.94)	**12.3**	(1.60)
Within-schools effect of ESCS[1]	26.7	(1.50)	20.4	(0.32)	25.7	(1.71)	19.4	(0.32)	1.0	(2.27)	**1.1**	(0.45)

[1] Student-level score point difference associated with one unit increase in the student-level ESCS.
[2] School-level score point difference associated with one unit increase in the school mean ESCS

The percentage of students in one-parent families decreased between 2003 and 2012. In the same period, scores for students in one-parent families improved slightly, closing the achievement gap between them and students in other types of families (Table 7.3). However, there is still a significant difference between the groups of approximately one quarter of a standard deviation.

Table 7.3. Change in print mathematics achievement scores between 2003 and 2012 by family structure for Ireland

	2003			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
One-parent families (Ref)	15.4	475.3	(4.25)	11.0	485.0	(4.05)	9.7	(6.18)
Other family types	84.6	508.0	(2.50)	89.0	509.9	(2.13)	1.9	(3.81)
Diff (SED)		**32.7**	(4.93)		**24.9**	(4.58)	-7.80	(6.73)

There was a significant increase in the percentage of participants from immigrant backgrounds in Ireland between 2003 and 2012, from 3.4% to 9.6% (Table 7.4). No significant differences in print mathematics achievement are observed between native students and immigrant students who speak English or Irish, or between native students and immigrant students who speak another language between the two PISA cycles. There has also been little change in the mean scores of native and immigrant students (English/Irish and other language speakers combined) across the two cycles. In 2003, the mean age at which English- or Irish-speaking immigrants arrived in Ireland was 8.5 years (*SD* = 4.5) while other-language-speaking immigrants were aged on average 11.3 years on arrival (*SD* = 3.3). In 2012, the average age or arrival of both groups is significantly lower, 6.6 years (*SD* = 4.4) for Irish- or English-speakers and 9.5 years (*SD* = 3.6) for other-language-speakers.

Table 7.4. Change in print mathematics achievement scores between 2003 and 2012 by immigrant and language status for Ireland

	2003			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
Native (Ref)	96.6	503.6	(2.45)	90.4	503.5	(2.29)	-0.1	(4.06)
Immigrant with English or Irish	2.7	500.4	(11.06)	5.1	508.4	(6.13)	8.0	(12.85)
Immigrant with other language	0.7	496.8	(23.60)	4.5	499.0	(6.92)	2.2	(24.70)
Diff: Native- Immigrant with Eng/Irish (SED)		3.2	(11.33)		-4.9	(6.54)	-8.1	(13.28)
Diff: Native- Immigrant with other lang (SED)		6.8	(23.73)		4.5	(7.29)	-2.3	(24.93)
Diff: Immigrant with Eng/Irish- Immigrant other lang (SED)		3.6	(26.06)		9.4	(9.24)	5.8	(27.71)

Between 2003 and 2012, there were some significant differences in the print mathematics achievement of students in Second Year and in Transition Year (Table 7.5). Second Years in 2012 score significantly higher than in 2003, though it is important to note the small groups involved: 2.8% in 2003 and 1.9% in 2012 (see Table A7.37 in in the *PISA 2012 E-appendix*). For Transition Year students, scores are significantly lower in 2012 while the proportion of students in Transition Year has increased, from 16.7% to 24.3%. Notably, scores for Third Year students are almost unchanged with just a 2.5 point increase between 2003 and 2012. Similar patterns are apparent in the comparison of science results between 2006, when science was the major domain, and 2012 with a significant increase in the scores of Second Years and decrease (although not significant) for Transitions Year and Fifth Year students. Comparing print reading to 2009, students at all grade levels have significantly higher scores in 2012.

Table 7.5. Change in print mathematics, print reading and science achievement scores between 2003 and 2012 by current school grade for Ireland

	2000		2003		2006		2009		2012		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Print mathematics											Diff 2012-2003
Second Year	409.1	12.14	406.8	(9.48)	414.9	9.48	384.8	11.63	444.9	(10.58)	**38.1** (14.34)
Third Year	495.4	3.11	492.3	(2.97)	492.3	2.95	480.1	3.07	494.8	(2.34)	2.5 (4.25)
Transition Year	537.3	5.72	542.9	(4.56)	530.1	4.30	509.5	3.88	522.7	(3.95)	**-20.2** (6.33)
Fifth Year	516.6	4.484	515.1	(5.32)	511.2	4.18	496.1	4.86	501.6	(5.48)	-13.5 (7.88)
Print reading											Diff 2012-2009
Second Year	410.7	9.55	406.8	10.01	420.2	13.06	376.0	10.88	452.3	11.25	**76.3** (15.87)
Third Year	516.9	3.60	502.8	3.23	506.9	3.85	487.9	3.43	517.4	2.72	**29.5** (5.09)
Transition Year	568.4	4.52	562.0	4.48	547.8	4.70	525.3	4.42	544.5	3.80	**19.2** (6.38)
Fifth Year	547.9	4.30	530.8	4.36	530.9	4.56	498.2	5.51	520.6	5.76	**22.4** (8.38)
Science											Diff 2012-2006
Second Year	425.8	10.49	400.5	9.95	408.5	11.0	403.7	10.24	458.3	11.68	**32.5** (16.09)
Third Year	504.6	3.86	494.1	3.30	499.3	3.50	501.7	3.74	516.3	2.68	**11.7** (5.87)
Transition Year	550.9	5.61	548.6	4.71	537.1	4.30	532.9	4.93	543.3	3.97	-7.6 (7.72)
Fifth Year	529.6	5.15	518.8	5.23	519.6	4.30	510.0	5.57	518.3	5.46	-11.3 (8.29)

Note: Significant differences are in bold

Another notable trend between 2003 and 2012 is the decrease in the proportion of students who are at risk of early school-leaving (Table 7.6). In 2003, more than 20% of students said they did not intend to complete or were not sure if they would complete the Leaving Certificate compared to 6.5% in 2012. The print mathematics achievement scores of the at-risk group are stable over time. Scores for the 'at-risk' group fell significantly, though this may reflect a corresponding increase in the proportion lower-achieving students among those planning to sit the Leaving Certificate examinations.

Table 7.6. Change in print mathematics achievement scores between 2003 and 2012 by early school-leaving risk for Ireland

	2003			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
Not at risk	79.5	518.0	(2.31)	93.5	508.0	(2.06)	**-10.0**	(3.65)
At risk	20.5	442.8	(3.91)	6.5	444.8	(5.16)	2.0	(6.76)
Diff (SED)		**75.2**	(4.54)		**63.2**	(5.56)	-12.0	(7.68)

The proportions of students arriving late for school were stable between 2003 and 2012 with over 70% reporting that they were not late in the two weeks prior to the PISA assessment and around one-fifth reporting that they were late on one or two days (Table 7.7). Print mathematics achievement scores are also stable for the majority of students who had not arrived late, and there was a small decrease for those late on three or more days. A significant drop is observed for those who were late on one or two days.

Table 7.7. Change in the print mathematics scores between 2003 and 2012 by the frequency of students arriving late for school in previous two weeks for Ireland

	2003			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
None	71.3	510.8	(2.46)	72.6	510.0	(1.90)	-0.8	3.66
1 or 2 days	21.0	498.1	(3.90)	20.1	485.2	(3.66)	**-12.9**	5.69
3 or more days	7.7	471.2	(5.85)	7.2	465.7	(6.25)	-5.5	8.78

Students reported on the disciplinary climate of their mathematics classes in both 2003 and 2012. In 2003, students' reports of the disciplinary climate in their classes were more positive (0.27) than the OECD average (0.0) and this was associated with 15.5-point increase in mathematics performance per unit (i.e. one standard deviation) increase in disciplinary climate. In 2012, Ireland again has a more positive disciplinary climate (0.13) than the OECD average (0.0), with a 19.6-point increase in mathematics performance per unit increase in disciplinary climate.

7.2.2. School Characteristics

Variation in achievement and other variables can be separated into between-school and within-school components. Between-school variance, expressed here as a percentage of total variance, is an indication of the extent to which schools differ with respect to average achievement. Between 2003 and 2012, the variation between schools in print mathematics in Ireland increased by 1.8%, although the difference is not statistically significant (Table 7.8). The average between-school variation across OECD countries increased by 4.2% in the same period, but this difference was also not significant. Between-school variation in Ireland was significantly below the OECD average in both cycles, suggesting that there are relatively small differences across school on average print mathematics performance in Ireland. Analysis of within-school variation (differences in achievement between students within schools), on the other hand, shows that Ireland is above the OECD average in both cycles. In 2003, within-school variation in Ireland was 71.2%, which is slightly, although not significantly higher than the OECD average, and in 2012 it is 68.4%, which is significantly higher than the OECD average. Within-school variance for both Ireland and the OECD dropped between the cycles, although the difference was not significant for Ireland.

Table 7.8. Comparison of between-school and within-school variance in print mathematics achievement between 2003 and 2012 for Ireland and on average across OECD countries

	2003		2012		Difference 2012-2003	
	IRL %	OECD %	IRL %	OECD %	IRL %	OECD %
Between-school variation	14.9	34.9	18.1	36.5	3.2	1.6
Within-school variation	84.2	66.8	81.3	63.8	-2.9	**-3.0**

Note. Significant differences in bold

Table 7.9 presents the between-school variance in Ireland for each domain between 2003 and 2012.[49] The between school variance in print reading, mathematics and science increased between 2003 and 2009, but has decreased in 2012 and is at similar levels to 2006. For digital reading, the

[49] Some estimates may differ from the estimates presented in tables 7.8 and 2.1 due to differences in the way that sampling weights are applied in different software package.

amount of variance attributable to differences between schools has increased between 2009 and 2012, by seven percentage points.

Table 7.9. Between-school variance in achievement (expressed as a percentage of total variance), for all domains between 2003 and 2012 in Ireland and on average across OECD countries

Domain	2003	2006	2009	2012
Print Reading	22.5	24.2	25.0	24.1
Print Mathematics	16.7	20.0	23.5	19.3
Science	16.2	17.7	25.0	19.6
Digital Reading	NA	NA	21.5	28.5

Note: Estimates of between-school variance were computed in HLM 6.0®.

As for the school sector and gender composition, print mathematics achievement scores are consistent between 2003 and 2012 for all but students in vocational schools, who saw a significant increase of almost 18 points (Table 7.10). There were small but non-significant decreases for all of the secondary school categories and for community and comprehensive schools.

Table 7.10. Change in mathematics achievement scores between 2003 and 2012 by school sector and gender composition for Ireland

	2003			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
Girls' Secondary	23.9	508.0	(6.03)	21.6	501.7	(5.27)	-6.3	(8.240
Boys' Secondary	18.9	530.0	(4.91)	16.2	520.7	(7.02)	-9.3	(8.78)
Community/Comprehensive	17.3	497.6	(5.05)	16.8	491.7	(4.23)	-5.9	(6.86)
Mixed Secondary	18.2	506.8	(5.80)	20.3	505.5	(4.59)	-1.3	(7.64)
Vocational	21.7	474.4	(5.52)	25.1	492.2	(5.86)	**17.8**	(8.28)

The definition of disadvantaged schools in Ireland changed in 2006 with the introduction of DEIS; therefore, it is not possible to trace trends in the performance of students in the School Support Programme (SSP) under DEIS prior to 2009. However, comparisons can be made for students in such schools between 2009 and 2012. The print mathematics performance of students in both SSP and non-SSP schools increased significantly between 2009 and 2012. Students in SSP schools obtained significantly lower scores that students in other schools in 2009 and 2012, but the magnitude of the difference is about the same in both cycles (Table 7.11). Similar patterns were found for the other domains, with the exception of digital reading which did not increase significantly for students in SSP schools between 2009 and 2012 (See tables A7.38 to A7.41 in in the *PISA 2012 E-appendix*) .

Table 7.11. Change in mathematics achievement scores between 2009 and 2012 by School Support Programme status for Ireland

	2009			2012			Difference 2012-2003	
	%	Mean	SE	%	Mean	SE	Mean	SE
Non-SSP (Ref)	78.5	499.4	2.89	79.3	513.9	(1.77)	**14.5**	4.09
SSP	21.5	442.3	5.45	20.7	454.0	(6.74)	**11.7**	8.97
Diff (SED)		**57.10**	6.17		**59.9**	(6.97)		

7.3. Trends in Students' Engagement with School, Motivation and Attitudes

This section compares student scores on seven indices for which comparable data are available for 2003 and 2012. The indices are students' attitudes towards school (learning outcomes), their sense of belonging to school, intrinsic motivation to learn mathematics, instrumental motivation to learn mathematics, mathematical self-efficacy, mathematical self-concept, and mathematical anxiety. Readers are referred to Chapter 6 for information on the specific items underlying each index. Prior to the analyses reported here, OECD average and country scores were adjusted for both 2003 and 2012 to include only those countries that participated in PISA in both years.

In Ireland, there was a small and non-significant decline in attitudes towards school (learning outcomes) between 2003 and 2012 (-0.03), and a small but significant decline on sense of belonging to school (-0.11) (Table 7.12). On average across OECD countries, there was a small but significant decline on attitudes towards school, but no difference on sense of belonging to school. There was no difference among male students in Ireland in attitudes towards school between 2003 and 2012; however, females have a significant negative difference score (-0.10), indicating a small decline (Table 7.13). On average across OECD countries, both males and females have small but significant negative difference scores. In Ireland, the correlation between attitudes towards school and print mathematics performance was 0.08 in both 2003 and 2012, and hence, there was no change in the strength of the relationship with performance between the two years (OECD, 2013d). The correlation between sense of belonging and print mathematics became weaker between 2003 (r = -0.06) to 2012 (0.01), and the difference (0.07, SED = 0.03) was statistically significant. On average across OECD countries, differences in correlation coefficients were small but statistically significant for both attitude towards school (r = 0.04 in 2003 and 0.11 in 2012) and sense of belonging (r = 0.05 in 2003 and 0.08 in 2012).

Table 7.12. Change in mean scores on indices of engagement, motivation to learn mathematics and self-beliefs about mathematics between 2003 and 2012, for Ireland and on average across OECD countries

	2003		2012		Difference 2012-2003	
	IRL	OECD	IRL	OECD	IRL	OECD
Engagement with school						
Attitudes towards school	0.14	0.02	0.11	-0.02	-0.03	**-0.04**
Sense of belonging to school	0.09	0.01	-0.03	0.00	**-0.11**	0.00
Motivation for mathematics						
Intrinsic motivation	-0.09	-0.04	0.06	-0.01	**0.14**	**0.02**
Instrumental motivation	0.04	-0.05	0.13	-0.03	**0.08**	**0.02**
Self-beliefs						
Mathematical self-efficacy	-0.11	-0.08	0.01	-0.01	**0.12**	**0.07**
Mathematical self-concept	-0.08	-0.06	-0.04	-0.01	0.04	**0.05**
Mathematical anxiety	0.02	-0.04	0.11	-0.01	**0.09**	0.03

Note: see Table A7.42 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores and their corresponding standard errors for each of these indices

Students in Ireland have significantly higher mean scores in 2012 than in 2003 on intrinsic motivation for mathematics (difference = 0.14), and on instrumental motivation to learn mathematics (0.08) (Table 7.12). On average across OECD countries, there were significant but very small increases on both indices. In Ireland, both male students (+0.15) and female students (+0.13) showed significant improvement on intrinsic motivation, while females (+0.13) also showed significant improvement on instrumental motivation (Table 7.13). On average across OECD countries, both males and females showed small but significant increases on intrinsic motivation (+0.03 and +0.02 respectively), while the gender gap in favour of males did not change. On average across OECD countries, females (-0.04) showed a significant but small decline on instrumental motivation between 2003 and 2012, while the mean scores for male students did not change significantly. In line with this, the gap in favour of males was reduced by 0.04 points. In Ireland, there was no significant difference in the strength of the correlation between intrinsic motivation and print mathematics performance between 2003 (r = 0.20) and 2012 (0.24) (OECD, 2013d). Similarly, there was no significant difference in the strength of the correlation coefficient between instrumental motivation and print mathematics between 2003 (0.09) and 2012 (0.14).

Table 7.13. Change in mean scores and difference scores on indices of engagement, motivation to learn mathematics and self-beliefs about mathematics between 2003 and 2012 for Ireland, by gender

	Males			Females			Gender Gap
	2003	2012	Difference (2012-2003)	2003	2012	Difference (2012-2003)	(Male Difference – Female Difference)
Engagement with school							
Attitudes towards school	0.04	0.07	0.03	0.25	0.15	**-0.10**	**0.13**
Sense of belonging to school	0.05	0.00	-0.06	0.12	-0.05	**-0.17**	0.12
Motivation to learn mathematics							
Intrinsic motivation	-0.07	0.08	**0.15**	-0.10	0.03	**0.13**	**0.18**
Instrumental motivation	0.19	0.21	0.02	-0.10	0.04	**0.15**	**-0.13**
Self-beliefs							
Mathematical self-efficacy	0.02	0.17	**0.15**	-0.24	-0.15	**0.09**	0.06
Mathematical self-concept	0.02	0.09	**0.07**	-0.19	-0.17	0.01	0.05
Mathematical anxiety	-0.10	-0.05	0.05	0.15	0.27	**0.13**	-0.07

Note: see Table A7.43 in the *PISA 2012 E-appendix* (www.erc.ie/p12eappendix) for mean scores for male and female students in Ireland and their corresponding standard errors for each of these indices

Mathematical self-efficacy increased significantly among students in Ireland between 2003 (-0.11) and 2012 (0.01) (Table 7.12). There was a small, non-significant increase in mathematical self-concept, from -0.08 to -0.04. Anxiety about mathematic increased from 0.02 in 2003 to 0.11 in 2012, and the increase was statistically significant. On average across OECD countries, mathematical self-efficacy and self-concept both increased significantly, by 0.07 and 0.05 scale points respectively, while there was a small, non-significant increase in anxiety about mathematics.

In Ireland, both male students (0.15) and female students (0.09) posted significant gains on mathematic self-efficacy between 2003 and 2012, and, while the gap in favour of males increased, the increase was not statistically significant (Table 7.13). While the mathematical self-concept of male students in Ireland increased by a significant 0.07 points between 2003 and 2012, there was a non-significant increase for females (0.01). In contrast, there was a significant increase in mathematical anxiety for Irish females (0.13), and a non-significant increase for males (0.05). On average across OECD counties, both males (0.08) and females (0.06) have significantly higher self-efficacy scores in 2012, compared with 2003. However, the difference in favour of males over females was the same in both years (OECD, 2013d). The OECD average scores for males and females on self-concept increased significantly, by 0.06 and 0.04 points respectively, while the overall gap in favour of males increased by a significant 0.03 points. The OECD average scores on mathematical anxiety increased significantly for both males (0.02) and females (0.05), while the large gap in favour of females increased significantly, by 0.03 points.

In Ireland, correlations between each of self-efficacy, self-concept and anxiety print mathematics were similar in 2003 and in 2012. On average across OECD countries, correlation coefficients were marginally but significantly stronger for self-efficacy (0.02) and self-concept (0.03), and weaker for anxiety (-0.02).

7.4. Trends in Students' Response Patterns on the PISA Tests

Analyses of the PISA 2009 cognitive data for Ireland revealed a decrease in the percentage of students answering test items correctly and an increase in the percentage of skipping questions since previous cycles (LaRoche & Cartwright, 2010). Cartwright (2011) and Cosgrove and Moran (2011) noted that response patterns in Ireland varied considerably depending on item type (e.g. written response compared to multiple choice) and domain. For print mathematics, performance on written response items declined markedly between 2003 and 2009, while performance on regular and complex multiple choice items remained stable. For print reading, performance on both regular multiple choice and complex multiple choice items declined substantially between 2000 and 2009, while there was no clear pattern for science between 2006 and 2009.Taken together, these data suggest that the overall decline in the mean print reading and print mathematics scores for Ireland in 2009 may have been due to a reduced level of effort invested by student in the assessment in 2009 compared to previous cycles.

Looking at the item response patterns across link items for Ireland between 2009 and 2012, it is evident that there has been an increase in the percentages of students answering items correctly across all domains (ranging from 2.3 to 3.6 percentage points; Table 7.14). The percentage of students in Ireland who answered test items incorrectly has remained stable for print mathematics and print reading, while there has been a small decrease for science (-1.3 percentage points) and digital reading (-2.1 percentage points). The percentage of students in Ireland skipping questions has reduced for all domains, although only very marginally for digital reading (-0.1 percentage points). In comparison, the OECD average item response statistics have remained relatively stable between 2009 and 2012.

Table 7.14. Overall link item response statistics for all domains and percentage difference across cycles, for 2009 and 2012, for Ireland and the average across OECD countries

	N	Correct	Incorrect	Missing
Mathematics		%	%	%
PISA 2009 (IRL)	34	45.8	43.9	10.3
PISA 2012 (IRL)	34	48.8	43.2	8.0
Diff (2012-2009)	34	+3.0	-0.7	-2.3
PISA 2009 (OECD)	34	47.2	41.5	11.3
PISA 2012 (OECD)	34	47.4	41.7	10.8
Diff (2012-2009)	34	+0.2	+0.2	-0.5
Science				
PISA 2009 (IRL)	52	54.4	40.3	5.3
PISA 2012 (IRL)	52	57.2	39.0	3.8
Diff (2012-2009)	52	+2.8	-1.3	-1.5
PISA 2009 (OECD)	52	53.7	39.8	6.5
PISA 2012 (OECD)	52	53.9	39.5	6.6
Diff (2012-2009)	52	+0.2	-0.3	+0.1
Print Reading				
PISA 2009 (IRL)	43	61.7	31.6	6.7
PISA 2012 (IRL)	43	65.3	30.8	3.9
Diff (2012-2009)	43	+3.6	-0.8	-2.8
PISA 2009 (OECD)	43	60.2	32.7	7.1
PISA 2012 (OECD)	43	60.6	32.5	6.9
Diff (2012-2009)	43	+0.4	-0.2	-0.2
Digital Reading				
PISA 2009 (IRL)	19	62.6	33.0	4.3
PISA 2012 (IRL)	19	64.9	30.9	4.2
Diff (2012-2009)	19	+2.3	-2.1	-0.1
PISA 2009 (OECD)	19	61.1	33.2	5.7
PISA 2012 (OECD)	19	59.6	34.8	5.6
Diff (2012-2009)	19	-1.5	+1.6	-0.1

Note: Percentages are based on weighted data. Thirty-five print mathematics items and 44 print reading link items were used to link PISA 2012 back to 2009; however due to data entry errors, comparison are only made for 34 mathematics items and 43 print reading items for analysis

The percentage of students in Ireland answering items correctly also increased on link items for each print mathematical content area between 2009 and 2012 (Table 7.15) and the largest increase was for the Space & Shape items (+4.4 percentage points). For all print mathematics items, with the exception of the Change & Relationship items, there were also corresponding decreases in the percentage of students answering items incorrectly and skipping items. While the percentage of students skipping Change & Relationships items in Ireland decreased by 2.9 percentage points between 2009 and 2012, there was an increase of almost one percentage point in the percentage of students answering these items incorrectly. On average across OECD countries there has been little change in the item response statistics for print mathematics content items. Similar patterns are also observed for the science and print reading content areas (see tables A7.44. and A7.45 in the *PISA 2012 E-appendix*). Item response patterns were not analysed by content area for digital reading due to the small number of items administered.

Table 7.15. Mathematics link item response statistics for link items in 2009 and 2012, by content area, for Ireland and the average across OECD countries

	N	Correct	Incorrect	Missing
Change and Relationships		%	%	%
PISA 2009 (IRL)	9	45.5	41.2	13.2
PISA 2012 (IRL)	9	47.7	42.1	10.3
Diff (2012-2009)	9	+2.2	+0.9	-2.9
PISA 2009 (OECD)	9	44.1	39.5	16.3
PISA 2012 (OECD)	9	44.2	40.1	15.7
Diff (2012-2009)	9	+0.1	+0.6	-0.6
Space & Shape				
PISA 2009 (IRL)	8	32.0	53.4	14.6
PISA 2012 (IRL)	8	36.4	51.1	12.6
Diff (2012-2009)	8	+4.4	-2.3	-2.0
PISA 2009 (OECD)	8	39.5	45.1	15.4
PISA 2012 (OECD)	8	39.5	45.7	14.8
Diff (2012-2009)	8	0.0	+0.6	-0.6
Quantity				
PISA 2009 (IRL)	10	53.5	40.0	6.5
PISA 2012 (IRL)	10	56.1	39.4	4.5
Diff (2012-2009)	10	+2.6	-0.6	-2.0
PISA 2009 (OECD)	10	54.7	38.8	6.5
PISA 2012 (OECD)	10	55.4	38.5	6.1
Diff (2012-2009)	10	+0.7	-0.3	-0.4
Uncertainty				
PISA 2009 (IRL)	7	51.1	42.0	6.9
PISA 2012 (IRL)	7	53.9	41.1	5.0
Diff (2012-2009)	7	+2.8	-0.9	-1.9
PISA 2009 (OECD)	7	49.1	43.9	7.0
PISA 2012 (OECD)	7	49.3	43.8	6.9
Diff (2012-2009)	7	+0.2	-0.1	-0.1

Additional analyses of response patterns were conducted on the PISA 2009 data to determine the extent to which a drop in the level of effort invested by students in the PISA tests (as opposed to their proficiency) contributed to the decline in the mean scores for print reading and print mathematics observed in 2009 (Cosgrove, 2011). These analyses are strongly suggestive of a decline in effort rather than proficiency for print reading, while declines in both proficiency and effort appear to have contributed to the drop in mean print mathematics performance. For science, effort remained stable across cycles (Cosgrove, 2011). However, caution is advised when interpreting these results as no direct measure of effort was included in the 2009 assessment. Further analyses will be conducted on the PISA 2012 data, including examination of nationally developed questions on student engagement with the assessments, to examine in more detail the contribution of student effort with the assessment to the changes in mean scores since 2009. These analyses will be described in an additional report, *Contextualising Achievement in PISA 2012,* which will be published in 2014.

7.5. Interpreting Changes in Achievement

Sections 7.1 to 7.3 described changes that have occurred in student performance, student and school characteristics, and students' engagement with and attitudes towards school and mathematics across PISA cycles. Section 7.4 explored how students' response patterns on the PISA test have changed since 2009. This section considers how and why some of these changes may have occurred. Firstly, changes in the procedures used to implement the PISA survey since 2009 are explored. Next, consideration is given to PISA's approach to estimating changes in achievement. Finally, changes in the school-going population in Ireland across cycles are considered.

7.5.1. Changes in the Implementation Procedures

A number of procedural changes were introduced in Ireland for PISA 2009, including the introduction of a prize draw to incentivise student participation, changes in the test administration, and changes in the sampling methodology to prevent overlap of sampled schools between PISA and the International Civics and Citizenship Study (ICCS).

In 2009, a prize draw was introduced to PISA in Ireland to incentivise students to participate in the study. In each school, participating students were entered into a draw and three students received a voucher worth 15 euro. For PISA 2012, no such incentive was offered by the national centre to students for their participation in the study in 2012.

Also, for the first time in PISA in Ireland, test administration was conducted by teachers in their own school (though not by the student's own teachers) in 2009, rather than by external administrators, as had been the case from 2000 to 2006. About three-quarters of schools in Ireland employed this model in 2009, while an external administrator (as ERC staff member, or a test administrator working on behalf of the ERC) was used in the remaining schools. In 2012, test administration in all schools was conducted by members of the Inspectorate of the Department of Education and Skills (DES) and staff from the national centre. In 2009 and 2012, all test administrators received standard training on test administration procedures. While no significant differences in test performance were found in 2009 between students attending schools where teachers administered the assessment and those in schools with an external administrator (Cosgrove et al., 2010), it is possible that the exclusive use of external test administrators in 2012 may have raised the profile of the study and this could have had an indirect effect on student engagement with the assessment.

Furthermore, as there were no other large-scale international assessments being conducted in post-primary schools at the time of PISA 2012, it was not necessary to split the population of post-primary schools as in 2009. The PISA 2009 sample was verified by the OECD and its contractors and no issues were raised. It was also verified by independent experts who concluded that the changes made to the sampling methodology did not affect the computation of sampling weights, representativeness of the PISA sample or response rates in any measurable way (LaRoche & Cartwright, 2010). However, it is difficult to estimate the effect that survey fatigue (i.e. the effect on schools and students of repeated participation in surveys[50]) might have had on the results of PISA 2009, which may have been less of an issue in 2012.

[50] The splitting of the population of schools for the PISA and ICCS would have led to an increased probability of schools being selected to participate in one or other of the studies, for both the field trials and main studies. Also, another large scale international study (TALIS) was conducted in post-primary schools in Ireland in 2008.

Despite the changes in the procedures used to administer PISA in Ireland in 2009 and 2012, Ireland met the technical standards set out and verified by the OECD and its contractors for both cycles and hence merited full inclusion of its results in international reporting in both cycles.

7.5.2. PISA's Approach to Estimating Changes in Achievement

A number of issues relating to the approaches used to estimate changes in achievement in PISA were highlighted by Cartwright (2011) and LaRoche & Cartwright (2010). In particular, they noted that the model used by PISA to produce achievement scores is problematic and that the link error used for estimating trends is underestimated.

With regard to the model used by PISA to estimate achievement (i.e. the Rasch model), two concerns were raised. Firstly, item discrimination is fixed (i.e. items are constrained to be equivalent in terms of the strength of their relationship with proficiency) and Cartwright (2011) demonstrated that the constraint on item parameters imposed by the Rasch model was inappropriate for both the OECD average and Ireland in 2009. Secondly, items are assigned parameters that are based on a random sub-sample of the same number of students from each OECD country (the PISA calibration sample). Cartwright (2011) noted that PISA print reading data are more sensitive to model specification and item calibration than print mathematics or science and suggested that international and Irish performance would have been higher, on average, had Irish item parameters been used to estimate achievement. The sensitivity of the PISA print reading assessment to model specification may be due to a number of factors, including the smaller number of link items used to estimate change and the fact that responses to individual items are more dependent on the passage on which they are based than in science or print mathematics. The number of link items for print reading has increased from 26 to 44 items between 2009 and 2012, creating a more robust link between these two cycles for print reading. The number of link items for print mathematics and science remain unchanged since 2009 (34 items and 52 items, respectively) as these were both assessed as minor domains in 2009.

Concerns over the particular model used to estimate achievement in PISA and estimates of link error have been raised before and are not specific to the Irish data. However, the trends between print reading in 2009 and 2012 can be considered as more robust (less sensitive to model specification) than print reading trends between 2009 and earlier cycles, given the increase in the number of link items between 2009 and 2012.

7.5.3. Changes in Demographics and Curriculum

As describe in section 7.2, there has been a number of demographic changes in the school-going population in Ireland since 2003, including an increase in the number of immigrant students (in particular the number of students speaking a language other than English or Irish). The proportion of immigrant students in the PISA samples for Ireland has increased from 3.5% in 2003 to 10.1%[51] in 2012. In particular, the number of immigrant students who speak a language other than English or Irish has increased from 0.7% to 4.5% between 2003 and 2012.

This means that it is likely that some schools that had participated in PISA 2009 also participated in other survey administrations in the year previous to the PISA 2009 administration.

[51] In PISA 2012, 10.1% of students in Ireland are classified as immigrant students. When language and immigrant status are considered together, this percentage changes to 9.6% due to missing data.

Table 7.16 presents the average ESCS and print mathematics performance of native and immigrant students in Ireland in 2003 and 2012. In both cycles, there was no significant difference between native and immigrant students in terms of their print mathematics performance.[52] Immigrant students in Ireland in 2003 had an average ESCS score that was significantly higher than the mean ESCS score of native students. In 2012, there is no significant difference between the two groups of students in terms of their average ESCS. While the average ESCS of native students in Ireland has increased by almost 4 tenths of a standard deviation, there has been a marginal but non-significant increase in the average ESCS of immigrant students. Furthermore, the average print mathematics scores of native and immigrant students have not changed significantly since 2003 in Ireland.

Table 7.16. Change in mean print mathematics achievement and average ESCS scores between 2003 and 2012 by immigrant status for Ireland

	2003					2012					Difference (2012-2003)			
	%	ESCS	SE	Mean	SE	%	ESCS	SE	Mean	SE	ECSC	SE	Mean	SE
Native	96.5	-0.27	(0.03)	503.2	(2.44)	89.9	0.12	(0.02)	502.8	(2.30)	**0.39**	(0.04)	-0.4	(3.87)
Immigrant	3.5	0.10	(0.10)	499.2	(10.19)	10.1	0.18	(0.06)	501.1	(4.64)	0.08	(0.11)	1.9	(11.36)
Diff (SED)		**0.37**	(0.10)	-4.00	(10.48)		0.06	(0.06)	-1.70	(5.18)	–	–	–	–

Note: The ESCS measure for 2003 has been adjusted to the 2012 measure of ESCS. Significant differences in bold.

There has also been a decrease in the percentage of students selected to participate in PISA who had already left the education system (from 1.7% in 2003 to 0.5% in 2012[53]), indicating that there may be higher proportions of lower-achieving students in the school-going population in Ireland in 2012. Furthermore, the proportion of students with Special Educational Needs participating in PISA in Ireland has increased from 2.0% in 2003 to 4.7% in 2012. Despite these changes in the school-going population in Ireland, the mean scores for print reading and print mathematics have remained stable between 2003 and 2012, while science performance has increased.

As well as changes in the demography of PISA students in Ireland, there have also been a number of recent curricular changes. The introduction of social, environmental and scientific education in the revised primary curriculum in 1999 (Government of Ireland, 1999) and changes in the junior cycle science syllabus (Department of Education and Science, 2003) may have contributed to the significant increase in science achievement observed in Ireland in 2012. While there has also been curriculum change in mathematics at post-primary level with the introduction of Project Maths in 2008 for an initial 23 schools, and from 2010 for all other schools, the vast majority of students who participated in PISA in 2012 (i.e. those in Third and Transition years) would not have had any formal exposure to the new curriculum. However, the PISA sample for Ireland in 2012 included the 23 initial

[52] In this instance, an immigrant student refers to both immigrant students who speak English/Irish and immigrant students who speak a language other than English/Irish. It was noted in Chapter 5 that 'other-language' immigrant students have a significantly lower mean print reading score than native students in Ireland in 2012.

[53] These percentages are based on the number of students who according to the DES database were enrolled in PISA schools in the academic year in which PISA was administered, but at the time of testing had left the school and it was not known if they had enrolled in another school. In 2012, schools were asked to check the DES list and remove any such students from it before students were sampled. The DES lists were not checked by schools before student sampling in 2003.

Project Maths schools[54]; therefore comparisons can be made between students attending these schools and students attending other schools. An upcoming ERC report*, PISA and Project Maths*, will explore the results of PISA 2012 in the initial and other schools.

Analysis of the PISA 2009 reading results for Ireland found that seven schools had an average print reading score that was over 100 points lower than the national average (496), while no such schools existed in the PISA 2000 sample for Ireland (LaRoche & Cartwright, 2010). These seven schools were more likely to be vocational schools, had fewer girls, more 'other language' students, students with lower levels of ESCS, and lower participation rates in PISA compared to other schools (Cosgrove et al., 2010). In 2012, three schools were identified in the sample for Ireland that have comparable results to the seven very low performing schools from 2009 (i.e. they have a mean print reading score below 400). These three schools also had mean scores on the print mathematics and science assessments that were below 400. The three schools are all-boys' schools; one is a vocational school and two are community schools; and all are part of the School Support Programme (SSP) under DEIS. The average ESCS of students attending these three schools in 2012 is -0.50 (which is 0.6 of a standard deviation below the average ESCS of students in all other schools), and participation rates in PISA ranged from 55% to 73% (compared to between 56% and 100% in all other schools). Just over 17% of students attending the three schools were immigrant students, compared to almost 10% in all other schools.

Although there are fewer very low performing schools in the 2012 sample compared to the 2009 sample, the range of average school scores has increased in Ireland between the two cycles. In 2009, the difference between the lowest- and highest-performing schools for print reading was 286.6 points, while in 2012 it was 298.3 points. The range also increased for science from 243.0 to 256.1 points, while for print mathematics the increase (from 220.6 to 223.1 points) was much smaller between the two cycles. Furthermore, three schools in Ireland were found to have average reading scores below 400 in 2003 and four schools in 2006, indicating that such low-performing schools are not a new phenomenon in the Irish education system. However, caution is advised when drawing conclusions about the lowest performing schools in PISA in Ireland as there are relatively large standard errors associated with their mean scores, and therefore the average scores of these schools may not in fact differ from some schools whose mean scores are over 400 points.

7.6. Summary

This chapter provided an overview of trends in student performance, characteristics, engagement with school, motivation and attitudes across PISA cycles. Changes in school-level characteristics and response patterns on the PISA test were also described. Finally, consideration was given to how or why some of these changes may have occurred.

Ireland's mean performance in print mathematics in 2012 has increased significantly from 2009 (from 487.1 to 501.5) but is slightly lower than in 2003 (502.8), although not significantly so. Students in Ireland performed best on the Uncertainty & Data content area subscale in both cycles; however, performance was significantly lower on this subscale in 2012 than in 2003 (508.7 compared to 517.2). There was little variation in the mean scores of students in Ireland on the other content areas between the two cycles. With the exception of 2009, which saw an increase in the

[54] In computing weights for the analyses in the current report, the contribution of students in these schools was weighted down, to reflect their representation in the population.

proportion of lower-achieving students (those scoring below proficiency level 2) and a decrease in the proportion of higher-achieving students (those scoring at Level 5 or higher) in print mathematics in Ireland, there has been little variation in the proportions of such students since 2003. The proportion of lower-achieving students in print mathematics in Ireland in 2012 is almost identical to 2003 (16.9% and 16.8%, respectively), while the percentage of higher-achieving students has declined marginally (from 11.4% to 10.7%). There is also little variation in the performance of lower-achieving students in Ireland on the overall print mathematics and the content area subscales between 2003 and 2012. On the other hand, the mean score of higher-achieving students on the Uncertainty & Data subscale has dropped significantly since 2003 (from 632.5 to 619.4). The performance of higher-achieving students on the other subscales and overall scale has not changed significantly since 2003 in Ireland.

Male students in Ireland significantly outperformed females in print mathematics in 2003 and 2012, and the mean scores of each of these groups of students have not changed significantly between the two cycles (510.2 and 509.0 for males in 2003 and 2012, respectively, and 495.4 and 493.7 for females). The gender difference in Ireland is also similar in 2003 and 2012 (14.8 points and 15.3 points, respectively). There have been slight changes in the mean scores of male and female students in Ireland across the content area subscales, although none of these are significant. There has also been little change in the proportion of lower- and higher-achieving males and females in Ireland across the two cycles.

The mean print reading score of students in Ireland has also increased significantly between 2009 and 2012 (from 495.6 to 523.2), and the score in 2012 is not significantly different to the mean score in 2000 (526.7). The proportions of both lower- and higher-achieving students in print reading in 2012 (9.6% and 11.4%, respectively) are lower than in 2000 (11.0% for lower-achievers and 14.2% for higher-achievers). The performance of students at the 10th percentile on the print reading assessment is higher in 2012 than in 2000 (410.2 compared to 401.3), while the performance of students at the 90th percentile is lower (631.5 compared to 641.1), although neither of these differences is significant. The mean print reading scores of male and female students in Ireland have not changed significantly since 2000 (541.5 and 537.7 for females in 2000 and 2012, respectively, and 512.8 and 509.2 for males). The gender difference, in favour of females, is also about the same in 2012 (28.5 points) as it was in 2000 (28.7 points). There has been little change in the proportion of lower-achieving male students in Ireland since 2000 (13.5% in 2000 and 13.0% in 2012), while the proportion of lower-achieving female students decreased slightly, from 8.3% in 2000 to 6.1% in 2012. On the other hand, the proportions of higher-achieving males and females in print reading have decreased since 2000, by 2.7 percentage points for males and 3.0 percentage points for females.

Ireland's performance on digital reading has also increased significantly since 2009, from 508.9 to 520.1. The proportion of lower-achieving students dropped from 12.1% to 9.4% between 2009 and 2012, while the proportion of higher-achieving students increased, from 7.8% to 9.0%. Furthermore, the scores of students at both the 10th and 90th percentiles on the digital reading scale in Ireland increased since 2009 (from 397.7 to 411.6 for lower-performing students and from 616.2 to 621.6 for higher-performing students). The digital reading performance of male and female students in Ireland also increased significantly between 2009 and 2012 (from 493.6 to 507.7 for males and from 524.6 to 533.0 for females). The gender difference, in favour of females, decreased from 31.1 points in 2009 to 25.3 points in 2012. The proportions of higher-achieving males and females have increased slightly since 2009, by 0.7% for males and 1.2% for females. On the other hand, the percentage of lower-achieving males on the digital reading assessment decreased from 16.6% to 12.2% between 2009 and 2012, while the proportion of lower-achieving females remained stable (7.4% in 2009 and 7.0% in 2012).

For science, the mean score of students in Ireland has increased significantly since 2006 (from 508.3 to 522.0). The percentage of lower-achieving students in science in Ireland decreased from 15.5% to 11.1% between 2006 and 2012, while the proportion of higher-achieving students increased from 9.4% to 10.8%. The performance of students scoring at the 10th and 90th percentiles increased significantly since 2009 (+18.6 points for students at the 10th percentile and +6.3 points for students at the 90th percentile). The mean science scores of both male and female students in Ireland also increased significantly between 2006 and 2012, although the increase was greater for male students (+17.3 points) than for females (+10.6 points). The gender difference, in favour of females in 2006 and males in 2012, has increased slightly, although not significantly, from 0.4 points to 3.9 points between the two cycles. The proportions of male and female students performing below Level 2 have decreased considerably since 2006 (-5.0 percentage points for males and -3.9 percentage points for females), while the proportions at or above Level 5 have increased slightly (+1.4 percentage points for males and +1.2 percentage points for females).

There have also been a number of changes in the characteristics of 15-year-old students in Ireland since 2003, including an increase in the socio-economic status of students (as measured by ESCS) (from -0.26 to 0.13) and the percentage of immigrant students (from 3.5% to 10.1%), and decreases in the percentage of students from one-parent families (from 15.4% in 2003 to 11% in 2012) and those who indicated that they intended to leave school before completing the Leaving Certificate (from 20.5% in 2003 to 6.5% in 2012). In particular, there has been an increase in the percentage of 'other-language' immigrant students in Ireland since 2003 (from 0.7% to 4.9%) and the level of ESCS relative to native students has changed, i.e. immigrant students had a significantly higher average ESCS score than native students in 2003, while in 2012, there is no significant difference between the two groups of students in terms of their average ESCS. Furthermore, the proportion of students with Special Educational Needs participating in PISA has increased since 2003 (from 2.0% to 4.7%), while the percentage of students selected to participate in PISA who had already left the education system decreased, from 1.7% to 0.5%.

Students' sense of belonging to school also decreased significantly between 2003 and 2012 (from 0.09 to -0.03) in Ireland, although the correlation with achievement is very weak in 2012 (r=0.01). Irish students' intrinsic and instrumental motivation for mathematics and their mathematical self-efficacy increased significantly since 2003 (+0.14 points for intrinsic motivation, +0.08 points for instrumental motivation and +0.12 points for mathematical self-concept), while there was also a significant increase in students' anxiety about mathematics (+0.09 points), especially among female students (+0.13 points compared to +0.05 points for males).

A number of factors can be considered to have contributed to the increase in student performance in Ireland between 2009 and 2012. Firstly, a decline in the percentage of students skipping items between 2009 and 2012 is likely to have contributed to the increase in mean scores for print reading, mathematics and science, although not for digital reading. This indicates that students invested more effort in the assessment in 2012 relative to 2009; however it is unclear if this was due to higher levels of proficiency or stronger motivation among students, or both. With regard to reading achievement, the increase in the number of common items (from 26 to 44) used to create links with previous cycles of PISA has allowed for more stable reading trends. For science, it is likely that the introduction of social, environmental and scientific education to the curriculum at primary level in 1999 and the revised junior cycle science syllabus had an impact on the increased science achievement in 2012. Given that science achievement in Ireland in 2009 remained unchanged since previous cycles, when reading and mathematics declined, it is possible that the science proficiency of students in Ireland actually improved previous to 2012, but may have been masked by other factors, such as low engagement.

Another report, *Contextualising Achievement in PISA 2012*, will further explore students' engagement with the PISA tests in 2012 and will be published by the Educational Research Centre in 2014.

8. Conclusions

This chapter presents an overview of the main trends in student performance across PISA cycles and draws a set of conclusions based on the outcomes of PISA 2012. It should be read in conjunction with the Executive Summary presented at the beginning of this report. Eight themes are examined: stability and instability in trends in PISA, performance on Space & Shape; students' attitudes towards and engagement with mathematics; underperformance of high-achieving students; towards equity in outcomes, comparing performance on PISA and other international studies; PISA and policy; and the move towards computer-based assessment.

8.1. Trends in Achievement

The mean print mathematics score for Ireland in 2012 (501.5) **is not significantly different from the mean score obtained in 2003 (502.8) but is significantly higher than in 2009** (487.1). Student achievement on print mathematics content area subscales was assessed only in 2003 and 2012, as mathematics was assessed as the major domain in these cycles. In both 2003 and 2102, students in Ireland performed best on the Uncertainty & Data content area subscale (517.2 in 2003 and 508.7 in 2012) and poorest on the Space & Shape subscale (476.2 in 2003 and 477.8 in 2012). There has been little change in the mean scores of students in Ireland on the Change & Relationships, Space & Shape and Quantity subscales since 2003, while the performance of students in Ireland on Uncertainty & Data declined significantly (by 8.5 points). The performance of students in Ireland on the Space & Shape subscale is of particular concern, as Irish students obtained scores on this subscale that were below the corresponding OECD averages in both 2003 and 2012.

In 2012, the proportion of lower-achieving students[55] in print mathematics in Ireland is almost identical to the proportion in 2003 (16.9% and 16.8%, respectively) but is lower than in 2009 (20.8%). On the other hand, the percentage of higher-achieving students on print mathematics in 2012 is lower than in 2003 (10.7% and 11.4%, respectively) though not significantly so but is higher than in 2009 (6.7%). **There has been little change in the performance of lower-achieving students in Ireland on the overall mathematics and the content area subscales between 2003 and 2012**. For higher-achieving students in Ireland, however, performance on the Uncertainty & Data subscale has dropped significantly since 2003 (by 13 points), while performance on the other subscales and the overall scale has not changed significantly since 2003 in Ireland.

Male students in Ireland obtained significantly higher mean print mathematics scores than females in 2003 and 2012 (510.2 for males and 495.4 for females in 2003; 509.0 for males and 493.7 for females in 2012), and the mean scores of each of these groups of students have not changed significantly between the two cycles. The difference between males and females in Ireland is also similar in 2003 and 2012 (14.8 points and 15.3 points, respectively). While there have been small changes in the mean scores of male and female students in Ireland across the content area subscales, none of these differences is significant. There has also been little change in the proportion of lower- and higher-achieving males and females in Ireland across the two cycles.

[55] Lower-achieving students refers to students who are performing below proficiency level 2, while higher-achieving students are those who are performing at proficiency level 5 or above.

The performance of students in Ireland on the assessment of print reading has also increased significantly since 2009 (from 495.6 to 523.2) **but performance in 2012 is not significantly different to performance in 2000** (526.7). In Ireland, the proportion of lower achieving students on print reading is considerably lower in 2012 compared to 2009 (9.6% and 17.2%, respectively) and is also slightly lower compared to 2000 (11.0%). On the other hand, the proportion of higher-achieving students on the print reading scale has increased from 7.0% in 2009 to 11.4% in 2012, but is slightly lower than in 2000 (14.2%). **The performance of lower-achieving students on the print reading assessment is higher in 2012 than in 2009** (410.2 compared to 373.4) **and 2000** (401.3), **while the performance of higher-achieving students is lower than in 2000** (631.5 compared to 641.1) **but is higher than in 2009** (610.5**). In Ireland, females have significantly outperformed males in print reading in all cycles of PISA**. The mean print reading scores of male and female students in Ireland have increased significantly since 2009 (from 476.3 to 509.2 for males and from 515.5 to 537.7 for females) but are not significantly different from 2000 (541.5 for females and 512.8 for males). The gender difference, in favour of females, is also about the same in 2012 (28.5 points) as it was in 2000 (28.7 points). In Ireland, the proportion of lower-achieving male students in 2012 (13.0%) is about the same as in 2000 (13.5%), while the proportion of lower-achieving female students decreased slightly, from 8.3% in 2000 to 6.1% in 2012. On the other hand, there has been a decline in the proportions of higher-achieving males (from 11.2% to 8.5%) and females (from 17.4% to 14.4%) in print since 2000.

There has also been a significant increase in Ireland's performance on digital reading between 2009 (508.9) **and 2012** (520.1). The proportion of lower-achieving students dropped from 12.1% to 9.4% between 2009 and 2012, while the proportion of higher-achieving students increased, from 7.8% to 9.0%. There have also been increases in the digital reading scores of students at both the 10th and 90th percentiles between 2009 and 2012, from 397.7 to 411.6 for lower-performing students and from 616.2 to 621.6 for higher-performing students. The digital reading performance of male and female students in Ireland increased significantly (by +14.1 points for males and +8.4 points for females) between 2009 and 2012 and the gender difference, in favour of females, decreased from 31.1 points in 2009 to 25.3 points in 2012. There are also slightly greater proportions of higher-achieving males (+0.7%) and females (+1.2%) on the digital reading scale since 2009. The proportion of lower-achieving females is largely unchanged since 2009 (7.4% in 2009 and 7.0% in 2012), while the percentage of lower-achieving males decreased from 16.6% to 12.2%.

The mean science score of students in Ireland in 2012 (522.0) is significantly higher than in 2006 (508.3) **and 2009** (508.0). The percentage of lower-achieving students in science in Ireland is lower in 2012 (11.1%) than in 2009 (15.2%) or 2006 (15.5%), while the proportion of higher-achieving students has increased from 8.7% in 2009 to 10.8% in 2012 (the proportion of higher-achieving students in science in 2006 was 9.4%). The scores of students in Ireland at the 10th and 90th percentiles on the science scale are significantly higher in 2012 (403.9 and 636.6, respectively) than in 2009 (382.3 and 627.3, respectively) or 2006 (385.3 and 630.3, respectively). In Ireland, the mean science scores of both male and female students have also increased significantly since 2006, by 17.3 points for males and by 10.6 points for females. The gender difference, in favour of females in 2006 and males in 2012, has increased from 0.4 points to 3.9 points between the two cycles, though neither difference was statistically significant. There has also been a decrease in the proportions of male and female students performing below Level 2 since 2006 (-5.0 percentage points for males and -3.9 percentage points for females), while the proportions at or above Level 5 have increased slightly (+1.4 percentage points for males and +1.2 percentage points for females).

In summary, performance on reading literacy and mathematics has returned to the levels observed in the first three cycles of PISA, while performance on science has increased significantly. Other conclusions arising from these findings are discussed below.

8.2. Stability and Instability of Trends in PISA

Chapter 7 and section 8.1 in this chapter provides an overview of trends in student performance in Ireland across PISA cycles. In general, the results for reading and mathematics in Ireland are relatively stable, with the exception of 2009 which saw large declines in both domains. Results for science remained unchanged between 2006 and 2009, but increased significantly in 2012.

Analyses of item response patterns for Ireland in 2009 revealed a decrease in the percentage of students answering test items correctly and an increase in the percentage skipping questions, compared with previous cycles (LaRoche & Cartwright, 2010). These analyses, in addition to analyses examining positioning effects in the PISA tests (i.e., the tendency for students to skip if they encounter it later in a test booklet, rather than earlier), suggest that a decline in the amount of effort invested by students in the PISA reading and mathematics tests contributed to the drop in mean performance in these domains, though the effort invested in the science tests remained stable across cycles (Cosgrove, 2011).

The decline in Ireland's performance in 2009 was much larger for reading (31 points, about a third of a standard deviation) than for mathematics (16 points, about a sixth of a standard deviation). Cartwright (2011) and LaRoche & Cartwright (2010) have highlighted the sensitivity of the PISA reading assessment to model specification, which is partly due to the smaller number of link items used for reading trends (26 items) than for mathematics trends (35 items). This may have contributed to greater instability in reading trends and an overestimation of change in reading achievement between cycles. Thus, factors such as decreased effort may have had a disproportionate effect on mean scores in reading (e.g. by overestimating the size of a decline) than in mathematics. Between 2012 and 2009, there has been an increase in the number of link items for print reading, from 26 in 2009 to 44 items in 2012, and it is likely that this increase has contributed, at least, in part, to a more stable estimate than in 2009. Also, most of the link items used to establish trends between 2009 and 2012 are different to the link items used to link 2009 to previous cycles (i.e. they were newly developed items in 2009). The number of trend items in mathematics (35) and science (52) remained the same.

One factor that may have indirectly contributed to student disengagement with the PISA 2009 assessment is survey fatigue. PISA 2009 was the fourth cycle of PISA to be administered in Ireland and a number of other large-scale studies were also carried out in post-primary schools at around the same time, including the International Civics and Citizenship Study (ICCS; in 2009) and the Teaching and Learning International Survey (TALIS; in 2008). Due to the relatively small population of post-primary schools in Ireland, the probability of schools being selected repeatedly (especially larger schools) to participate in surveys is comparatively high. This is especially the case if the population of schools is split to prevent overlap of samples between different surveys (due to an even greater probability of selection) as happened in 2009 with the PISA and ICCS samples. It is difficult to estimate the effect of such repeated participation on survey results; however, it is possible that survey fatigue may have, at least partially, contributed to the 2009 results in Ireland. The effect of survey fatigue could have been compounded in Ireland in 2009 with the change in administration procedures from external administrators (DES inspectors) to internal administrators (teachers in students' schools) in most schools in 2009, which meant greater involvement of teachers in the administration in 2009. However, no significant differences in performance were found between schools that used external administrators and those that used internal administrators in 2009. Therefore, the effect, if any, of such a change on students' engagement with the assessment is likely to be small.

On the other hand, greater awareness of the study may have had the effect of increasing effort in the survey in 2012. The results of PISA 2009 received widespread attention in the media and elsewhere, raising the profile of the study in Ireland and this may have led schools and students to be more engaged with the assessment in 2012.

When comparing the OECD average across different cycles of PISA, it is also important to bear in mind that the number of OECD member states has changed, from 30 countries in 2000 to 34 in 2009. Therefore, any changes in OECD averages across cycles are reflective of both the different composition of OECD countries and changes among students over time. The above-average mathematics performance of students in Ireland in 2012 may be due, in part, to a lower OECD average in that year.

The decline in reading and mathematics achievement in 2009 may have been due to a number of factors (for example, a combination of disengagement and problems with scaling). For PISA 2012, some of these factors have been resolved, including the administration of fewer international studies at post-primary level, enhanced administration procedures and improvements in the number of link items. While the improvements in the number of link items will be carried forward to future cycles, the implementation of fewer studies in post-primary schools around the same time as PISA cannot be guaranteed. Given the potential difficulties in estimating changes over time, Adams (2009) has cautioned against drawing strong conclusions based on one-off changes in performance.

8.3. Performance on Space & Shape

As in 2003, when mathematics was last a major assessment domain in PISA, Irish pupils performed poorly on the Space & Shape content area in PISA 2012. They achieved a mean score that was significantly below the corresponding OECD average score. Further, while the proportion of students in Ireland who scored below Level 2 on Space & Shape in 2012 was about the same as the OECD average, 5% fewer pupils in Ireland achieved at Level 5 or higher. Performance on Space & Shape stands in marked contrast to other mathematics content areas, where mean scores were above the corresponding OECD averages (though a significant drop in performance on Uncertainty & Data was found between 2003 and 2012), and fewer pupils in Ireland than on average across OECD countries performed below Level 2. The gender difference on Space & Shape in Ireland (one-quarter of a standard deviation in favour of male students) was also greater than on any other content area, though there was also a relatively large difference in favour of male students on Uncertainty & Data.

Ireland is not unique in terms of performing relatively poorly on Space & Shape. Other countries, especially those that might be described as mainly English-speaking, also underperform on Shape & Space. Indeed, students in the United Kingdom, the United States and New Zealand, as well as students in Northern Ireland, achieved mean scores on Shape & Space that were well below the

OECD average. Their scores were also lower than for other mathematical content areas. In all of these countries, male students outperformed females, though the difference was considerably larger in Ireland and New Zealand than in the United States and the United Kingdom. Interestingly, students in a number of European countries do quite well on Space & Shape. For example, students in Austria, Belgium, Estonia, Germany, the Netherlands and Poland perform at a level that is above the corresponding OECD average, though none perform as well as Asian countries such as Chinese-Taipei, Japan and Korea. In general, countries with above average scores on Shape & Space do well on overall PISA mathematics.

It is unclear why students in Ireland in general, and female students in particular, struggle with Space & Shape, though Close (2006) pointed to a significant mismatch between PISA Space & Shape and geometry on the pre-Project Maths Junior Certificate syllabus. In an initial evaluation of mathematics performance among Junior Cycle students in initial Project Maths (PM) schools (the original 24 schools in which PM was piloted) and comparison schools, students in the initial schools did marginally, though not significantly, better (by 2.4%) on a test of 10 Geometry and Trigonometry items (Jeffes et al., 2012). For both groups, performance was similar to the corresponding international average. Most of the Geometry items administered focused on aspects of synthetic geometry (which is not assessed directly by PISA), and tended not to address visual and spatial reasoning, to the same extent or in the same way as PISA. A follow-up study (Jeffes et al., 2013) indicated a decline in the performance of students in non-phase one (i.e. non initial) schools on Geometry and Trigonometry compared with students in phase one (initial) schools, though this may have related to the time of year at which testing was conducted.

It seems reasonable to accept that at least some of the knowledge and skills assessed in PISA Space & Shape questions are important, and not just within the discipline of mathematics. Looking ahead, it would be worth examining the approach to geometry that is advocated in Project Maths (in particular the content of the Geometry and Trigonometry strand) with a view to ascertaining its overlap with PISA Space & Shape. However, it would also be important to consider the extent to which other Junior Certificate content strands, such as Algebra, are congruent with the approach to PISA Space & Shape in terms of content and process. There might also be value in providing direct instruction in spatial skills ('spatially-enriched education') to students, whether in the context of mathematics, or as separate modules or short courses, since research (e.g., Uttal et al., 2012) suggests that such programmes, when presented in computer-based environments, can have beneficial effects on mathematics performance as well as on performance in science subjects. The provision of such courses would seem particularly important as PISA, and perhaps education more generally, moves towards computer-based assessment.

The significant decline on Data & Change between 2003 and 2012 is also a matter of concern, and needs to be monitored. The strong emphasis on statistics and probability on the Project Maths syllabi, which had not been studied by Third-year or Transition-year students in PISA 2012, may help in recovering at least some of the ground lost on Data & Chance since 2003.

8.4. Students' Attitudes towards and Engagement with Mathematics

In line with the status of mathematics as a major assessment domain in PISA 2012, PISA allocated particular attention to measuring and reporting on students' attitudes towards and engagement with mathematics. However, caution is warranted in interpreting findings on a number of grounds. These include the complex relationship between dispositions and performance (where performance might be expected to impact on attitude and vice versa), as well as the observation that some dispositional scales (for example, self-efficacy) may, in fact, function as proxies for mathematics proficiency (instead of responding to actual achievement test items, students indicate how confident they would be in completing such items) (for example see Williams & Williams, 2010). It might also be pointed out that the cross-country comparability of its attitudinal scales has not been established, and hence comparisons across countries on attitudinal items may not be robust. In addition, as noted in Chapter 6, even within Ireland, several engagement scales had very low correlations with achievement, and hence their importance is difficult to interpret.

Two clusters of dispositional measures that have reasonably strong correlations with mathematics achievement in Ireland are those relating to motivation to learn mathematics and mathematics self-beliefs. Correlations between these measures and performance are slightly stronger for print mathematics than for computer-based mathematics. Students in Ireland had significantly higher mean scores than on average across OECD countries on instrumental motivation to learn mathematics, perseverance on tasks involving problem solving, and anxiety about mathematics.

As with overall mathematics achievement in Ireland, where male students had a significantly higher mean score than females, male students in Ireland had significantly higher mean scores than females on instrumental motivation to learn mathematics, perseverance on problem-solving tasks, mathematical self-efficacy and mathematical self-concept. Female students had a significantly higher mean score on anxiety about mathematics, which can also be viewed as a negative outcome for females since there is a negative correlation between anxiety about mathematics and mathematics performance.

The relatively large gender differences in favour of male students in Ireland on instrumental motivation, perseverance, mathematical self-efficacy and mathematical self-concept are a matter of concern in light of the relatively large gender difference in performance in favour of male students in Ireland on PISA mathematics. Moreover, differences may not be apparent at Junior Cycle level in school-based settings, where, on average, greater percentages of females achieve higher grades on mathematics at Higher, Ordinary and Foundation levels than males on the Junior Certificate mathematics examination (see Junior Certificate 2013 results by gender at www.examinations.ie).

While a key aim of Project Maths is to foster a positive attitude towards mathematics (presumably with a view to increasing students' engagement with mathematics, their mathematical performance, and their interest in careers related to mathematics), early evidence suggests that this may be not be achieved easily. In their initial evaluation of the impact of Project Maths, Jeffes et al. (2012) reported that Junior Cycle students in the initial PM schools had lower confidence in their ability to solve problems based on real-life situations, despite having more opportunities to do so than students in comparison schools who had not studied the PM syllabus. Jeffes et al. also reported that students in initial and comparison schools did not differ from one another on perceptions of the importance of mathematics outside the classroom setting. More positively, however, there was some evidence of improved attitudes among Leaving Certificate students in initial PM schools relating to their confidence in synthesising what they have learned on more than one topic, though no differences were found on general attitudes towards mathematics.

One area in which students in Ireland could be encouraged to do more relates to their engagement in mathematics behaviours. Compared with students in other OECD countries, students in Ireland reported relatively little engagement in activities such as participating in mathematics clubs, taking part in mathematics competitions and programing computers. It would seem important to increase the engagement of students in these activities, and perhaps there will be more scope to promote such activities in the context of forthcoming changes to the Junior Cycle (DES, 2012).

Clearly, the topic of attitudes towards mathematics is a complex one, which requires further examination. As a starting point, it might be hoped that initiatives such as Project Maths and the *National Strategy to Improve Literacy and Numeracy 2011-20* (DES, 2011) will set in train a virtuous cycle of enhanced performance in mathematics and more positive attitudes towards mathematics. However, as noted above, significant attention must be paid to specific aspects of mathematics (for example, Shape & Space, and perhaps problem solving more generally) if this is to occur.

Finally, there will be concern at the significant decline, between 2003 and 2012, in Irish students' sense of belonging in school, and the significant increase, between the same years, in their anxiety about mathematics.

8.5. Underperformance of High-achieving Students

While lower-achieving students in Ireland performed at average or above-average levels across all domains in 2012, there is evidence that higher-achieving students in Ireland are underperforming relative to their counterparts in other countries, especially in mathematics. In 2012, the mean print mathematics score for students in Ireland is significantly above the OECD average (in part due to a drop in the OECD average since previous cycles); however, the score of students at the 90th percentile does not differ significantly from the OECD average score. The view that Ireland's above average score is attributable, at least in part, to the relatively good performance of lower-achieving students is further reinforced when one notes that fewer students in Ireland scored at Level 5 or above on PISA print-based mathematics compared with the corresponding OECD average. The performance of higher-achieving students in Ireland on the computer-based assessment of mathematics is significantly below the corresponding OECD average score, while the proportion scoring at Level 5 or above is also lower than on average across OECD countries.

Particular aspects of mathematics on which higher-achieving students in Ireland perform poorly (i.e. at a level below the corresponding OECD average score) are Change & Relationships and Space & Shape content areas, and the Formulating process. Also of concern is the significant drop in the performance of higher-achieving students in Ireland on the Uncertainty & Data subscale between 2003 and 2012.

While higher-achieving students in Ireland perform at above-average levels in reading (print and digital) and science, there is still room for improvement. The proportions of students performing at or above Level 5 in science, print reading and digital reading in Ireland (10.8%, 11.4% and 9.0%, respectively) are only slightly above the corresponding OECD average proportions (8.4%, 8.5% and 8.0%, respectively), while countries with similar mean scores to Ireland, such as Finland (for print reading) and New Zealand (for science) have higher percentages of students reaching this benchmark (13.5% for Finland for print reading and 13.4% for New Zealand for science). Similarly, the performance of higher-achieving students in Finland (for print reading) and New Zealand (for science) are somewhat higher than in Ireland.

One of the aims of the *National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020* (DES, 2011) is to increase the percentage of 15-year-old students performing at or above Level 4 on the PISA literacy and numeracy tests by 5 percentage points. This has been achieved for print reading and mathematics in 2012, although most of the gain for print reading has been at Level 4 rather than at levels 5 and 6. It should also be noted that this and other targets related to PISA were established in the aftermath of the PISA 2009 results. It may be worthwhile examining the targets again at this time, and determining how best to revise them, with reference to longer term trends in PISA performance.

One of the challenges for Project Maths at both junior and senior cycles, and for courses in mathematics offered in Transition Year will be to ensure that the needs of higher-achieving students are met and that these students are afforded the opportunity to be able to fully reach their potential.

8.6.Towards Equity in Outcomes

According to the OECD (2013c), Ireland is among a small group of countries, including Canada, Denmark, Estonia, and Finland, which combine “excellence with equity”, and above-average levels of achievement are reached with relatively small differences across socio-economic groups. This section considers the accuracy of the ‘equity’ claim by examining between-school variance in achievement, between-school variance in ESCS, the impact of school mean ESCS on achievement, differences in achievement in SSP and non-SSP schools, and other indicators of equity or inequity in the Irish school system.

Between-school variance in achievement, which, when low, can be interpreted as an indicator of equity in a school system, has increased in Ireland between 2000 and 2009, though Ireland was below the OECD average in all cycles. In 2012, however, the percentage of variance in mathematics (and also print reading and science) attributed to differences between schools was lower than in 2009. Just seven countries had lower between-school variance in mathematics in 2012: Albania, Denmark, Estonia, Finland, Iceland, Norway, and Sweden. On the one hand, low between-school variance in mathematics reflects well on the school system. On the other, it must be considered in a context of a mean score that is marginally, albeit significantly, above the OECD average, and higher-achieving students who perform less well in mathematics relative to their peers in other OECD countries, though lower-achieving students perform better than might be expected (see above). This points to a need to raise the performance of both higher- and lower-achieving students and continuing to ensure equitable outcomes between schools. Given that performance in mathematics was only just above the OECD average, and significantly behind Estonia and Finland, it might be concluded that the OECD’s depiction of Ireland as a country which combines excellence with equity is slightly overstated.

A source of much of the variation between schools relates to school mean ESCS. The between-school association between ESCS and mathematics performance[56] in Ireland is just over half a standard deviation, while the average across OECD countries is just under three-quarters of a standard deviation. However, the OECD average masks wide variation among member countries with the highest association at one-and-a-half standard deviations and the lowest at about a fifth of a standard deviation (OECD, 2013c). Differences in both school and student ESCS account for more

[56] This is the school-level score point difference associated with one unit increase in the school mean ESCS

than fourth-fifths of the variation in mathematics performance in Ireland, compared to less than two-thirds across OECD countries, and student ESCS alone accounts for almost half of the variance.

Multi-level models of achievement, such as those conducted in Ireland in earlier PISA cycles, which show that both student ESCS and school mean ESCS simultaneously contribute to differences in achievement (e.g., Perkins et al., 2012). Similarly, as detailed for PISA 2012 in Chapter 5, differences are accentuated for high-ESCS students attending high-ESCS schools or low-ESCS students attending low-ESCS schools. Students with high ESCS would perform below average when in a low-ESCS school, suggesting some negative impact of school mean ESCS. The performance of low-ESCS students in a high-ESCS school would be improved but remains below average. The impact of the context of learning on achievement, then, is manifest in differences between advantaged and disadvantaged schools (see Sofroniou, Archer, & Weir, 2004 for a discussion on 'social-context effect').

In Ireland, 20.7% of PISA 2012 students are at schools in the SSP under DEIS and students at these schools have significantly lower ESCS than those in non-SSP schools.[57] Students in SSP schools scored significantly lower on all achievement domains, with differences of the order of one-half to two-thirds of a standard deviation. The performance of students in SSP and non SSP schools has increased significantly across domains (with the exception of digital reading in SSP schools) since 2009; however the magnitude of the difference between students in SSP schools and those in other schools has remained about the same in both cycles. The definition of disadvantaged schools in Ireland changed in 2005 with the introduction of DEIS, therefore it is not possible to trace trends in the performance of students in the SSP under DEIS prior to 2009

Inequities in the Irish school system can also be seen in differences in ESCS across a number of areas of participation. Children from low-ESCS families are less likely to attend preschool, which is significantly and positively associated with achievement across OECD countries. Those deemed at risk of early school-leaving and those who missed classes or were late for school in the two weeks prior to the PISA assessment were also more likely to be from low-ESCS families. By contrast, students in fee-paying schools (8.1% of students) and in girls' secondary schools (21.6% of students) had higher ESCS and the existence of these differences may contribute to inequity in the school system in Ireland.

Relative to other OECD countries, Ireland is judged to have an equitable school system. It has smaller numbers of students in disadvantaged schools (as defined by the OECD) and smaller differences in achievement between schools. Whether the supports available to SSP schools are contributing towards the reasonably well performance of lower-achieving students relative to their counterparts in other OECD countries may be investigated further, perhaps through the current evaluation of DEIS. However, the school mean ESCS still has a strong and significant impact on students' achievement, with students from low-ESCS families who attend low-ESCS schools doing particularly poorly. Hence, the performance of disadvantaged students continues to be a challenge.

8.7. Comparing Performance on PISA and Other Studies

In addition to PISA, students in Ireland have participated in a number of international studies of educational achievement in recent years. In 2011, students in Fourth class in primary schools

[57] The number of students in SSP schools is broadly consistent with a different measure of disadvantage used by the OECD, as detailed in Chapter 5 of this Report.

participated in the Progress in International Reading Literacy Study (PIRLS) and the Trends in International Mathematics and Science Study (TIMSS) (see Chapter 2). In 2011-12, Irish adults participated in the Programme for the International Assessment of Adult Competencies. While the outcomes of PISA are broadly consistent with PIRLS and TIMSS, they differ from those of PIAAC in significant ways.[58]

In both PISA and PIRLS, just five countries/economies had significantly higher mean scores than Ireland. Of the five countries in PIRLS, only the Russian Federation and Northern Ireland achieved significantly lower mean scores than Ireland on print-based literacy in PISA 2012. The difference between Ireland and Northern Ireland on PISA reading literacy was one-quarter of an international standard deviation, while that between Ireland and the Russian Federation was one-half. These differences might be taken to suggest that there is considerable loss of skills between primary and lower-secondary levels in Northern Ireland and in the Russian Federation. However, there may be other factors at work as well (for example, related to the administration of PISA) that have not been documented to date, while Northern Ireland's PISA sample is not formally adjudicated by the OECD, which is only concerned with its representativeness as part of the United Kingdom sample. The gap between Ireland and the highest-scoring countries was about the same for PIRLS and PISA – about one-quarter of a standard deviation in each.[59] It would not seem unreasonable to expect this gap to reduce further as the impact of the *National Strategy to Improve Literacy and Numeracy 2011-20* (DES, 2011), and other initiatives, such as revisions to the English curriculum at primary level, and the English syllabus at junior cycle are taken on board by schools.

While students in Fourth class in Ireland performed reasonably well on TIMSS 2011 mathematics, 13 countries achieved significantly higher mean scores, including a number of countries with significantly lower mean scores than Ireland on PISA 2012 mathematics (Northern Ireland, the Russian Federation, and the United States). On the other hand, a few countries that were significantly ahead of Ireland on PISA mathematics performed less well than Ireland on TIMSS mathematics (New Zealand, Poland). In overall terms, Ireland performed at roughly the same level on TIMSS and PISA mathematics, and the gap between Ireland and the highest scoring country was about the same in both studies (about three-quarters of a standard deviation). This can be interpreted as suggesting that, in general, the basis for strong achievement in mathematics is established in educational systems during primary schooling and, for most systems, is maintained during lower secondary schooling. This would seem to confirm concerns about standards in mathematics at primary (as well as post-primary) level in the *National Strategy to Improve Literacy and Numeracy 2011-20* and endorse efforts to raise standards at primary level, as well as at post-primary level.

Students in Fourth grade in Ireland did not do as well on TIMSS 2011 science as their counterparts in PISA 2012. While just seven countries had significantly higher mean science scores than Ireland in PISA, 17 countries had higher mean science scores in TIMSS. Furthermore, several countries with higher mean scores than Ireland in TIMSS science had significantly lower mean scores on PISA

[58] Care should be exercised in drawing comparisons across international studies because studies can differ along a number of dimensions, including content and processes assessed, use of grade vs. aged-based samples, and approaches to scaling and analysing performance.

[59] Shanghai-China was not included in this comparison, or in those involving PISA and TIMSS mathematics and science, as it is not a country and no evidence has been provided that its very high performance is representative of China as a whole.

science, including Austria, Denmark, the Czech Republic, Hungary, the Russian Federation, Sweden and the United States. However, no country that performed below Ireland in TIMSS science achieved a significantly higher mean score in science than Ireland on PISA. While the gap between the highest-scoring country and Ireland is about the same in TIMSS and PISA (over one-half of a standard deviation), Singapore in PISA is an outlier, and the gap between Ireland and the second-highest country (Korea) is well below this. The outcomes for TIMSS and PISA science suggest that countries with high performance on TIMSS science at Grade 4 will not necessarily attain high performance on PISA science at age 15. While Ireland is unusual in terms of making a marked improvement in science between Fourth grade and age 15, it might be argued that Ireland could have done even better on PISA science if a stronger foundation of conceptual knowledge in science had been established at primary level.

The performance of adults in Ireland on literacy and numeracy in the PIAAC study was somewhat disappointing, with an overall mean score on reading literacy that was slightly below the international average, and a mean score that was below the international average in numeracy. Although countries participating in PIACC tended to be the more economically advanced OECD countries, on the basis of previous performance on PISA, at least up to 2006, Ireland would have expected to rank among the highest-performing PIACC countries on literacy and perform at around the international average on numeracy.

The performance of 16-24-year olds in PIAAC (those who completed compulsory education relatively recently), was also disappointing, with mean scores in literacy and numeracy that were below the corresponding PIAAC international averages. Higher levels of performance, especially in literacy, might have been expected on the basis of performance on PISA since 2012. Among the eight countries scoring above the average for 16-24-year olds on PIAAC literacy, only Sweden had a mean score that was significantly below the OECD average on PISA 2012 reading literacy. However, 16-24 years olds in both Ireland and Canada underperformed on PIAAC literacy, relative to their PISA performance.

The performance of 16-24 year-olds in Ireland on PIAAC numeracy was also disappointing, with just Italy, the United States and Spain doing less well. However, countries such as Australia, Canada, Korea and Poland, which, like Ireland, performed above the OECD average on PISA 2012 mathematics, also performed below the international average this age range on PIAAC numeracy.

At this time, we can only speculate on why 16-24 year-olds in Ireland (and indeed adults in Ireland more generally) performed less well than expected on PIAAC. However, it would be a matter of concern if skills acquired in school settings deteriorated more quickly in Ireland than in most other countries soon after young adults leave school. If this was the case, it might reflect lack of opportunity to build on skills acquired in school in out-of-school settings in higher education and in the economy, or it might indicate that some skills acquired in school are not sufficiently deep-rooted to survive once they are no longer required outside of the context in which they were acquired. These issues need to be examined further with ongoing efforts to understand the findings of PIAAC, and, in particular, discrepancies between PISA and PIAAC, continue.

Finally, we can draw some broad comparisons between the outcomes of PISA and recent national assessments. In general, trends on national assessments at primary level in both reading and mathematics have been stable over time with no statistically significant changes in performance since the late 1990s (Eivers et al., 2010), while performance trends on PISA have also been stable, except in 2009. The drop in performance in mathematics on PISA 2009 was not matched by a drop at primary level, even though a majority of students participating in PISA 2009 (those in Third year) were drawn from the same cohort (Fourth class) that participated in the 2004 National Assessment of Mathematics achievement. Similarly, the drop in performance on reading literacy in PISA 2009 was not reflected in a drop in performance in Fifth class on the National Assessment of English reading between 1998 and 2004. There are currently no national assessments at post-primary level.

8.8. PISA and Policy

One of the main aims of PISA is to provide governments with data to help shape their policy making. In Ireland, the results of PISA have been used to inform the *National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020* (DES, 2011) and specific targets relating to PISA have been outlined in this strategy. In particular, the strategy aims to increase the percentage of 15-year-old students performing at or above Level 4 'on literacy and numeracy' by at least 5 percentage points and to halve the percentage of 15-year-old students performing below Level 2 in PISA literacy and numeracy tests by 2020.

As noted earlier, the target aimed at higher-achieving students (i.e. those performing at Level 4 or above) has been met for print reading (+ 8.5 percentage points) and mathematics (+4.9 percentage points) in 2012, although there is, of course, measurement error attached to these increases. There has also been a reduction in the proportions of lower-achieving students, especially for print reading which has seen a change from 17.2% to 9.6% in the percentage of students performing below Level 2 since 2009. However, the target to halve the proportion of lower-achieving students in Ireland has not yet been fully met for either domain. For mathematics, the percentage of students below Level 2 will have to decrease by another 6.5 percentage points in order to meet the target of a 50% reduction on 2009 levels.

Given the differing results across content areas and processes within domains, especially for mathematics in 2012, it may be appropriate to develop targets aimed at specific subareas within domains (e.g. Space & Shape for mathematics). It is likely that such directed targets would not only raise performance in the subdomain, but might also have the effect of increasing performance overall. Also, as suggested above, any new or revised targets should be based on overall trends in PISA performance, rather than on performance in PISA 2009, which was unusually low in reading literacy and mathematics.

PISA can provide important information on the implementation of Project Maths in post primary schools. All of the 23 initial Project Maths schools were included in the sample for Ireland in 2012 and an ERC report, due for publication in 2014, will explore the PISA 2012 results in these schools and make comparisons with performance in 'non-initial' schools. A report describing the views of mathematics teachers in PISA 2012 schools on Project Maths (Cosgrove et al., 2012), has already been published by the ERC. However, as the majority of students who participated in PISA in 2012 (i.e. those in Third and Transition years) would not have had any formal exposure to Project Maths, it may not be until PISA 2015 or beyond that we can explore fully the impact of Project Maths on overall performance on PISA mathematics.

8.9. Move towards Computer-based Assessment

PISA 2012 included assessments of print mathematics and computer-based, and of print reading and digital reading, and the different modes of assessment used different items, as detailed in Chapter 1. For PISA 2015, only computer-based assessments will be used in most countries, including Ireland, and these will involve computer-based presentation of print-based items from previous PISA cycles in reading literacy and mathematics, and a combination of older print items, and newer computer-based items in science. In advance of PISA 2015, the field trial in March 2014 will include a mode effects study to determine whether students perform differently on computer-based and print-based modes of assessment and to facilitate linking scores to previous PISA cycles. In light of the results of PISA 2012, it is worth considering the potential impact of the move to computer-based as the only mode of testing. Results for computer-based mathematics and for digital reading are examined again here, along with some possible factors that may influence performance on computer-based assessments.

In PISA 2012, students in Ireland scored below, but not significantly different from, the OECD average on computer-based mathematics and significantly above the OECD average on print mathematics. This could be attributable to the different groups of countries which administered each mode: of the 34 OECD countries that participated in the print-based assessment, 23 also administered computer-based assessment and of these 12 had a mean print mathematics score that is above the OECD average for print mathematics, while three scored at the OECD average and eight below the OECD average. However, there are notable gender differences in performance in the two forms of assessment. Female students in Ireland achieved a mean score that was significantly above the corresponding OECD average on print mathematics but performed significantly below the OECD average on computer-based mathematics. Furthermore, a higher percentage of female students than males in Ireland performed below Level 2 on the computer-based assessment; the baseline level of proficiency that the OECD claims is required to participate fully in society and in future learning. At the opposite end of the proficiency scale, twice as many male as female students achieved scores above Level 5 on computer-based mathematics. Overall, the pattern of differences in scores on print-based and computer-based mathematics between males and females suggests that the computer-based assessment might favour males. As noted above, the PISA 2015 assessments will use items from previous print-based cycles but more items designed specifically for a computer-based environment (such as those used in PISA 2012 computer-based mathematics) will be developed in subsequent cycles. Students in Ireland, and female students in particular, may be disadvantaged in future PISA cycles, unless computer-usage patterns in schools change in significant ways.

The picture is somewhat different for print reading and digital reading. In PISA 2012, Ireland's mean scores for print and digital reading were significantly above the corresponding OECD average. Female students significantly outperformed males by over a quarter of a standard deviation on both assessments, and both male and female students scored above the OECD averages for print and digital reading. For both assessments, more male than female students performed below Level 2 while more females than males performed at Level 5 or above.

Other studies of literacy and numeracy described in Chapter 1 indicate differences in students' confidence in engaging with technology, and there may also be some important implications arising from PIAAC. In PIAAC, adults in Ireland had rate of opting out of the computer-based assessment that was well above the PIACC average. On the problem solving in technology-rich environments domain in PIAAC, Ireland had the third-highest percentage of 16-24 year olds among participating countries scoring below proficiency level 1. This pattern of outcomes may indicate that the confidence levels of adults in general in Ireland, including young adults, in relation to ICT are lower than in other developed countries – a situation which might have an effect on performance on computer-based assessments in PISA 2015 and beyond.

Looking to other issues that may affect how students perform on print-based and computer-based tests, the use of ICT in mathematics lessons is worthy of consideration. In PISA 2012, Ireland was below but not significantly different from the OECD average on the use of ICT in mathematics lessons (as reported by students), and only 13.7% of students were at schools which had policies in place on such use. There may be less urgency to extend the use of ICT in mathematics lessons as assessments such as the State examinations, are still print-based.

Differences between male and female students on computer-based mathematics and digital reading could be attributed to gender differences in underlying reading and mathematics skills. However, the mode of assessment appeared to compound those differences, with, for example, the gap in favour of males, increasing on computer-based mathematics, compared with print mathematics. The different ways in which students interact with technology, as well as their access to technology at school, could have implications for the computer-based delivery of PISA 2015.

8.10. Looking towards PISA 2015

Preparation for the next cycle of PISA, which will take place in March 2015 in Ireland, is already underway. Science will be the main focus of this cycle, with reading and mathematics assessed as minor domains. This cycle of PISA will be somewhat different from previous cycles, as it is planned to administer the entire assessment on computers. A field trial in March 2014 will examine the effect, if any, of administering the assessment on a computer-based platform and may shed further light on differences in student achievement between the print and computer-based assessments. Furthermore, for the first time in Ireland, a Parent Questionnaire will be administered as part of the PISA 2015 field trial, and, depending on response rates, may also form part of the main study administration in 2015.

A number of additional national reports on PISA 2012 will be published by the ERC in 2014. The results of the computer-based assessment of problem solving will be released by the OECD in spring 2014, and a national report providing an overview of the findings for Ireland will be published at the same time. The ERC will also publish a report, *PISA and Project Maths*, which will compare the results of PISA 2012 for Ireland in the initial 23 Project Maths and other schools. It is also planned to examine students' engagement with the PISA tests further, and this analysis will be described in a report *Contextualising Achievement in PISA 2012* which will be published in the autumn of 2014. Finally, a *Teachers' Guide to PISA 2012 Mathematics* will describe the results for Ireland with particular reference to their implications for schools and classrooms.

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Appendix A: Membership of the PISA 2012 National Advisory Committee

In Ireland, PISA is administered on behalf of the Department of Education and Skills (DES) by the Educational Research Centre. These bodies are supported in their work by a National Advisory Committee. Members of the PISA 2012 National Advisory Committee, along with ERC staff, are:

Pádraig MacFhlannchadha (DES, Chair, from February 2012)

Éamonn Murtagh (DES, Chair, to February 2012)

Declan Cahalane (DES, joined 2012)

Conor Galvin (UCD)

Séamus Knox (DES, joined 2012)

Rachel Linney (NCCA, joined 2012)

Bill Lynch (NCCA, joined 2012, previously a member)

Hugh McManus (SEC)

Philip Matthews (TCD)

Brian Murphy (UCC)

Maurice O'Reilly (St Patrick's College, Drumcondra, joined 2012)

Elizabeth Oldham (TCD)

George Porter (DES, to February 2012).

Appendix B: Sample Passages and Questions from PISA

Overview

This appendix contains examples of print mathematics, reading (print and computer-based/digital) and science units used in the PISA assessment. The mathematics items presented are from the PISA 2012 assessment. As no new science or reading items were released from PISA 2012, science and reading tasks are taken from PISA 2006 and PISA 2009, respectively. Examples of computer-based mathematics items used in PISA 2012 can be found at http://cbasq.acer.edu.au/.

In total, 37 questions are included from 12 passages or stimuli, consisting of 3 print mathematics passages and 9 print mathematics questions; 3 print reading passages and 10 print reading questions; 3 digital reading passages and 9 digital reading questions; and 3 science passages and 9 science questions. The format of the passages is changed slightly from that presented to students to reduce pagination.

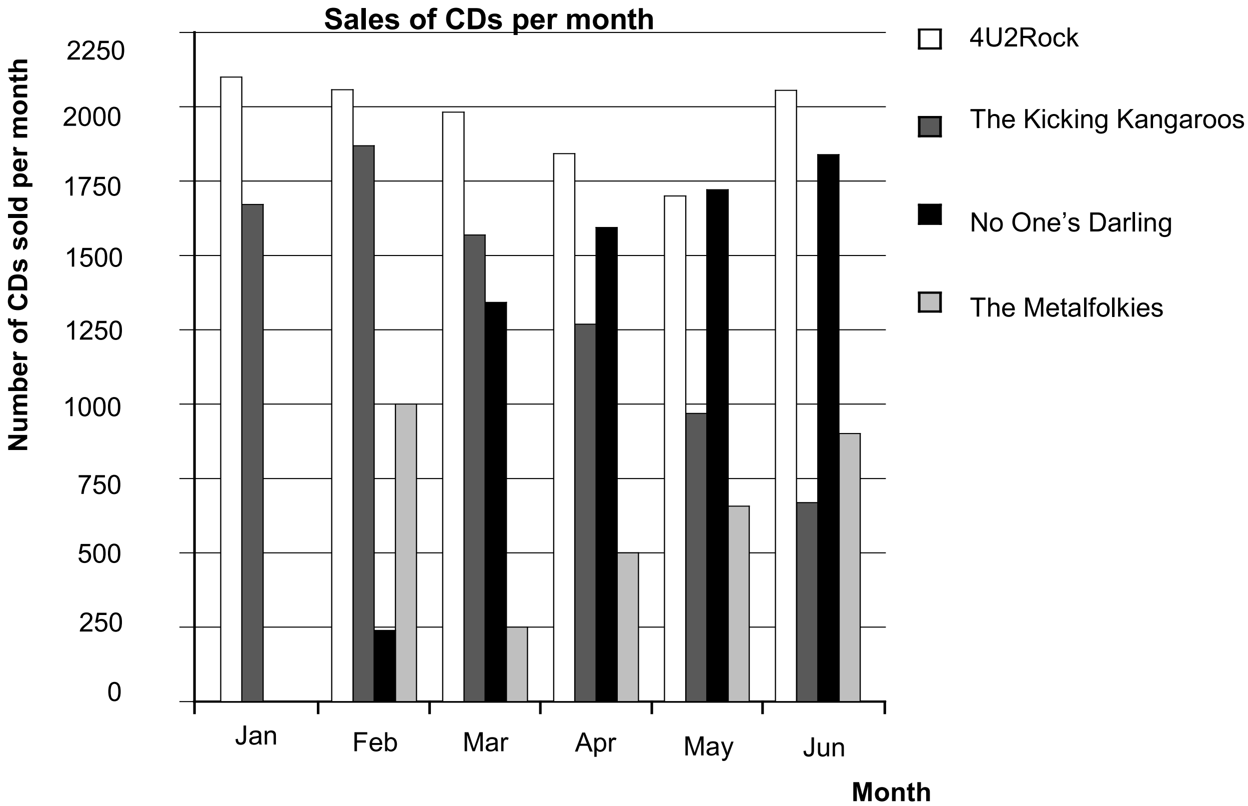
The appendix also provides some item statistics for the sample items. The average percentage correct, incorrect and missing/not reached scores are provided for Ireland and the OECD. Information on item difficulty is also provided for each item, in the form of a scale score (the item's score on an item difficulty scale, with a mean of 500 and a standard deviation of 100) and the proficiency level that the scale score falls into.

The OECD (2013b) provides further discussion of sample PISA tasks, and has published a set of all released print PISA tasks from the first three cycles of PISA (OECD, 2009e).

Print Mathematics Sample Questions

PRINT MATHEMATICS UNIT 1: Charts

In January, the new CDs of the bands *4U2Rock* and *The Kicking Kangaroos* were released. In February, the CDs of the bands *No One's Darling* and *The Metalfolkies* followed. The following graph shows the sales of the bands' CDs from January to June.



Charts – Question 1

How many CDs did the band *The Metalfolkies* sell in April?

A 250
B 500
C 1000
D 1270

Response	Ireland	OECD	Item Difficulty
Correct (option B)	84.2	87.3	Scale Score: 347.7 Proficiency Level <1
Incorrect	2.0	1.3	
Missing/Not reached	13.8	11.4	

Description: *Read a bar chart*

Mathematical content area: *Uncertainty and data*

Context: *Societal*

Process: *Interpret*

Charts – Question 2

In which month did the band *No One's Darling* sell more CDs than the band *The Kicking Kangaroos* for the first time?

A No month
B March
C April
D May

Response	Ireland	OECD	Item Difficulty
Correct (option C)	77.2	79.5	Scale Score: 415.0 Proficiency Level 1
Incorrect	19.9	19.4	
Missing/Not reached	2.9	2.1	

Description: *Read a bar chart and compare the height of two bars*

Mathematical content area: *Uncertainty and data*

Context: *Societal*

Process: *Interpret*

Charts – Question 3

The manager of *The Kicking Kangaroos* is worried because the number of their CDs that sold decreased from February to June.

What is the estimate of their sales volume for July if the same negative trend continues?

A 70 CDs
B 370 CDs
C 670 CDs
D 1340 CDs

Response	Ireland	OECD	Item Difficulty
Correct (option B)	76.2	76.7	Scale Score: 428.2 Proficiency Level 2
Incorrect	23.6	23.3	
Missing/Not reached	0.2	0.0	

Description: *Interpret a bar chart and estimate the number of CDs sold in the future assuming that the linear trend continues*

Mathematical content area: *Uncertainty and data*

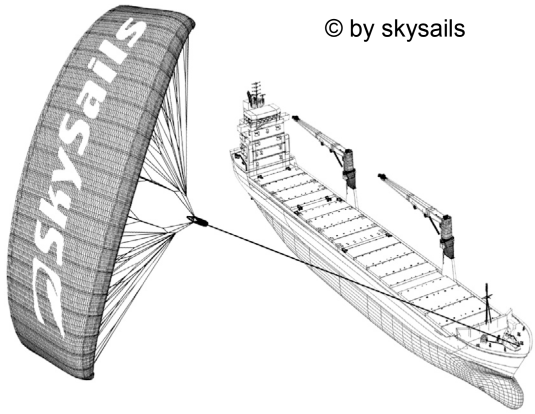
Context: *Societal*

Process: *Employ*

PRINT MATHEMATICS UNIT 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.



Sailing Ships – Question 1

One advantage of using a kite sail is that it flies at a height of 150 m. There, the wind speed is approximately 25% higher than down on the deck of the ship.

At what approximate speed does the wind blow into a kite sail when a wind speed of 24 km/h is measured on the deck of the ship?

A 6 km/h
B 18 km/h
C 25 km/h
D 30 km/h
E 49 km/h

Response	Ireland	OECD	Item Difficulty
Correct (option D)	60.9	59.5	Scale Score: 511.7 Proficiency Level 3
Incorrect	37.4	37.4	
Missing/Not reached	1.7	3.1	

Description: *Apply calculation of percentage within a given real world situation*

Mathematical content area: *Quantity*

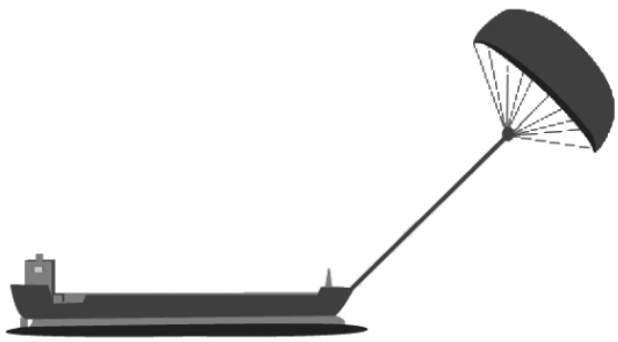
Context: *Scientific*

Process: *Employ*

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



Response	Ireland	OECD	Item Difficulty
Correct (option B)	47.8	49.8	Scale Score: 538.5 Proficiency Level 3
Incorrect	49.6	46.2	
Missing/Not reached	2.6	4.0	

Description: Use Pythagorean Theorem within a real geometric context

Mathematical content area: Space and shape

Context: Scientific

Process: Employ

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: ....

Response	Ireland	OECD	Item Difficulty
Correct	15.8	15.3	Scale Score: 702.1 Proficiency Level 6
Incorrect	65.5	53.1	
Missing/Not reached	18.7	31.7	

Description: *Solve a real world situation involving cost savings and fuel consumption*

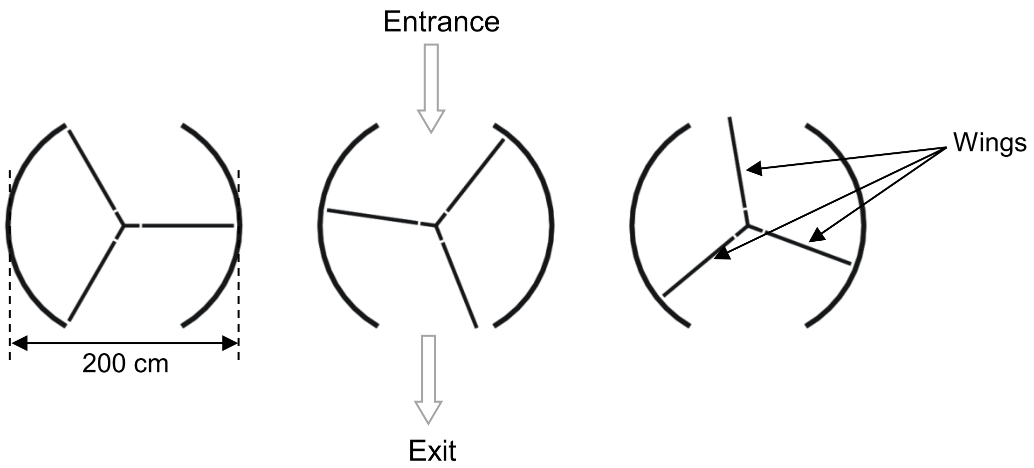
Mathematical content area: *Change and relationships*

Context: *Scientific*

Process: *Formulate*

PRINT MATHEMATICS UNIT 3: 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 centimetres). 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.



Revolving Door – Question 1

What is the size in degrees of the angle formed by two door wings?

Size of the angle: .... º

Response	Ireland	OECD	Item Difficulty
Correct	63.4	57.7	Scale Score: 512.3 Proficiency Level 3
Incorrect	30.1	32.8	
Missing/Not reached	6.5	9.5	

Description: *Compute the central angle of a sector of a circle*

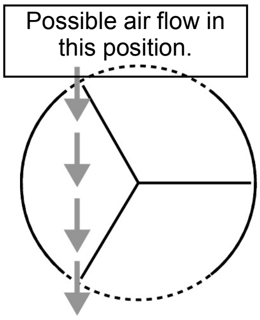
Mathematical content area: *Space and shape*

Context: *Scientific*

Process: *Employ*

Revolving Door – Question 2

The two door **openings** (the dotted arcs in the diagram) are the same size. If these openings are too wide the revolving wings cannot provide a sealed space and air could then flow freely between the entrance and the exit, causing unwanted heat loss gain. This is shown in the diagram opposite.



or

door

What is the maximum arc length in centimetres (cm) that each opening can have, so that air never flows freely between the entrance and the exit?

Maximum arc length: .... cm

Response	Ireland	OECD	Item Difficulty
Correct	2.4	3.5	Scale Score: 561.3 Proficiency Level 4
Incorrect	76.0	69.6	
Missing/Not reached	21.6	26.9	

Description: *Interpret a geometrical model of a real life situation to calculate the length of an arc*

Mathematical content area: *Space and Shape*

Context: *Scientific*

Process: *Formulate*

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

Response	Ireland	OECD	Item Difficulty
Correct (option D)	48.8	46.4	Scale Score: 840.3 Proficiency Level 6
Incorrect	48.9	50.3	
Missing/Not reached	2.3	3.3	

Description: Identify information and construct an (implicit) quantitative model to solve the problem

Mathematical content area: Quantity

Context: Scientific

Process: Formulate

Print Reading Sample Questions

PRINT READING PASSAGE 1: Telecommuting

The way of the future

Just imagine how wonderful it would be to 'telecommute'[1] to work on the electronic highway, with all your work done on a computer or by phone! No longer would you have to jam your body into crowded buses or trains or waste hours and hours travelling to and from work. You could work wherever you want to – just think of all the job opportunities this would open up! – *Molly*

Disaster in the making

Cutting down on commuting hours and reducing the energy consumption involved is obviously a good idea. But such a goal should be accomplished by improving public transportation or by ensuring that workplaces are located near where people live. The ambitious idea that telecommuting should be part of everyone's way of life will only lead people to become more and more self-absorbed. Do we really want our sense of being part of a community to deteriorate even further? – *Richard*

[1] 'Telecommuting' is a term coined by Jack Nilles in the early 1970s to describe a situation in which workers work on a computer away from a central office (for example, at home) and transmit data and documents to the central office via telephone lines.

Telecommuting – Question 1

What is the relationship between 'The way of the future' and 'Disaster in the making'?

A They use different arguments to reach the same general conclusion.
B They are written in the same style but they are about completely different topics.
C They express the same general point of view, but arrive at different conclusions.
D They express opposing points of view on the same topic.

Response	Ireland	OECD	Item Difficulty
Correct (option D)	52	52	Scale Score: 537 Proficiency Level 3
Incorrect	45	44	
Missing/Not reached	3	4	

Situation: *Occupational*

Text Format: *Multiple*

Text type: *Argumentation*

Aspect: *Integrate and interpret – Develop a broad understanding*

Question format: *Multiple choice*

Telecommuting – Question 2

What is one kind of work for which it would be difficult to telecommute? Give a reason for your answer.

Examples of correct answers (full credit only):

Electrician. It's a practical job and can't be done on a computer.
Teaching, as you could not keep control of the class.

Farming. It is usually done in the countryside. There would be no demand for telecommuting in the countryside.

Examples of incorrect answers:

It would be difficult for people who aren't interested.
Practical work (no example provided).

Response	Ireland	OECD	Item Difficulty
Correct	47	56	Scale Score: 514 Proficiency Level 3
Incorrect	37	29	
Missing/Not reached	16	15	

Situation: *Occupational*

Text Format: *Continuous*

Text type: *Argumentation*

Aspect: *Reflect and evaluate – Reflect on and evaluate the content of a text*

Question format: *Open constructed response*

Telecommuting – Question 3

Which statement would **both** Molly and Richard agree with?

A People should be allowed to work for as many hours as they want to.
B It is not a good idea for people to spend too much time getting to work.
C Telecommuting would not work for everyone.
D Forming social relationships is the most important part of work.

Response	Ireland	OECD	Item Difficulty
Correct (option B)	55	60	Scale Score: 503 Proficiency Level 3
Incorrect	41	36	
Missing/Not reached	4	4	

Situation: *Occupational*

Text Format: *Continuous*

Text type: *Argumentation*

Aspect: *Integrate and Interpret – Develop an interpretation*

Question format: *Multiple Choice*

PRINT READING PASSAGE 2: Mobile Phone Safety

Key Point
Conflicting reports about the health risks of mobile phones appeared in the late 1990s.

Key Point
Millions of euro have now been invested in scientific research to investigate the effects of mobile phones.

Key Point
Given the immense numbers of mobile phone users, even small adverse effects on health could have major public health implications.

Key Point
In 2000, the Stewart Report (a British report) found no known health problems caused by mobile phones, but advised caution, especially among the young, until more research was carried out. A further report in 2004 backed this up.

Are mobile phones dangerous?

	Yes	No
1.	Radio waves given off by mobile phones can heat up body tissue, having damaging effects.	Radio waves are not powerful enough to cause heat damage to the body.
2.	Magnetic fields created by mobile phones can affect the way that your body cells work.	The magnetic fields are incredibly weak, and so unlikely to affect cells in our body.
3.	People who make long mobile phone calls sometimes complain of fatigue, headaches, and loss of concentration.	These effects have never been observed under laboratory conditions and may be due to other factors in modern lifestyles.
4.	Mobile phone users are 2.5 times more likely to develop cancer in areas of the brain adjacent to their phone ears.	Researchers admit it's unclear this increase is linked to using mobile phones.
5.	The International Agency for Research on Cancer found a link between childhood cancer and power lines. Like mobile phones, power lines also emit radiation.	The radiation produced by power lines is a different kind of radiation, with much more energy than that coming from mobile phones.
6.	Radio frequency waves similar to those in mobile phones altered the gene expression in nematode worms.	Worms are not humans, so there is no guarantee that our brain cells will react in the same way.

If you use a mobile phone …

Do	Don't
Keep the calls short.	Don't use your mobile phone when the reception is weak, as the phone needs more power to communicate with the base station, and so the radio-wave emissions are higher.
Carry the mobile phone away from your body when it is on standby.	Don't buy a mobile phone with a high 'SAR' value[1]. This means that it emits more radiation.
Buy a mobile phone with a long 'talk time'. It is more efficient, and has less powerful emissions.	Don't buy protective gadgets unless they have been independently tested.

SAR (specific absorption rate) is a measurement of how much electromagnetic radiation is absorbed by body tissue whilst using a mobile phone.

Mobile Phone Safety – Question 1

What is the purpose of the **Key Points**?

- A To describe the dangers of using mobile phones.
- B To suggest that debate about mobile phone safety is ongoing.
- C To describe the precautions that people who use mobile phones should take.
- D To suggest that there are no known health problems caused by mobile phones.

Response	Ireland	OECD	Item Difficulty
Correct (option B)	47	46	Scale Score: 561 Proficiency Level 4
Incorrect	50	49	
Missing/Not reached	3	5	

Situation: *Public*

Text Format: *Non-continuous*

Text type: *Exposition*

Aspect: *Integrate and interpret – Develop a broad understanding*

Question format: *Multiple choice*

Mobile Phone Safety – Question 2

'It is difficult to prove that one thing has definitely caused another.'

What is the relationship of this piece of information to the Point 4 **Yes** and **No** statements in the table **Are mobile phones dangerous?**

- A It supports the Yes argument but does not prove it.
- B It proves the Yes argument.
- C It supports the No argument but does not prove it.
- D It shows that the No argument is wrong.

Response	Ireland	OECD	Item Difficulty
Correct (option C)	30	35	Scale Score: 604 Proficiency Level 4
Incorrect	66	59	
Missing/Not reached	4	6	

Situation: *Public*

Text Format: *Non-continuous*

Text type: *Exposition*

Aspect: *Reflect and evaluate – Reflect on and evaluate the content of a text*

Question format: *Multiple choice*

Mobile Phone Safety – Question 3

Look at Point 3 in the **No** column of the table. In this context, what might one of these ‘other factors’ be? Give a reason for your answer.

Examples of correct answers (full credit only):

Not getting enough sleep.
Being busy.
Stress.
Taking drugs.
Pollution.

Examples of incorrect answers:

Headaches.
Lifestyle.

Response	Ireland	OECD	Item Difficulty
Correct	60	55	Scale Score: 526 Proficiency Level 3
Incorrect	21	21	
Missing/Not reached	19	24	

Situation: *Public*

Text Format: *Non-continuous*

Text type: *Exposition*

Aspect: *Reflect and evaluate – Reflect on and evaluate the content of a text*

Question format: *Open constructed response*

Mobile Phone Safety – Question 4

Look at the table with the heading **If you use a mobile phone …** Which of these ideas is the table based on?

A There is no danger involved in using mobile phones.
B There is a proven risk involved in using mobile phones.
C There may or may not be danger involved in using mobile phones, but it is worth taking precautions.
D There may or may not be danger involved in using mobile phones, but they should not be used until we know for sure.
E The **Do** instructions are for those who take the threat seriously, and the **Don’t** instructions are for everyone else.

Response	Ireland	OECD	Item Difficulty
Correct (option C)	71	63	Scale Score: 488 Proficiency Level 3
Incorrect	25	30	
Missing/Not reached	4	7	

PRINT READING PASSAGE 3: The Play's the Thing

Takes place in a castle by the beach in Italy.

FIRST ACT

Ornate guest room in a very nice beachside castle. Doors on the right and left. Sitting room set in the middle of the stage: couch, table, and two armchairs. Large windows at the back. Starry night. It is dark on the stage. When the curtain goes up we hear men conversing loudly behind the door on the left. The door opens and three tuxedoed gentlemen enter. One turns the light on immediately. They walk to the centre in silence and stand around the table. They sit down together, Gál in the armchair to the left, Turai in the one on the right, Ádám on the couch in the middle. Very long, almost awkward silence. Comfortable stretches. Silence. Then:

GÁL

Why are you so deep in thought?

TURAI

I'm thinking about how difficult it is to begin a play. To introduce all the principal characters in the beginning, when it all starts.

ÁDÁM

I suppose it must be hard.

TURAI

It is – devilishly hard. The play starts. The audience goes quiet. The actors enter the stage and the torment begins. It's an eternity, sometimes as much as a quarter of an hour before the audience finds out who's who and what they are all up to.

GÁL

Quite a peculiar brain you've got. Can't you forget your profession for a single minute?

TURAI

That cannot be done.

GÁL

Not half an hour passes without you discussing theatre, actors, plays. There are other things in this world.

TURAI

There aren't. I am a dramatist. That is my curse.

GÁL

You shouldn't become such a slave to your profession.

TURAI

If you do not master it, you are its slave. There is no middle ground. Trust me, it's no joke starting a play well. It is one of the toughest problems of stage mechanics. Introducing your characters promptly. Let's look at this scene here, the three of us. Three gentlemen in tuxedoes. Say they enter not this room in this lordly castle, but rather a stage, just when a play begins. They would have to chat about a whole lot of uninteresting topics until it came out who we are. Wouldn't it be much easier to start all this by standing up and introducing ourselves? *Stands up.* Good evening. The three of us are guests in this castle. We have just arrived from the dining room where we had an excellent dinner and drank two bottles of champagne. My name is Sándor Turai, I'm a playwright, I've been writing plays for thirty years, that's my profession. Full stop. Your turn.

GÁL

Stands up. My name is Gál, I'm also a playwright. I write plays as well, all of them in the company of this gentleman here. We are a famous playwright duo. All playbills of good comedies and operettas read: written by Gál and Turai. Naturally, this is my profession as well.

GÁL and TURAI

Together. And this young man …

ÁDÁM

Stands up. This young man is, if you allow me, Albert Ádám, twenty-five years old, composer. I wrote the music for these kind gentlemen for their latest operetta. This is my first work for the stage. These two elderly angels have discovered me and now, with their help, I'd like to become famous. They got me invited to this castle. They got my dress-coat and tuxedo made. In other words, I am poor and unknown, for now. Other than that I'm an orphan and my grandmother raised me. My grandmother has passed away. I am all alone in this world. I have no name, I have no money.

TURAI

But you are young.

GÁL

And gifted.

ÁDÁM

And I am in love with the soloist.

TURAI

You shouldn't have added that. Everyone in the audience would figure that out anyway.

They all sit down.

TURAI

Now wouldn't this be the easiest way to start a play?

GÁL

If we were allowed to do this, it would be easy to write plays.

TURAI

Trust me, it's not that hard. Just think of this whole thing as …

GÁL

All right, all right, all right, just don't start talking about the theatre again. I'm fed up with it. We'll talk tomorrow, if you wish.

Note:

Line numbers were given in the margin of the script to help students find parts that are referred to in the questions and the extract from the play was formatted to two columns per page.

The Play's the Thing – Question 1

What were the characters in the play doing **just before** the curtain went up?

Examples of correct answers:

Eating their dinner.
The characters were behind the door on the left coming back from dinner.

Examples of incorrect answers:

Talking about boring topics
They are in their positions for the play.
They were conversing loudly behind the door to the left.

Response	Ireland	OECD	Item Difficulty
Correct	11	13	Scale Score: 730 Proficiency Level 6
Incorrect	81	75	
Missing/Not reached	8	12	

Situation: *Personal*

Text Format: *Continuous*

Text type: *Narrative*

Aspect: *Integrate and Interpret – Develop an interpretation*

Question Format: *Short response*

The Play's the Thing – Question 2

'It's an eternity, sometimes as much as a quarter of an hour … ' (lines 29-30)

According to Turai, why is a quarter of an hour 'an eternity'?

A It is a long time to expect an audience to sit still in a crowded theatre.
B It seems to take forever for the situation to be clarified at the beginning of a play.
C It always seems to take a long time for a dramatist to write the beginning of a play.
D It seems that time moves slowly when a significant event is happening in a play.

Response	Ireland	OECD	Item Difficulty
Correct (option B)	62	66	Scale Score: 474 Proficiency Level 2
Incorrect	36	30	
Missing/Not reached	2	4	

Situation: *Personal*

Text Format: *Continuous*

Text type: *Narration*

Aspect: *Integrate and Interpret – Develop an interpretation*

The Play's the Thing – Question 3

Overall, what is the dramatist Molnár doing in this extract?

A He is showing the way that each character will solve his own problems.
B He is making his characters demonstrate what an eternity in a play is like.
C He is giving an example of a typical and traditional opening scene for a play.
D He is using the characters to act out one of his own creative problems.

Response	Ireland	OECD	Item Difficulty
Correct (option D)	46	46	Scale Score: 556 Proficiency Level 4
Incorrect	48	48	
Missing/Not reached	6	6	

Situation: *Personal*

Text Format: *Continuous*

Text type: *Narration*

Aspect: *Integrate and interpret – Develop a broad understanding*

Question format: *Multiple choice*

Digital Reading Sample Questions

DIGITAL READING PASSAGE 1: IWANTTOHELP

IWANTTOHELP – Question 1

Read Maika's blog entry for January 1. What does the entry say about Maika's experience of volunteering?

A She has been a volunteer for many years.
B She only volunteers in order to be with her friends.
C She has done a little volunteering but would like to do more.
D She has tried volunteering but does not think it is worthwhile.

Response	Ireland	OECD	Item difficulty
Correct (option C)	89	85	Scale score: 362 Below proficiency level 2
Incorrect	10	14	
Missing/Not reached	2	1	

Situation: *Occupational*

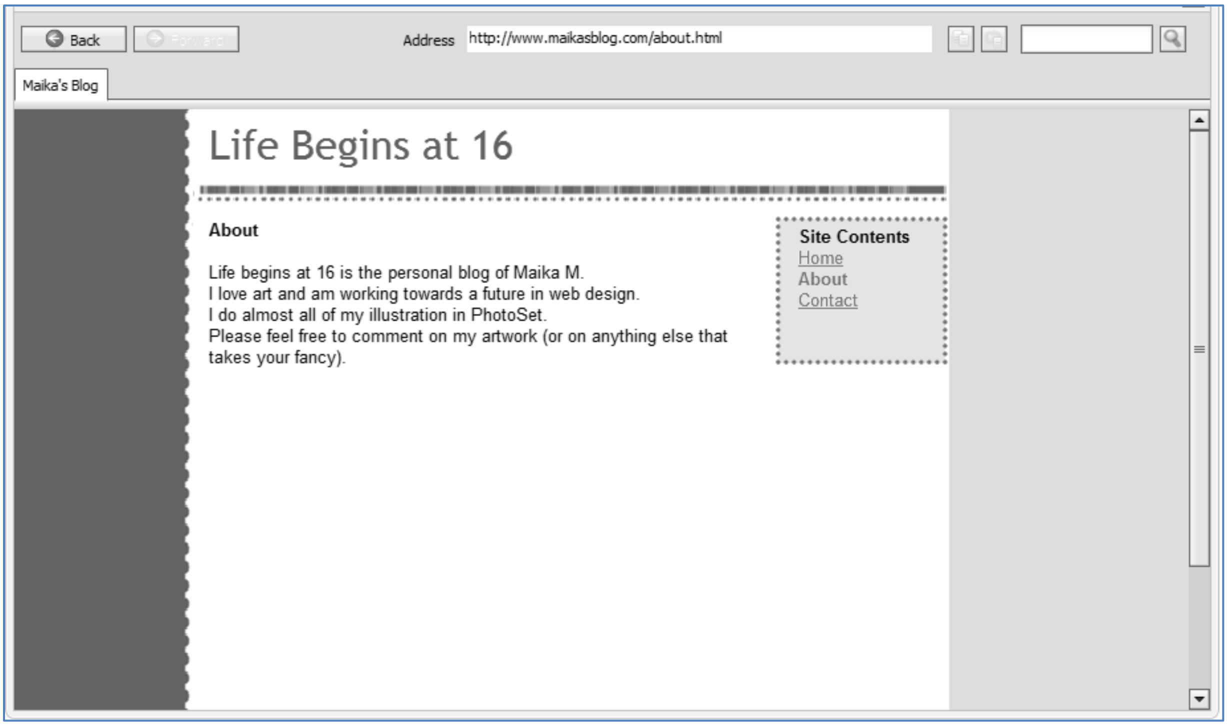
Environment: *Message-based*

Text Format: *Continuous*

Text type: *Description*

Aspect: *Access and retrieve – Retrieve information*

Question Format: *Multiple choice*



IWANTTOHELP: Question 2

Go to Maika's 'About' page.

What kind of work does Maika want to do when she leaves school?

- A Photography.
- B Web design.
- C Banking.
- D Social work.

Response	Ireland	OECD	Item difficulty
Correct (option B)	76	78	Scale score: 417 Proficiency level 2
Incorrect	22	20	
Missing/Not reached	2	2	

Situation: *Educational*

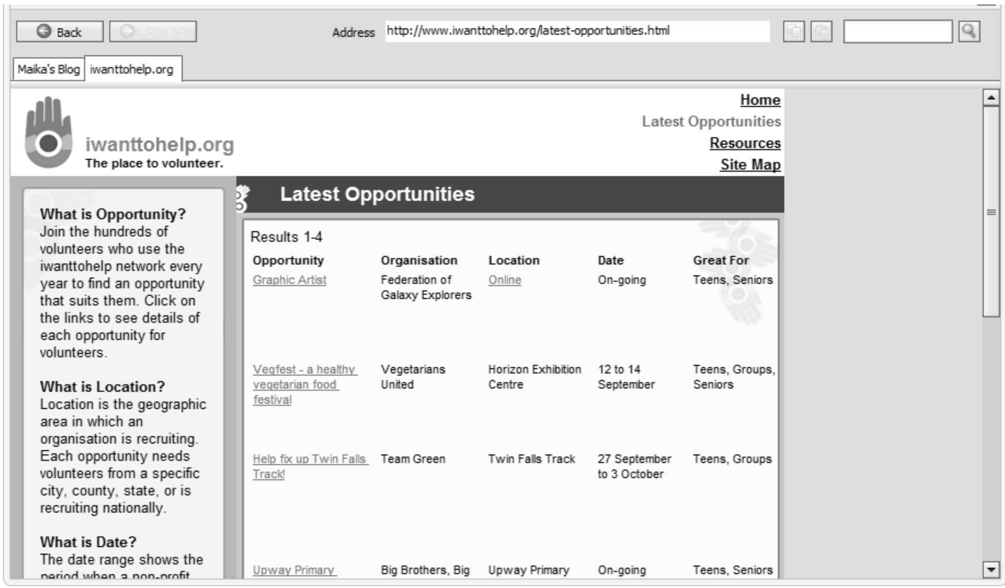
Environment: *Message-based*

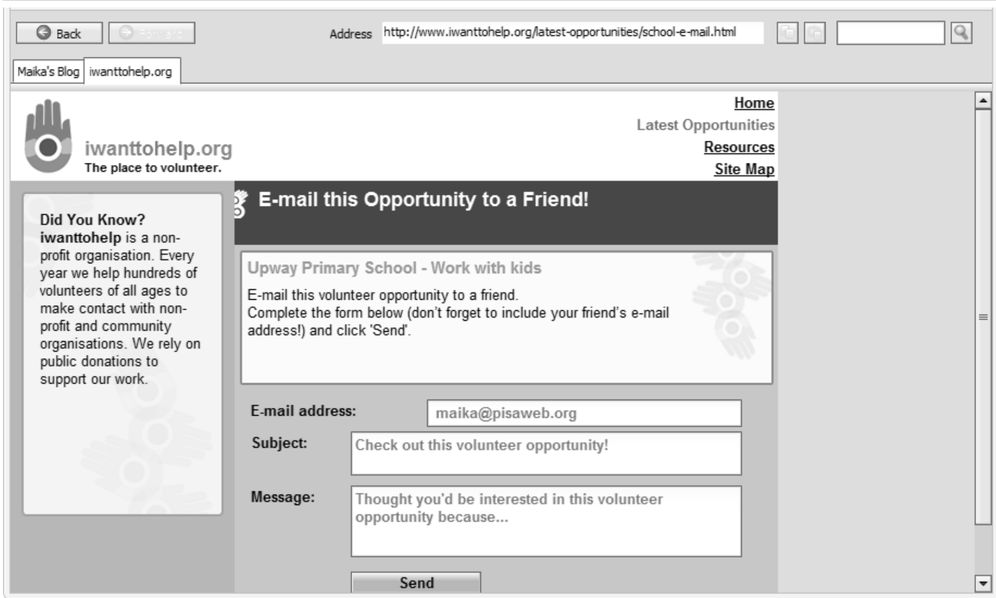
Text Format: *Multiple*

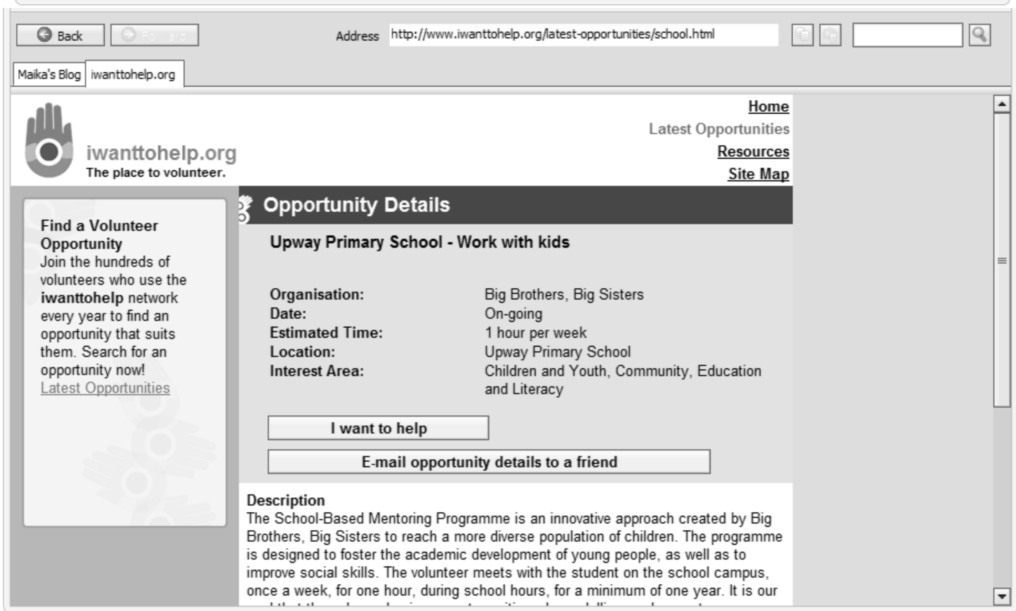
Text type: *Description*

Aspect: *Access and retrieve – Retrieve information*

Question Format: *Multiple choice*


Back
Address http://www.iwanttohelp.org/latest-opportunities.html
Maika's Blog
iwanttohelp.org
Home
Latest Opportunities
Resources
Site Map
iwanttohelp.org
The place to volunteer.
What is Opportunity?
Join the hundreds of volunteers who use the iwanttohelp network every year to find an opportunity that suits them. Click on the links to see details of each opportunity for volunteers.
What is Location?
Location is the geographic area in which an organisation is recruiting. Each opportunity needs volunteers from a specific city, county, state, or is recruiting nationally.
What is Date?
The date range shows the
Latest Opportunities
Results 1-4
Opportunity
Organisation
Location
Date
Great For
Graphic Artist
Federation of Galaxy Explorers
Online
On-going
Teens, Seniors
Vegfest - a healthy vegetarian food festival
Vegetarians United
Horizon Exhibition Centre
12 to 14 September
Teens, Groups, Seniors
Help fix up Twin Falls Track!
Team Green
Twin Falls Track
27 September to 3 October
Teens, Groups
Upway Primary
Big Brothers, Big
Upway Primary
On-going
Teens, Seniors


Back
Address http://www.iwanttohelp.org/latest-opportunities/school-e-mail.html
Maika's Blog
iwanttohelp.org
Home
Latest Opportunities
Resources
Site Map
iwanttohelp.org
The place to volunteer.
Did You Know?
iwanttohelp is a non-profit organisation. Every year we help hundreds of volunteers of all ages to make contact with non-profit and community organisations. We rely on public donations to support our work.
E-mail this Opportunity to a Friend!
Upway Primary School - Work with kids
E-mail this volunteer opportunity to a friend.
Complete the form below (don't forget to include your friend's e-mail address!) and click 'Send'.
E-mail address:
maika@pisaweb.org
Subject:
Check out this volunteer opportunity!
Message:
Thought you'd be interested in this volunteer opportunity because...
Send


Back
Address http://www.iwanttohelp.org/latest-opportunities/school.html
Maika's Blog
iwanttohelp.org
Home
Latest Opportunities
Resources
Site Map
iwanttohelp.org
The place to volunteer.
Find a Volunteer Opportunity
Join the hundreds of volunteers who use the iwanttohelp network every year to find an opportunity that suits them. Search for an opportunity now!
Latest Opportunities
Opportunity Details
Upway Primary School - Work with kids
Organisation: Big Brothers, Big Sisters
Date: On-going
Estimated Time: 1 hour per week
Location: Upway Primary School
Interest Area: Children and Youth, Community, Education and Literacy
I want to help
E-mail opportunity details to a friend
Description
The School-Based Mentoring Programme is an innovative approach created by Big Brothers, Big Sisters to reach a more diverse population of children. The programme is designed to foster the academic development of young people, as well as to improve social skills. The volunteer meets with the student on the school campus, once a week, for one hour, during school hours, for a minimum of one year. It is our

IWANTTOHELP – Question 3:

Read Maika's blog for January 1. Go to the iwanttohelp site and find an opportunity for Maika. Use the email button on the 'Opportunity Details' page for this opportunity to tell Maika about it. Explain in the email why the opportunity is suitable for her. Then send your email by clicking on the 'Send' button.

Examples of correct answers (full credit):

Students get credit for locating the place to set up and send the email and refer to ongoing position or future or web design or art, e.g.
You're a great artist and it is ongoing - you said you wanted a longer type of work right?
It's ongoing and it would help you get experience for your future.
You are obviously interested in graphic design, and want to pursue this when you finish school, and you would also love to volunteer. This would be a great opportunity to do both these things, and will look great on your CV too!

Examples of correct answers (partial credit):

Students get credit for locating the place to set up and send the email and the message in the email is vague, incomplete, irrelevant or missing.

Examples of incorrect answers:

Other responses.

Response	Ireland	OECD	Scale score	Proficiency level
Full credit	49	44	567	4
Partial credit	15	14	525	3
Incorrect	3	5		
Missing/Not reached	33	37		

Situation: *Educational*

Environment: *Mixed*

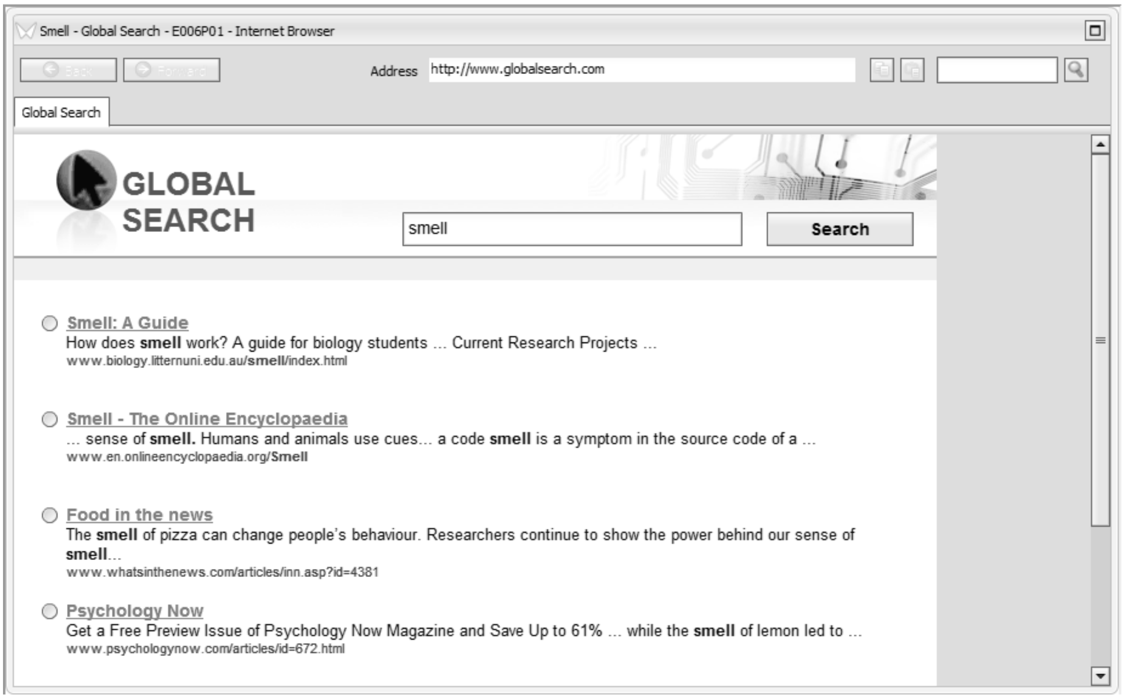
Text Format: *Multiple*

Text type: *Not specified*

Aspect: *Complex*

Question Format: *Open constructed response*

DIGITAL READING PASSAGE 2: Smell



Smell – Question 1:

Go to the 'Smell: A Guide' web page. Which of these statements best expresses the main idea on this page?

- A Smell can interfere with normal patterns of behaviour.
- B Smell warns humans and animals of danger.
- C The primary purpose of smell is to help animals to find food.
- D The development of smell takes place early in life.
- E The basic function of smell is recognition.

Response	Ireland	OECD	Item difficulty
Correct (option E)	37	42	Scale score: 572 Proficiency level 4
Incorrect	59	54	
Missing/Not reached	4	4	

Situation: *Educational*

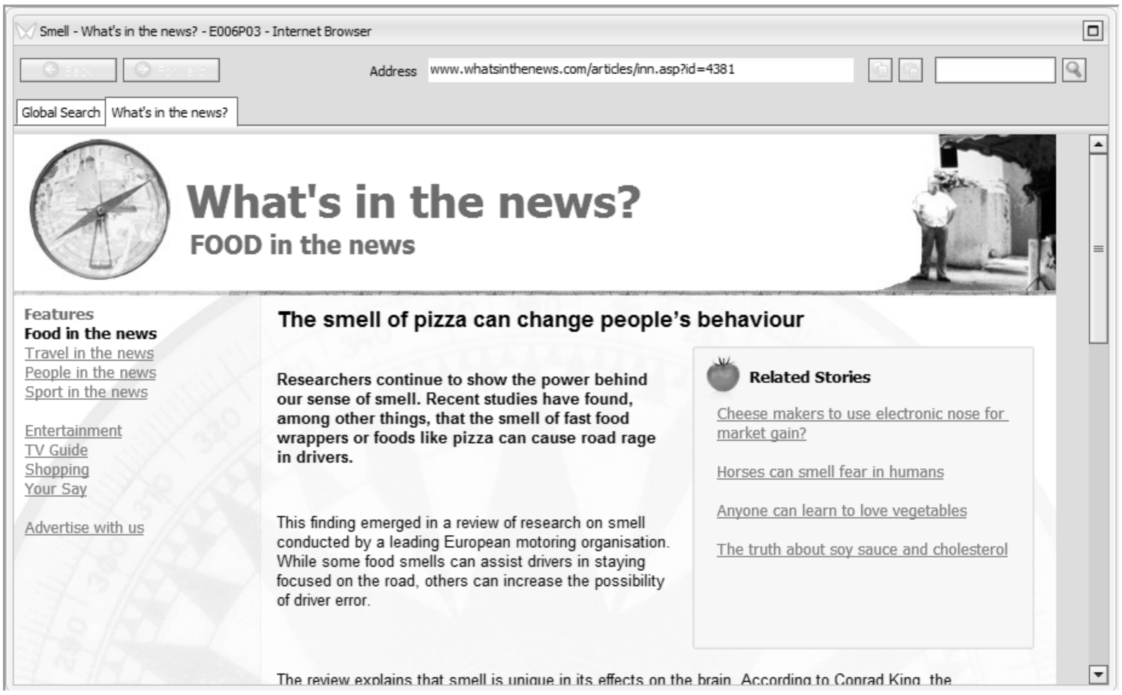
Environment: *Authored*

Text Format: *Multiple*

Text type: *Exposition*

Aspect: *Integrate and Interpret – Form a broad understanding*

Question Format: *Multiple choice*



Smell – Question 2:

Go to the ‘Food in the news’ web page. Would this web page be a suitable source for you to refer to in a school science assignment about smell? Answer Yes or No and refer to the content of the ‘Food in the news’ web page to give a reason for your answer.

Examples of correct responses (full credit only):

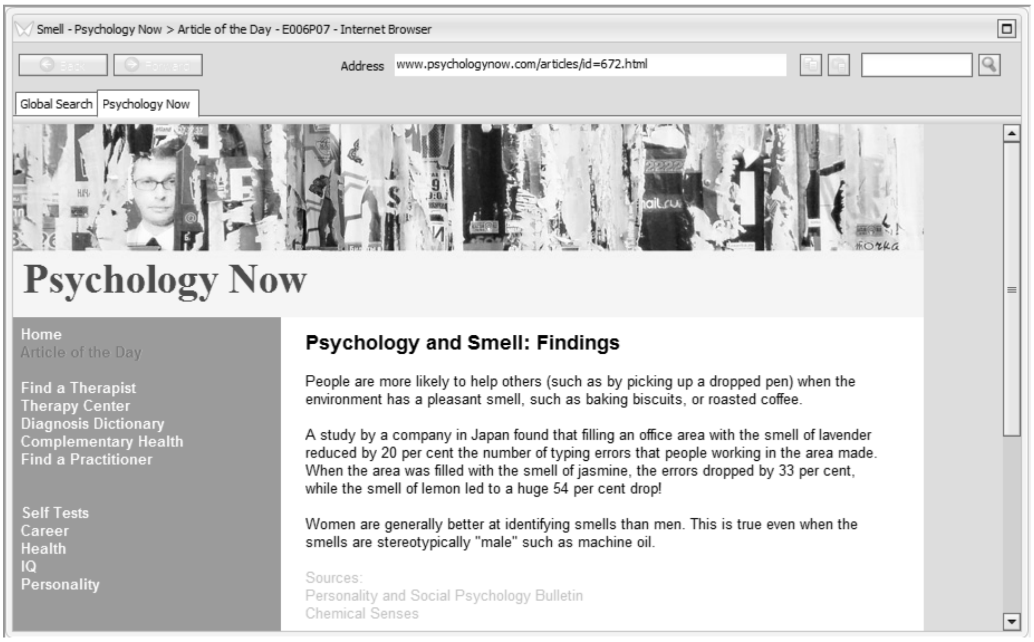
Answers (or implies) **No** and gives a plausible supporting explanation, referring to the trivial or sensational nature of the website content, or the popularisation of the issues by journalists or the site’s failure to explicitly give its sources of information; or answers (or implies) **Yes** and indicates that the site would be helpful as a secondary source, leading to more reputable sources; or answers (or implies) Yes and gives a plausible supporting explanation, referring to the article’s sources of information or the level of detail provided.

Examples of incorrect responses:

Other irrelevant, vague or incorrect responses.

Response	Ireland	OECD	Item difficulty
Correct	23	27	Scale score: 657 Proficiency level 5
Incorrect	69	64	
Missing/Not reached	8	9	

Situation: *Public*
Environment: *Authored*
Text format: *Multiple*
Text type: *Exposition*
Aspect: *Reflect and evaluate – Reflect on and evaluate content of text*
Question format: *Open constructed response*



Smell - Psychology Now > Article of the Day - E006P07 - Internet Browser

Address www.psychologynow.com/articles/id=672.html

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Psychology Now

Home
Article of the Day

Find a Therapist
Therapy Center
Diagnosis Dictionary
Complementary Health
Find a Practitioner

Self Tests
Career
Health
IQ
Personality

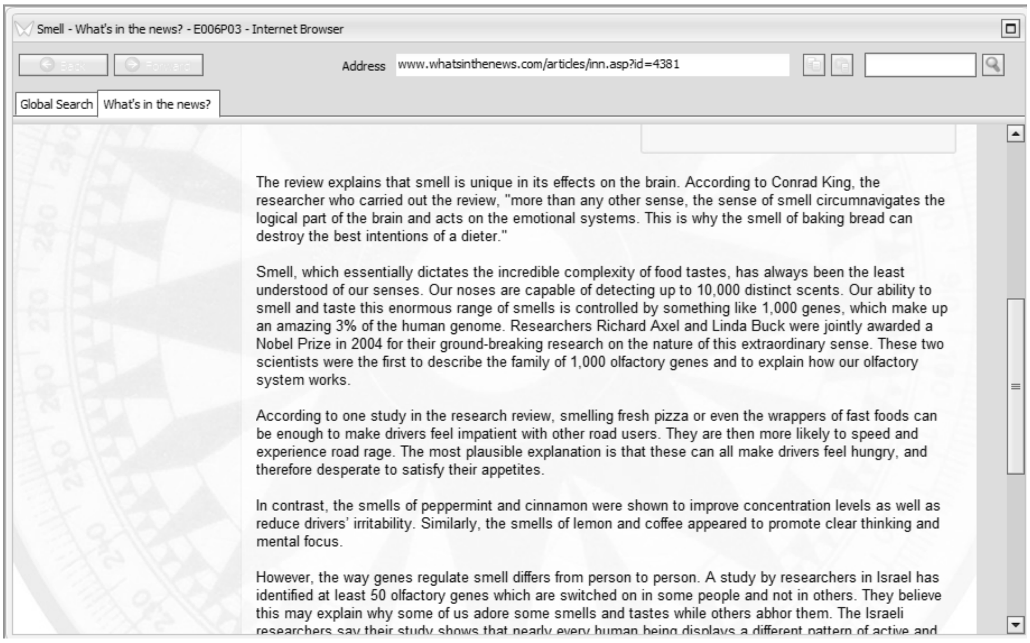
Psychology and Smell: Findings

People are more likely to help others (such as by picking up a dropped pen) when the environment has a pleasant smell, such as baking biscuits, or roasted coffee.

A study by a company in Japan found that filling an office area with the smell of lavender reduced by 20 per cent the number of typing errors that people working in the area made. When the area was filled with the smell of jasmine, the errors dropped by 33 per cent, while the smell of lemon led to a huge 54 per cent drop!

Women are generally better at identifying smells than men. This is true even when the smells are stereotypically "male" such as machine oil.

Sources:
Personality and Social Psychology Bulletin
Chemical Senses



Smell - What's in the news? - E006P03 - Internet Browser

Address www.whatsinthenews.com/articles/inn.asp?id=4381

Global Search | What's in the news?

The review explains that smell is unique in its effects on the brain. According to Conrad King, the researcher who carried out the review, "more than any other sense, the sense of smell circumnavigates the logical part of the brain and acts on the emotional systems. This is why the smell of baking bread can destroy the best intentions of a dieter."

Smell, which essentially dictates the incredible complexity of food tastes, has always been the least understood of our senses. Our noses are capable of detecting up to 10,000 distinct scents. Our ability to smell and taste this enormous range of smells is controlled by something like 1,000 genes, which make up an amazing 3% of the human genome. Researchers Richard Axel and Linda Buck were jointly awarded a Nobel Prize in 2004 for their ground-breaking research on the nature of this extraordinary sense. These two scientists were the first to describe the family of 1,000 olfactory genes and to explain how our olfactory system works.

According to one study in the research review, smelling fresh pizza or even the wrappers of fast foods can be enough to make drivers feel impatient with other road users. They are then more likely to speed and experience road rage. The most plausible explanation is that these can all make drivers feel hungry, and therefore desperate to satisfy their appetites.

In contrast, the smells of peppermint and cinnamon were shown to improve concentration levels as well as reduce drivers' irritability. Similarly, the smells of lemon and coffee appeared to promote clear thinking and mental focus.

However, the way genes regulate smell differs from person to person. A study by researchers in Israel has identified at least 50 olfactory genes which are switched on in some people and not in others. They believe this may explain why some of us adore some smells and tastes while others abhor them. The Israeli researchers say their study shows that nearly every human being displays a different pattern of active and

Smell – Question 3:

There is information about the smell of lemon on the pages 'Food in the news' and 'Psychology Now'.

Which statement summarises the conclusions of the two studies about the smell of lemon?

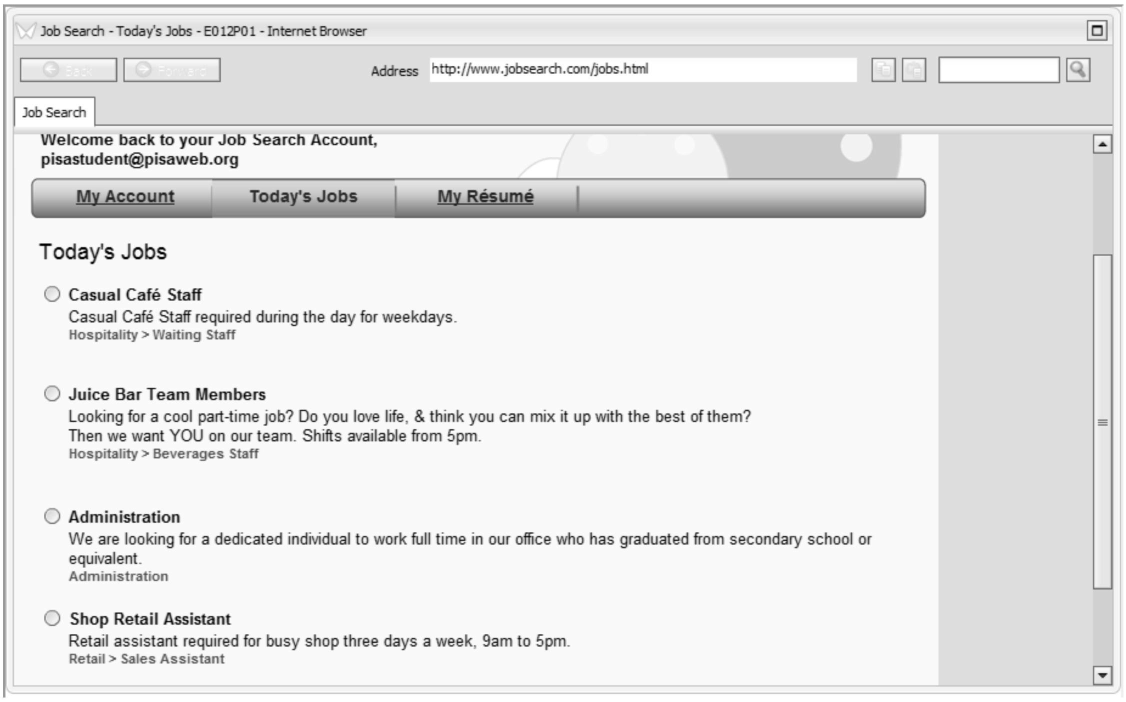
A Both studies suggested that the smell of lemon helps you work quickly.
B Both studies suggested that most people like the smell of lemon.
C Both studies suggested that the smell of lemon helps you to concentrate.
D Both studies suggested that females are better at detecting the smell of lemon than males.

Response	Ireland	OECD	Item difficulty
Correct (option C)	61	64	Scale score: 485 Proficiency level 3
Incorrect	34	31	
Missing/Not reached	5	5	

Situation: *Educational*
Environment: *Authored*
Text Format: *Multiple*
Text type: *Exposition*
Aspect: *Integrate and Interpret – Develop an interpretation*
Question Format: *Multiple choice*

DIGITAL READING PASSAGE 3: Job Search

Job Search – Question 1



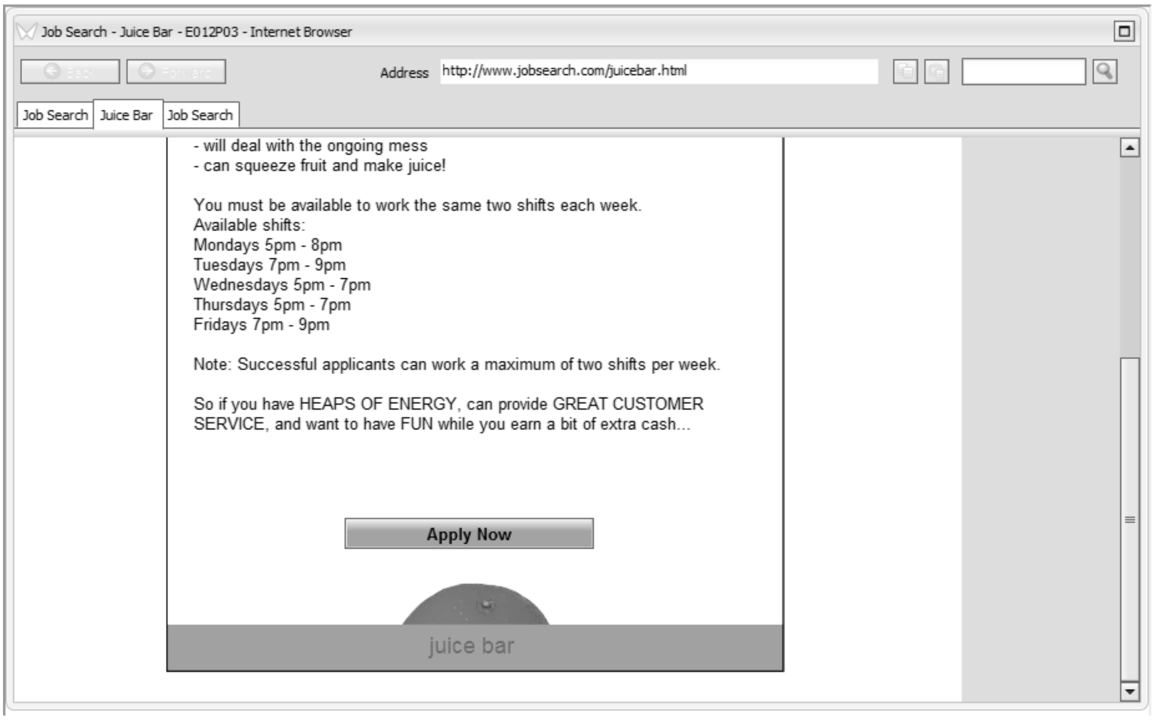
This is a page from a job search website. Which job in this list is most suitable for school students?

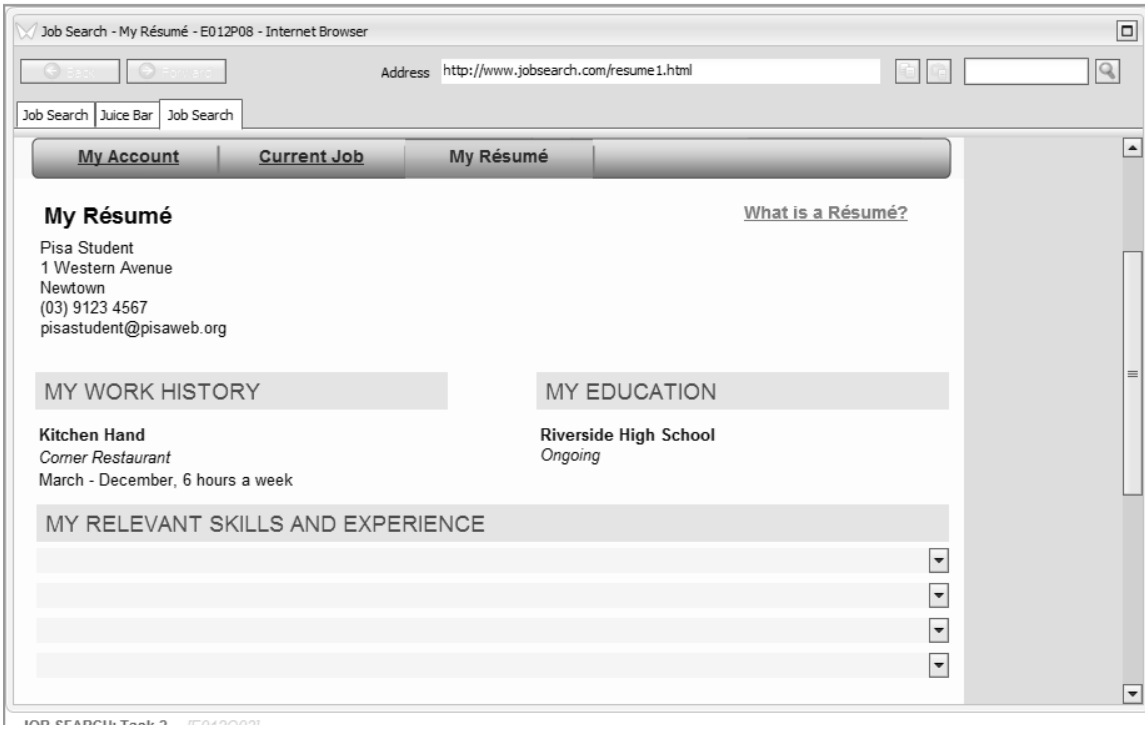
Click on the button next to the job.

Response	Ireland	OECD	Item difficulty
Correct (option B)	77	67	Scale score: 463 Proficiency level 2
Incorrect	21	30	
Missing/Not reached	2	3	

Situation: *Occupational*
Environment: *Authored*
Text format: *Non-continuous*
Text type: *Description*
Aspect: *Reflect and evaluate – Reflect on and evaluate content of text*
Question format: *Multiple choice*

Job Search – Question 2





You have decided to apply for the Juice Bar job. Click on the link and read the requirements for this job. Click on 'Apply Now' at the bottom of the Juice Bar job details to open your résumé page. Complete the 'Relevant Skills and Experience' section of the 'My Résumé' page by choosing four experiences from the drop down lists that match the requirements of the Juice Bar job.

Examples of correct responses (full credit): Selects the following four experiences (in any order):

Efficient at cleaning dishes: working at Corner Restaurant
Good at following instructions: followed kitchen safety regulations daily
Knowledge of food handling and preparation experience: work at Corner Restaurant
Work well with team: won the 2007 sports team player award

Examples of correct responses (partial credit): Selects any three of the following four experiences (in any order):

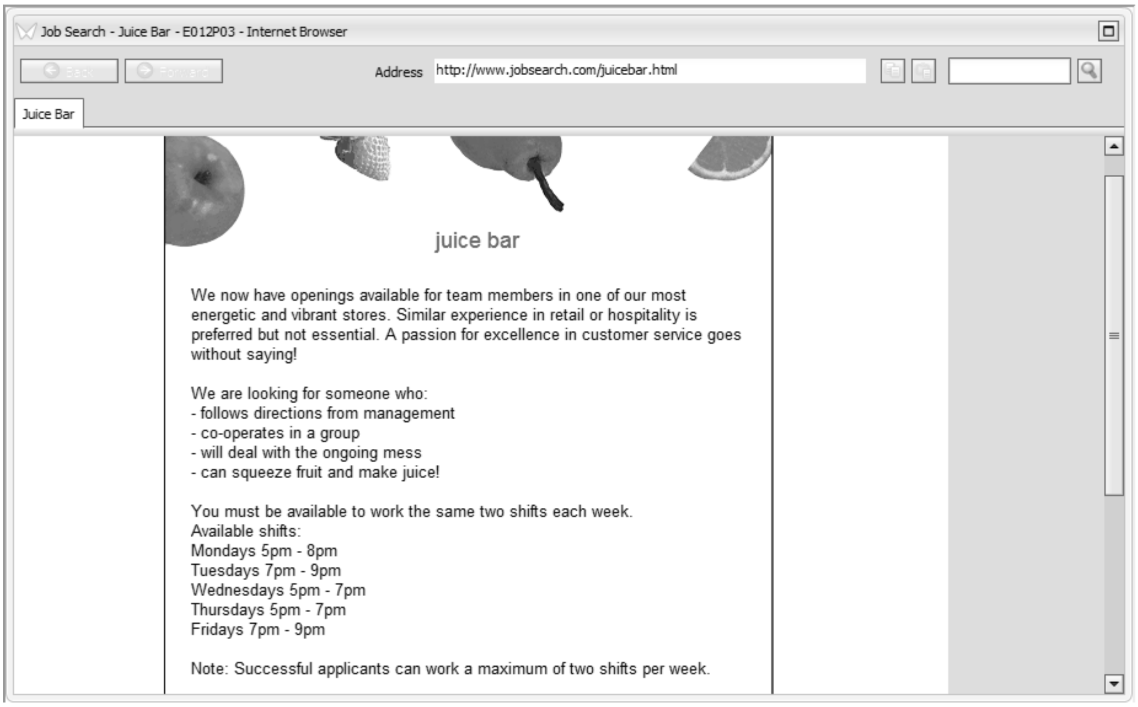
Efficient at cleaning dishes: working at Corner Restaurant
Good at following instructions: followed kitchen safety regulations daily
Knowledge of food handling and preparation experience: work at Corner Restaurant
Work well with team: won the 2007 sports team player award

Examples of incorrect responses: Selects two or fewer experiences, correct or otherwise.

Response	Ireland	OECD	Scale score	Proficiency level
Full credit	9	11	624	4
Partial credit	34	29	462	2
Incorrect	23	31		
Missing/Not reached	34	29		

Situation: *Occupational*
Environment: *Message-based*
Text format: *Multiple*
Text type: *Description*
Aspect: *Integrate and interpret – Develop an interpretation*
Question format: *Complex multiple choice*

Job Search – Question 3



'Note: Successful applicants can work a maximum of two shifts per week.'

Why do you think the employer has made this rule?

Examples of correct answers (full credit only):

Refers to a benefit or protection for the employer or employee that is consistent with the stipulation of not working more than two shifts and with working a fixed two shifts. May refer to flexibility, reliability or effectiveness of employees or to the employer's concerns about employee welfare.

Examples of incorrect answers:

Refers to gaining work experience, earning money, or other irrelevant or incorrect reasons.

Response	Ireland	OECD	Item difficulty
Correct	46	49	Scale score: 558 Proficiency level 4
Incorrect	42	35	
Missing/Not reached	12	16	

Situation: *Occupational*
Environment: *Authored*
Text format: *Mixed*
Text type: *Description*
Aspect: *Reflect and evaluate – Reflect on and evaluate content of text*
Question format: *Open constructed response*

Science Sample Questions

SCIENCE PASSAGE 1: Greenhouse

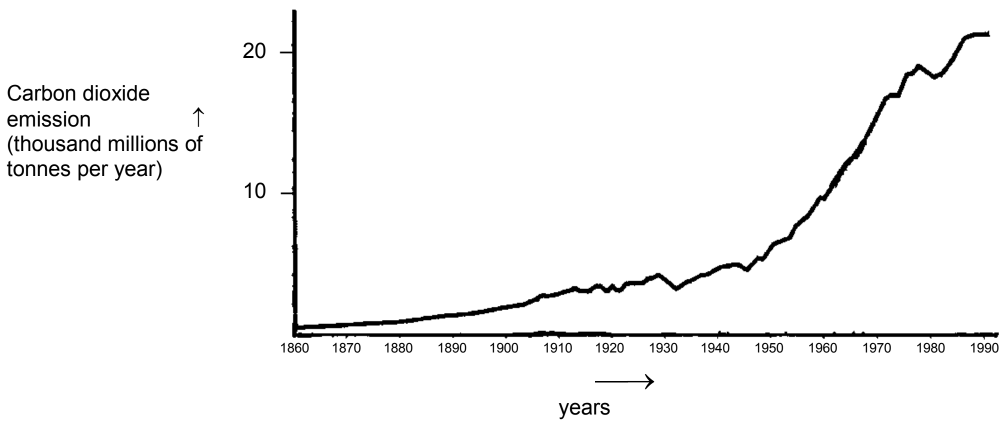
The Greenhouse Effect: Fact or Fiction?

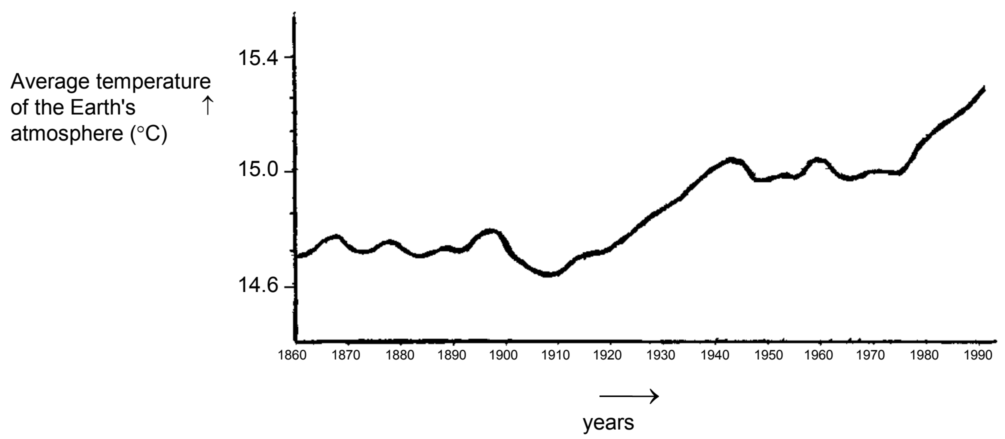
Living things need energy to survive. The energy that sustains life on the Earth comes from the Sun, which radiates energy into space because it is so hot. A tiny proportion of this energy reaches the Earth. The Earth's atmosphere acts like a protective blanket over the surface of our planet, preventing the variations in temperature that would exist in an airless world.

Most of the radiated energy coming from the Sun passes through the Earth's atmosphere. The Earth absorbs some of this energy, and some is reflected back from the Earth's surface. Part of this reflected energy is absorbed by the atmosphere.

As a result of this the average temperature above the Earth's surface is higher than it would be if there were no atmosphere. The Earth's atmosphere has the same effect as a greenhouse, hence the term *greenhouse effect.* The greenhouse effect is said to have become more pronounced during the twentieth century.

It is a fact that the average temperature of the Earth's atmosphere has increased. In newspapers and periodicals the increased carbon dioxide emission is often stated as the main source of the temperature rise in the twentieth century. A student named André becomes interested in the possible relationship between the average temperature of the Earth's atmosphere and the carbon dioxide emission on the Earth. In a library he comes across the following two graphs.





André concludes from these two graphs that it is certain that the increase in the average temperature of the Earth's atmosphere is due to the increase in the carbon dioxide emission.

Greenhouse – Question 1

What is it about the graphs that supports André's conclusion?

Examples of correct answers (full credit only):

Response refers to the increase of both (average) temperature and carbon dioxide emission, or refers (in general terms) to a positive relationship between temperature and carbon dioxide emission.

Examples of incorrect answers:

Refers to the increase of either the (average) temperature or the carbon dioxide emission; refers to temperature and carbon dioxide emission without being clear about the nature of the relationship.

Response	Ireland	OECD	Item Difficulty
Correct	60	54	Scale Score: 529 Proficiency Level: 3
Incorrect	31	32	
Missing/Not reached	9	14	

Situation: *Global*
Aspect: *Using scientific evidence; Scientific explanations*
Question format: *Short constructed response*

Greenhouse – Question 2

Jeanne disagrees with André's conclusion. She compares the two graphs and says that some parts of the graphs do not support his conclusion. Give an example of a part of the graphs that supports Jeanne's conclusion.

Examples of correct answers (full credit only):

Refers to one particular part of the graphs in which the curves are not both descending or both climbing and gives the corresponding explanation.

Examples of incorrect answers:

Mentions a correct period, without any explanation; mentions only one particular year (not a period of time), with an acceptable explanation.

Response	Ireland	OECD	Item Difficulty
Correct	23	22	Scale Score: 659 Proficiency Level: 5
Incorrect	58	42	
Missing/Not reached	19	26	

Situation: *Global*
Aspect: *Using scientific evidence; Scientific explanations*
Question format: *Short constructed response*

Greenhouse – Question 3

André persists in his conclusion that the average temperature rise of the Earth's atmosphere is caused by the increase in the carbon dioxide emission. But Jeanne thinks that his conclusion is premature. She says: 'Before accepting this conclusion you must be sure that other factors that could influence the greenhouse effect are constant'. Name one of the factors that Jeanne means.

Examples of correct answers (full credit only):

Gives a factor referring to the energy/radiation coming from the Sun, or to a natural component or a potential pollutant.

Examples of incorrect answers:

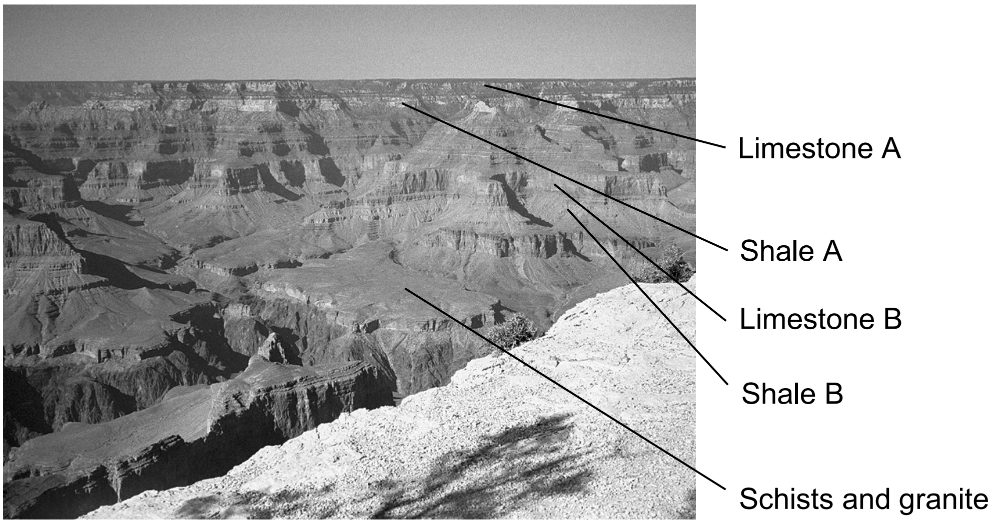
Refers to a cause that influences the carbon dioxide concentration, or a non-specific factor.

Response	Ireland	OECD	Item Difficulty
Correct	19	19	Scale Score: 709 Proficiency Level: 6
Incorrect	50	46	
Missing/Not reached	31	35	

Situation: *Global*
Aspect: *Explaining phenomena scientifically; Earth and space systems*
Question format: *Short constructed response*

SCIENCE PASSAGE 2: The Grand Canyon

The Grand Canyon is located in a desert in the USA. It is a very large and deep canyon containing many layers of rock. Sometime in the past, movements in the Earth's crust lifted these layers up. The Grand Canyon is now 1.6 km deep in parts. The Colorado River runs through the bottom of the canyon. See the picture below of the Grand Canyon taken from its south rim. Several different layers of rock can be seen in the walls of the canyon.



The Grand Canyon – Question 1

About five million people visit the Grand Canyon national park every year. There is concern about the damage that is being caused to the park by so many visitors. Can the following questions be answered by scientific investigation? Circle 'Yes' or 'No' for each question.

Can this question be answered by scientific investigation?	*Yes or No?*
How much erosion is caused by use of the walking tracks?	Yes / No
Is the park area as beautiful as it was 100 years ago?	Yes / No

Response	Ireland	OECD	Item Difficulty
Correct (Yes, No)	74	61	Scale Score: 485 Proficiency Level: 3
Incorrect	25	37	
Missing/Not reached	1	2	

Situation: *Social*
Aspect: *Identifying scientific issues; Scientific enquiry*
Question format: *Complex multiple choice*

The Grand Canyon – Question 2

The temperature in the Grand Canyon ranges from below 0 °C to over 40 °C. Although it is a desert area, cracks in the rocks sometimes contain water. How do these temperature changes and the water in rock cracks help to speed up the breakdown of rocks?

A Freezing water dissolves warm rocks.
B Water cements rocks together.
C Ice smoothes the surface of rocks.
D Freezing water expands in the rock cracks.

Response	Ireland	OECD	Item Difficulty
Correct (option D)	87	68	Scale Score: 451 Proficiency Level: 2
Incorrect	11	29	
Missing/Not reached	2	3	

Situation: *Social*
Aspect: *Explaining phenomena scientifically; Earth and space systems*
Question format: *Multiple choice*

The Grand Canyon – Question 3

There are many fossils of marine animals, such as clams, fish and corals, in the Limestone A layer of the Grand Canyon. What happened millions of years ago that explains why such fossils are found there?

A In ancient times, people brought seafood to the area from the ocean.
B Oceans were once much rougher and sea life washed inland on giant waves.
C An ocean covered this area at that time and then receded later.
D Some sea animals once lived on land before migrating to the sea.

Response	Ireland	OECD	Item Difficulty
Correct (option C)	70	76	Scale Score: 411 Proficiency Level: 2
Incorrect	26	20	
Missing/Not reached	4	4	

Situation: *Social*
Aspect: *Explaining phenomena scientifically; Earth and space systems*
Question format: *Multiple choice*

SCIENCE PASSAGE 3: Acid Rain

Below is a photo of statues called Caryatids that were built on the Acropolis in Athens more than 2500 years ago. The statues are made of a type of rock called marble. Marble is composed of calcium carbonate. In 1980, the original statues were transferred inside the museum of the Acropolis and were replaced by replicas. The original statues were being eaten away by acid rain.

Acid Rain – Question 1

Normal rain is slightly acidic because it has absorbed some carbon dioxide from the air. Acid rain is more acidic than normal rain because it has absorbed gases like sulfur oxides and nitrogen oxides as well. Where do these sulphur oxides and nitrogen oxides in the air come from?

Examples of correct answers (full credit only):

Gives any one of car exhausts, factory emissions, burning fossil fuels, or similar, or just refers to pollution.

Examples of incorrect answers:

Responses that do not mention 'pollution' and do not give a significant cause of acid rain.

Response	Ireland	OECD	Item Difficulty
Correct	70	58	Scale Score: 506 Proficiency Level: 3
Incorrect	21	26	
Missing/Not reached	9	16	

Situation: *Social*
Aspect: *Explaining phenomena scientifically; Physical systems*
Question format: *Short constructed response*

Acid Rain – Question 2

The effect of acid rain on marble can be modelled by placing chips of marble in vinegar overnight. Vinegar and acid rain have about the same acidity level. When a marble chip is placed in vinegar, bubbles of gas form. The mass of the dry marble chip can be found before and after the experiment.

A marble chip has a mass of 2.0 grams before being immersed in vinegar overnight. The chip is removed and dried the next day. What will the mass of the dried marble chip be?

A Less than 2.0 grams
B Exactly 2.0 grams
C Between 2.0 and 2.4 grams
D More than 2.4 grams

Response	Ireland	OECD	Item Difficulty
Correct (option A)	68	67	Scale Score: 460 Proficiency Level: 2
Incorrect	30	31	
Missing/Not reached	2	2	

Situation: *Personal*
Aspect: *Using scientific evidence; Physical systems*
Question format: *Multiple choice*

Acid Rain – Question 3

Students who did this experiment also placed marble chips in pure (distilled) water overnight.

Explain why the students include this step in their experiment.

Examples of correct answers (full credit only):

Response explains that the students used water to show that acid (vinegar) is necessary for the reaction.

Examples of incorrect answers:

Refers to a comparison with the vinegar and marble test, without clarifying that vinegar is necessary for the reaction; other insufficient, vague, or irrelevant responses.

Response	Ireland	OECD	Item Difficulty
Correct	23	14	Scale Score: 717 Proficiency Level: 6
Incorrect	67	69	
Missing/Not reached	10	17	

Situation: *Personal*
Aspect: *Identifying scientific issues; Scientific enquiry*
Question format: *Open constructed response*