Reading, mathematics and science achievement in DEIS schools: Evidence from PISA 2018

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Preface

The Programme for International Student Assessment (PISA) is a project of the Organisation for Economic Co-operation and Development (OECD). It was first conducted in 2000 with the aim of assessing the achievement of 15-year-olds in reading, mathematics and science. It has taken place every three years since then and Ireland has participated in each cycle.

Ireland has been a high performing country across PISA cycles, particularly in reading literacy. Findings from the OECD (2019a) and the initial national report (McKeown, Denner, McAteer, & Shiel, 2019) show that in 2018, students in Ireland scored significantly above the corresponding OECD averages in reading, mathematics and science. Performance in reading literacy was among the highest across OECD and EU countries. In reading, there were significantly fewer low performers and significantly more high performers in Ireland than on average across OECD countries (McKeown et al., 2019). Findings from PISA also point towards a relatively high degree of equity of achievement in Irish post-primary schools, as measured by between-school variance in achievement. These two keys outcomes – high average reading performance and relatively small differences in achievement between schools – are positive findings for the Irish education system.

A recent paper examining achievement in PISA mathematics, inequality and disadvantage in high-income countries provides a useful distinction between educational inequality and educational disadvantage (Rowley et al., 2020). According to the definitions of these terms used by the authors, educational inequality refers to the achievement gap associated with student socio-economic status (SES) whereas educational disadvantage refers to whether or not students have low levels of achievement in absolute terms relative to international standards. Although these terms are used differently by different authors, the approach of Rowley et al. is useful for guiding the interpretation of findings in the current report.

Recent analyses of PISA data (including the current report) have highlighted a number of positive findings regarding the achievement of low-SES students in Ireland. Firstly, a positive finding emerging from the work of Rowley et al. shows that low-SES students in Ireland (i.e., students in the bottom quarter on the PISA measure of economic, cultural and social status [ESCS]) had above-average achievement in mathematics in PISA 2012 relative to their international counterparts from similar backgrounds[1] (Rowley, et al., 2020). A second positive finding from the current report is that in PISA 2018, students in DEIS schools scored at the OECD average level in reading (i.e., did not differ significantly from the OECD reading average). Thirdly, in analyses conducted by the OECD (2020b), Ireland was identified as one of just five PISA 2018 participants where not more than a quarter of boys from low socio-economic backgrounds were below Level 2 in reading; i.e., the percentage in Ireland of boys from low socio-economic backgrounds who are low achievers compares favourably to that in most PISA countries.

1 However, high-SES students in Ireland had below-average achievement relative to their high-SES counterparts internationally, resulting in Ireland's placement in the 'inverted disadvantage' category (Rowley et al., 2020).

While students in Ireland from low-SES backgrounds perform well relative to students from similar backgrounds in other countries, in Ireland and internationally, a gap remains between the achievement of students from high and low-SES backgrounds (OECD, 2020b). The importance of narrowing this achievement gap in Ireland is emphasised in the foreword to the DEIS Plan 2017 (DES, 2017a). The current in-depth national analysis of PISA achievement in DEIS schools is designed to contribute to the understanding of the achievement gap in Ireland between those schools with high percentages of students from socio-economically disadvantaged backgrounds and those schools with lower percentages. The primary focus of this report is on the achievement gap between students in DEIS and non-DEIS schools; a secondary focus, which capitalises on the international comparative nature of PISA, situates the achievement of disadvantaged students in Ireland in the international context.

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Acronyms and Abbreviations

CDI	Childhood Development Initiative
DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills
EC	European Commission
EU	European Union
ERC	Educational Research Centre
ESCS	PISA index of economic, social and cultural status
HP Index	Pobal HP Deprivation Index
NCCA	National Council for Curriculum and Assessment
NEPS	National Educational Psychological Service
OECD	Organisation for Economic Cooperation and Development
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
PPAD-E	Post-Primary Assessment & Diagnosis – English
SE	Standard error
SES	Socio-economic status
STEM	Science, Technology, Engineering and Maths
TIMSS	Trends in International Mathematics and Science Study
UNICEF	United Nations International Children's Emergency Fund

Disclaimer

Findings and opinions expressed in this document are those of the authors. While every effort has been made to ensure the accuracy of the analyses presented, we cannot guarantee the accuracy or completeness of the material. We make every effort to minimise disruption caused by technical errors. If errors are brought to our attention, we will try to correct them. Neither the authors nor the Educational Research Centre are liable for losses, damages, liability or expense arising from the work in this report.

Executive Summary

Introduction and aims

Tackling educational disadvantage is a key policy issue in Ireland where the term is defined in Section 32 of the Education Act as "the impediments to education arising from social or economic disadvantage which prevent students deriving appropriate benefit from education in schools" (Government of Ireland, 1998, p. 32). Since 2005, Delivering Equality of Opportunity in Schools (DEIS), the Action Plan for Educational Inclusion has been the main policy instrument of the Department of Education and Skills (DES) for addressing educational disadvantage.

Monitoring performance and achievement in schools serving large numbers of students from disadvantaged backgrounds can help shape education practices and systems to become more equitable. The Programme for International Student Assessment (PISA) measures the outcomes of education achieved by the age of 15 and in Ireland, it offers the opportunity to compare the achievements of students in DEIS schools with those in non-DEIS schools.[2] This has direct relevance to the DEIS Plan 2017 (DES, 2017a) which includes achievement targets for post-primary level based on percentages of students scoring at the highest and lowest PISA proficiency levels.[3]

PISA 2018 was conducted in a nationally representative sample of 157 Irish post-primary schools (41 DEIS schools; 116 non-DEIS schools). Of all participating students in Ireland, 24% attended a DEIS school.[4] In PISA 2018, reading literacy was the main domain, with science and mathematics assessed as the minor domains. The 2018 results showed that students in Ireland scored significantly above the OECD average in reading, mathematics and science in PISA 2018. Irish performance in reading literacy was among the highest across OECD and EU countries. Compared to many other countries participating in PISA, Irish post-primary schools are considered relatively equitable based on comparisons of between-school variance in reading achievement (McKeown et al., 2019).

The initial national report for PISA 2018 presented mean scores in reading, mathematics and science for students in DEIS and non-DEIS schools (McKeown et al., 2019). Each of these differences was shown to be statistically significant, in favour of students in non-DEIS schools. The current report builds on the initial national report by: examining achievement in DEIS schools across PISA cycles; considering whether or not the achievement gap between DEIS and non-DEIS schools has changed over time; examining progress towards targets in literacy and numeracy; exploring gender differences in achievement in DEIS schools; and by describing some non-cognitive outcomes in DEIS schools such as engagement in reading. Box 1 presents technical

2 Readers interested in alternative approaches to examining the achievement gap between students in DEIS and non-DEIS post-primary schools are advised to consult (Weir & Kavanagh, 2018).

3 Targets originally presented in the DEIS Plan 2017 (DES, 2017a) have been revised in this report in light of errors identified in the calculation of the baseline percentages (for details, see ERC, 2019). A full description of the targets presented in this report and the process used to correct earlier published targets is given in Chapter 2.

4 In the academic year 2016/2017, 21.5% of 15-year-old students nationally attended a DEIS post-primary school. Analyses by the PISA national team in Ireland found no statistically significant difference in the percentage of assessed students in the PISA 2018 sample attending DEIS schools and the percentage of PISA-eligible students (i.e., 15-year-olds) in the population attending DEIS schools (see Table 1.6, McKeown et al., 2019).

information to guide the interpretation of PISA scores. The remainder of this Executive Summary outlines key findings and implications of the current report.

Key findings: PISA 2018

This section presents key findings for DEIS schools for PISA 2018 reading, mathematics and science. Some findings from the initial national report (McKeown et al., 2019) are also referenced to contextualise the current results. In the text, mean achievement scores are given in parentheses. More detailed findings are provided for reading literacy as this was the major domain in PISA 2018.

Reading Literacy 2018

- In reading, students in DEIS schools (479.2) scored at the level of the OECD average (487.1). Students in non-DEIS schools (530.4) achieved a mean reading score significantly above the corresponding OECD average.
- There was a difference of 51.2 points (over half an international standard deviation) between the average reading performance of students attending DEIS schools and those attending non-DEIS schools. This difference is statistically significant and adequately large to be of substantive importance.
- Students in DEIS schools had significantly lower achievement on each of the three reading subscales than their counterparts in non-DEIS schools. On each subscale, the gap was approximately 50 points.
- In DEIS schools, just over one-fifth of students (21.8%) achieved a reading score below Level 2. Such students are considered low-achievers by the OECD. In non-DEIS schools, just 9% of students are classified as low achievers in reading.
- Conversely, looking at high-achievers in reading, the percentage of students at or above Level 5 is lower in DEIS schools (5.5%) compared to non-DEIS schools (14.2%).
- Turning to student attitudes and engagement in reading, a higher percentage of students in DEIS schools reported that they did not read at all for enjoyment (58.5%) compared to students in non-DEIS schools (44.3%).
- Students in DEIS schools reported a less positive self-concept in reading competence compared to students in non-DEIS schools.
- In summary, results show that although the average reading score in DEIS schools was on a par with the OECD average, there remains a high percentage of students with low reading achievement. Furthermore, there was a noticeable engagement gap between students in DEIS and non-DEIS schools, with lower reading enjoyment and reading self-concept amongst students in DEIS schools.

Box 1: Technical information to guide the interpretation of PISA scores

As a guide to interpreting score point differences between DEIS and non-DEIS schools, it is useful to note that the PISA achievement scales, when originally established, had an OECD mean of 500 and OECD international standard deviation of 100. In PISA 2018, the national standard deviation for reading was 90.7; for mathematics, it was 77.8; and for science, it was 88.3 (McKeown et al., 2019). The OECD international standard deviations are used for reference within this report.

PISA also reports results in terms of proficiency levels. These describe the knowledge and skills of students at various points on the scale. Low achievers are those with a PISA score below proficiency Level 2 (also described as 'at or below Level 1') in the domain in question. Students with achievement at this level are regarded by the OECD as unlikely to have the basic levels of literacy required to support future learning and work. High achievers, scoring at or above Level 5, are regarded as having an advanced level of knowledge and skills in the domain in question. There is approximately an 80-point gap between one proficiency level and the next.

The DEIS Action Plan 2017 (DES, 2017a) specifies targets for reading and mathematics on the basis of the percentages of students with achievement scores at proficiency Level 1 and below; at or above Level 4; and, at or above Level 5. Since the achievement scores in PISA are based on a sample rather than on the population and since the test design for PISA is complex, there is both measurement and sampling error associated with the percentages at the various proficiency levels. The size of this error[5] is larger for estimates associated with DEIS schools than for the Irish PISA sample as a whole because students in DEIS schools represent a subset of the full sample. This is one of the limitations of relying on a study such as PISA which is designed for monitoring the population of 15-year-olds as a whole rather than for monitoring a particular subset such as students in DEIS schools: a larger sample of DEIS students would be required to obtain more precise estimates of achievement.

Having quantified the measurement and sampling error, a confidence interval can be constructed to more accurately estimate where the true population percentage is expected to occur. As an example, if the percentage of students at a particular level in the PISA sample is equal to 20% and the standard error associated with the percentage is 2.5, we can be 95% certain that the 'true' population percentage lies within the range of 15%-25%.[6] The concepts of measurement and sampling error are important in interpreting the PISA results with respect to the DEIS targets described in this report.

5 The term 'error' is used in a statistical sense and in line with OECD definitions means: "the (unknown) difference between the retained value and the true value. The larger the error, the lower the accuracy" (Eurostat, 2003).
6 Based on a 95% confidence interval constructed as: [estimate - (1.96*standard error), estimate + (1.96*standard error)].

Mathematical Literacy 2018

- The average mathematics performance of students in DEIS schools (466.4) is significantly lower than the corresponding OECD average score (489.3). Students in non-DEIS schools (510.2) had an average mathematics score significantly above the OECD average.
- The average mathematics performance of students attending DEIS schools (466.4) was significantly and substantially lower than that of students in non-DEIS schools (510.2), with a difference of 43.8 score points in favour of students in non-DEIS schools. This difference represents two-fifths of an international standard deviation.
- The percentages of students categorised as low achievers in mathematics (below proficiency Level 2) is higher in DEIS schools (28%) compared to non-DEIS schools (12%). A small percentage (3.6%) of students in DEIS schools reached the highest levels of achievement in mathematics (at or above Level 5). The corresponding percentage in non-DEIS schools was 9.7%.

Scientific Literacy 2018

- Students attending DEIS schools had an average science score (465.0) that was significantly lower than the corresponding OECD average (488.7). Students in non-DEIS schools had an average science score (506.0) that was significantly above the OECD average.
- With a mean score of 465.0, the average science performance of students attending DEIS schools was significantly, and substantially, lower than the average of students in non-DEIS schools (mean score 506.0). The difference between the two amounts to 41 score points which is equivalent to two-fifths of an international standard deviation.
- The percentage of low achieving students in science (i.e., achieving scores below Level 2) is higher in DEIS schools (28.2%) compared to non-DEIS schools (13.5%).
- A small percentage (3.1%) of students in DEIS schools reached the highest levels of achievement in science (at or above Level 5). The corresponding percentage in non-DEIS schools was 6.7%.

Gender differences in achievement 2018

- A significant gender difference was found in reading in both DEIS and non-DEIS schools. Female students had significantly higher reading scores than male students in both DEIS (+17 points) and non-DEIS schools (+20 points). Gender differences in favour of girls were found in all PISA 2018 participants and the average gender gap was almost 30 points (OECD, 2020a).
- One quarter of boys (23.9%) in DEIS schools had a reading score below Level 2 in PISA 2018. Thus, one quarter of boys in DEIS schools have reading skills described by the OECD as inadequate for future study and work. The corresponding percentage for females is 18.9%.
- In Ireland overall, there was no significant gender difference in average mathematics achievement. The magnitude of the gender gap was similar in DEIS and non-DEIS schools (+9.5 points in favour of males) but statistically significant in non-DEIS schools only.

- There was no overall gender difference in science achievement in Ireland. No significant gender differences in science achievement were evident in either DEIS or non-DEIS schools.
- The small and non-significant gender differences in mathematics and science achievement in DEIS schools is positive, given common misconceptions about gender and interest and ability in STEM subjects (e.g., as highlighted in the STEM Education Policy Statement 2017–2026, DES, 2017b). However, given the average scores in mathematics and science in DEIS schools and the percentages of low achievers in both domains, both boys and girls should be targeted for ongoing improvement.

Key findings: achievement trends and progress towards targets

An analysis of trends in PISA achievement indicates that in reading, mathematics and science, students in DEIS schools have consistently achieved significantly lower average achievement than students in non-DEIS schools across all PISA cycles examined.[7] The magnitude of the gap is around half a standard deviation, or a little over half a PISA proficiency level, being narrowest in the domain of science. While the size of the gap has narrowed significantly in reading, it has not changed significantly in mathematics or science. This section presents key findings for reading, mathematics and science trends separately and examines progress towards targets in reading and mathematics.

Trends in PISA reading (2009 - 2018)

- There was a significant and substantial improvement in the average reading performance of students in DEIS schools between 2009[8] and 2018, with a 39.2 point increase in average reading scores from 2009 to 2018. Student reading performance in non-DEIS schools also improved since 2009, with an improvement of 19.6 points in average achievement between 2009 and 2018.
- For students in DEIS schools, the main gain in reading performance was between the years 2009 and 2012 (score difference of 31.8 points). This has plateaued since 2012, with no subsequent change or improvement in performance in the more recent cycles. Similarly in non-DEIS schools, average reading scores improved significantly between 2009 and 2012 but changes since then have been smaller.
- There has been a marked drop in the percentage of low achievers in reading (i.e., below Level 2) in DEIS schools from 35.4% in 2009 to 21.8% in 2018. Similar to trends in average achievement, this change mainly occurred between 2009 and 2012 and performance since then has remained largely unchanged.
- There is some evidence of a narrowing of the achievement gap in reading between students in DEIS and non-DEIS school over time. While in 2009, the difference in mean reading scores between DEIS and non-DEIS schools was about 70 points, the gap was about 50 points in both 2015 and 2018. Although this is an encouraging finding, it should be interpreted in conjunction with the findings of very little change in average reading scores across the 2012, 2015, and 2018 PISA cycles.

7 Analysis of trends in reading, mathematics and science use different cycles as their starting point. This is a consequence of the PISA design which nominates one domain as the major domain in each cycle. Trend analysis should begin with the year in which the subject was a major domain (see Chapter 2 for details).

8 Ireland's poorer reading literacy performance in PISA 2009 was atypical relative to other cycles of PISA. This has been the subject of extensive analysis and some of the key issues are summarised briefly in Chapter 2 of this report.

- Regarding targets for 2020 outlined in the DEIS Plan 2017 (DES, 2017a) aiming to reduce the percentages of low achievers in reading in DEIS schools, there has been no change between 2015 (21.8%, baseline for target setting) and 2018 (also 21.8%) in the percentages of low reading achievers in DEIS schools and therefore no progress to date towards this target.
- For low achievers in reading, the 2020 target value for DEIS schools (18% below Level 2) is contained within the 95% confidence interval associated with the PISA 2018 sample estimate for the percentage of low achievers in DEIS schools. That is, given the sample estimate of 21.8% of low achievers in DEIS schools in PISA 2018, the 'true' value for the population of students in DEIS schools is likely to range between 17.8% and 25.8%. Therefore, due to the error associated with the PISA estimate, it is likely that the 2020 target could be met without any real change between the baseline (21.8%) and the outcome.
- Turning to targets for high achievers in reading (at or above Level 5), we note that in spite of a modest increase between 2015 (4.7%) and 2018 (5.5%) in the percentage of high reading achievers in DEIS schools, as the difference is not statistically significant, it is at best limited evidence of progress towards the 2020 target of 8% at or above Level 5. The 2020 target value (8%) is not contained within the 95% confidence interval for the PISA 2018 value. That is, given the 5.5% of high achievers in DEIS schools in PISA 2018, the 'true' population value of high achievers in DEIS schools is likely to range between 3.9% and 7.0%. Therefore, the target of 8% currently appears unlikely to be met in the context of limited gains in the percentages of high achievers in DEIS schools across the PISA 2012, 2015 and 2018 cycles.
- There is also limited evidence of progress towards the target for the percentages at or above Level 4 in reading (2020 target 26%), given that the percentage in 2015 was 21.4% and in 2018, 21.2%. The 95% confidence interval for the percentage at Level 4 in 2018 ranges from 17.6% to 24.9%. This does not contain the 2020 target value of 26%.
- Conclusions of this report suggest reviewing the targets for DEIS schools in light of international findings on the percentages of low and high achievers from disadvantaged backgrounds. We also note that while 2020 was selected as the year in which targets should be met in DEIS schools for the purposes of alignment with other national targets (DES, 2016), these outcomes are not measurable in 2020 given the current PISA schedule, where the next cycle of PISA occurs in 2022[9]

Trends in PISA mathematics (2012 – 2018)

- There were no significant changes in average mathematics scores between 2012 and 2018 in either DEIS or non-DEIS schools.
- The achievement gap in mathematics between students in DEIS and non-DEIS schools was somewhat smaller in 2018 (44 points) than in 2012 (60 points), although the difference between the two is not statistically significant.

9 It was originally planned to continue the three-year cycle of PISA and implement it in 2021, but a decision has been reached by the OECD and PISA Governing Board to postpone the next cycle of PISA by one year due to the COVID-19 pandemic.

- There has been a significant reduction in the percentage of students in DEIS schools at the lowest levels of proficiency in mathematics. While in 2012, about three in eight students (37%) in DEIS schools had mathematics scores below Level 2, by 2018, this had reduced to just over one in four (28%). Although this reduction in the percentage of low achievers is positive, the percentage in 2018 (28%) is very similar to that in 2015 (29%).
- The 95% confidence interval for the percentage of students in DEIS schools below Level 2 in mathematics in 2018 ranges from 23.1% to 33.0%. The target for 2020 is 23%. Given no significant change in the percentage of low achievers between 2015 (29.0%) and 2018 (28.1%), and given that the 2020 target value is (just) outside the confidence interval for 2018, it is currently unlikely to be met.
- There has been no increase in the percentages of students in DEIS schools performing at the highest levels in mathematics across PISA cycles. In particular, the percentage of students at or above Level 5 in mathematics in 2015 (4.7%) is not significantly different to that in 2018 (3.6%). It is therefore highly unlikely that target for 2020 (9%) will be met.

Trends in PISA science (2015 – 2018)

- There was no significant change in science performance from 2015 to 2018 in either DEIS or non-DEIS schools.
- The achievement gap in science between students in DEIS and non-DEIS schools was slightly (but not statistically significantly) smaller in 2018 (41 points) than in 2015 (48 points).
- As the STEM Education Policy Statement 2017–2026 (DES, 2017b) aims to address the achievement gap in STEM subjects between students in DEIS and non-DEIS schools, it is of policy relevance to note that there has been no significant reduction in the gap between the 2015 and 2018 PISA cycles.
- There are no specific 2020 targets for science achievement in DEIS schools.

Key policy implications

Assuming that PISA is to be continued to be used as a tool for monitoring achievements in DEIS schools (and educational disadvantage more generally), five key observations can be made on the basis of the results considered in this report and within the national context more broadly.

- First, PISA 2018 and 2022 are not well aligned chronologically with the 2020 targets: it would be preferable that future target years are aligned to the data collection years of PISA.
- Second, standards of achievement as measured by PISA are significantly higher in reading than in mathematics or science (overall, and in both DEIS and non-DEIS schools). This suggests that the scope for improvement in the latter two domains may be greater than that for reading.
- Third, given the unavoidable (measurement and sampling) error associated with the PISA scores, it could be useful to revisit DEIS targets, and consider them in both absolute and relative terms. Currently, DEIS targets, as well as those associated with the national literacy and numeracy strategy, are specified in absolute terms, i.e., a reduction of low achievers from X% to Y%. In the context of DEIS where

narrowing the achievement gap is a key policy concern, it could be useful to also consider targets in relative terms. For example, the present analysis found that 2.4 times as many students in DEIS schools (21.8%) scored below Level 2 in PISA 2018 reading relative to students in non-DEIS schools (9.0%). A target in this instance could be to further reduce this 2.4 ratio, for example, to 2.0.

- Fourth, going forward, revisions to the DEIS identification model will make comparisons over time of PISA performance in DEIS and non-DEIS schools more complex. The revised identification approach for DEIS involves identifying schools using the HP deprivation index (DES, 2017a) whereas the original identification approach used a different model (Weir, 2006). Careful consideration should be given in future monitoring activities to making clear the differences between DEIS classifications over time while at the same time enabling trend comparisons. Also, in order to enhance the precision of the PISA sample overall as well as for PISA-based estimates of DEIS schools, the sample design of PISA should be revisited and consideration given to the incorporation of the HP index as one of its stratifying (grouping) variables.
- Fifth, and finally, depending on the priorities of the DES with respect to DEIS monitoring and evaluation, there is merit in considering supplementing the PISA data with national standardised assessments at post-primary level. (National assessment data at primary level are already available for this purpose.) At post-primary level, standardised tests are available (for example, the ERC supplies post-primary schools with online standardised tests of reading and mathematics for Second Years). There are two key advantages to administering national standardised tests in DEIS post-primary schools to monitor reading and mathematics standards. First, unlike an international assessment such as PISA which has a fixed timeline, we are free to administer these assessments in accordance with any schedule. Second, given that national standardised assessments are normed to the Irish population as a whole, it is possible to benchmark achievements of students in DEIS schools against national norms. It is felt that extending the monitoring of DEIS in this way would provide a useful complement to the existing international data available from studies like PISA. Decisions related to the future monitoring of reading and mathematics achievement in DEIS schools should include detailed consideration of oversampling of DEIS schools in PISA versus the administration of national standardised tests to either the population of students or a sample of students in DEIS schools. Consideration should be given to factors such as costs, operational issues, and flexibility with data collection schedules and reporting. Also, it should be noted that additional assessment tools are both used and required by both DEIS and non-DEIS schools for diagnostic and support purposes, particularly in early post-primary year levels, to allow early identification and supports for students in junior cycle.

While the above points are intended to encourage reflection on the optimal use of PISA (and possibly other) data for monitoring standards in DEIS schools, undoubtedly findings of the current report underscore the ongoing need for a continued, strong focus on improving skills in reading, mathematics, and science for students from disadvantaged backgrounds who are at risk of underachievement. The current report does not set out to examine background or contextual factors that may explain why such differences in achievement exist. A forthcoming report from the same authors will look at some of the home and school contextual factors of students attending DEIS schools.

Chapter 1: Introduction

Underachievement associated with socio-economic disadvantage is a significant problem at all levels of the education system. Social and economic factors such as poverty, unemployment, and low educational achievement can limit people from achieving their potential. It is widely recognised nationally and internationally that students from disadvantaged backgrounds have lower performance across various educational outcomes, including achievement (Reardon, 2011; Weir & Kavanagh, 2018). This achievement gap is evident across school systems, levels, and countries (Crenna-Jennings, 2018; Weir, Kavanagh, Kelleher, & Moran, 2017). Examining differences in achievement between schools within countries can be instructive in better understanding how to reduce the achievement gap (UNICEF, 2018). This chapter briefly outlines how the evaluation of DEIS has been conducted to date and considers how data from PISA can contribute to this evaluation.

Worldwide, various initiatives and policies have been introduced to tackle educational disadvantage. Ireland has a strong record of intervention aimed at supporting early education and targeting greater parental involvement in students at risk of disadvantage (Kelly & Kellaghan, 1999; Weir, 2004; Weir & Archer, 2005; Weir, Milis, & Ryan, 2002). Recognising the central role of schools in combatting disadvantage, Ireland, through the Department of Education and Skills (DES), introduced the Delivering Equality of Opportunity in Schools (DEIS) policy of additional resources directed at schools with the highest concentrations of students from disadvantaged backgrounds (DES, 2005). Schools included in DEIS are offered additional financial support and teaching resources including priority access to numeracy and literacy initiatives. The DEIS programme was updated in the DEIS Plan 2017 with new objectives and actions to further support students at risk of underachievement (DES, 2017a). One of the key goals of the DEIS Plan 2017 is to improve the learning experience and outcomes of students in DEIS schools. There is a strong emphasis on raising the numeracy and literacy achievement of students.

Evaluations of progress under DEIS to date have used a variety of methods, including interviews and surveys of students, teachers, principals, parents, and Home School Community Liaison coordinators within DEIS schools designed to gather attitudinal and implementation data (Kavanagh, Weir, & Moran, 2017; Weir, Kavanagh, Moran, & Ryan, 2018; Weir, McAvinue, Moran, & O'Flaherty, 2014). Standardised tests have been administered at various time points in a longitudinal study designed to look at changes in performance over time (Weir, Archer, O'Flaherty, & Gilleece, 2011; Kavanagh, Weir, & Moran, 2017). Centrally-held administrative data have been examined to consider changes in various input and output variables such as retention rates (Weir & Kavanagh, 2018) and class sizes (Kelleher & Weir, 2017). Focusing on outcomes at post-primary level, these evaluations have shown some positive impacts on a number of educational outcomes. For example, there have been improvements in attendance rates (i.e., a reduction in student/days lost and 20-day absences) in DEIS schools between 2015/16 and 2016/17 (Millar, 2017); increases in the proportions of students in DEIS schools opting for higher level papers in English and Mathematics (Weir & Kavanagh, 2018); a narrowing of the gap between DEIS and non-DEIS schools in retention rates to Junior

Certificate and to Leaving Certificate (McAvinue & Weir, 2015); and a narrowing over time of the gap in Junior Certificate achievement between DEIS and non-DEIS schools (Weir & Kavanagh, 2018; Weir, McAvinue, Moran, & O'Flaherty, 2014).

Research has shown that the 'raw'[10] achievement differences between students in DEIS and non-DEIS schools can be at least partly explained by differences in the social and home backgrounds of students in the two school types. For example, analyses of contextual effects at primary level have shown that achievement differences in mathematics between pupils in non-DEIS schools, DEIS Rural, and Urban Band 2 schools are not statistically significant, after controlling for individual social background (McCoy, Quail, & Smyth, 2014). In reading at primary level, controlling for social background alone reduces the reading gap between children in urban DEIS schools and those in non-DEIS schools by more than half, although the contextual difference remains statistically significant. A very small amount of the remaining variance in achievement is explained by key school and teacher factors (McCoy, Quail, & Smyth, 2014). Separately, it has been shown that differences in reading achievement between DEIS and non-DEIS schools are not statistically significant once parental involvement and home background factors are considered (Gilleece, 2015).

At post-primary level, data from Growing Up in Ireland have been used to show that while indicators of school type (fee-paying; non-DEIS secondary; non-DEIS vocational/community; and DEIS) are associated with the raw rank of Junior Certificate results, these are not significant for value-added rank (i.e., the school's rank after controlling for prior student achievement and compositional differences including socio-economic and family characteristics) (Doris, O'Neill, & Sweetman, 2019). While on average fee-paying schools were ranked about 163 places above DEIS schools in raw outcomes, in value-added analyses (i.e., after controlling for prior achievement and family background), differences between school types were not statistically significant. Notably, schools in areas with high local unemployment were ranked lower both in raw rankings and in value-added terms (Doris, O'Neill, & Sweetman, 2019).

While it is common practice in school effectiveness research to control statistically for prior achievement and socio-economic characteristics (OECD, 2008), the main focus of DEIS evaluation work to date has been on raw differences in achievement between students in DEIS and non-DEIS schools (e.g., Weir & Kavanagh, 2018). As the focus of the DEIS programme is on reducing the achievement gap between students from disadvantaged backgrounds and their more advantaged peers, it seems appropriate to examine raw achievement differences without adjusting for prior achievement or socio-economic status. Therefore, in this report the focus is on raw achievement differences between students in DEIS schools and non-DEIS schools on PISA reading, mathematics and science, with no adjustment for prior achievement or socio-economic background. It is clear that omitting background variables from the present analyses mean that like is not compared with like; i.e., there is evidence that there are differences in prior achievement, household income, medical card possession, and non-cognitive outcomes of students in DEIS and non-DEIS schools (Doris, O'Neill, &

10 Here, the term 'raw' refers to the achievement differences (however measured) between schools and students in the absence of any statistical adjustments for measures such as socioeconomic context and home environment. Reports on results of statistical models variously use terms such as 'adjusted', 'value added' or 'controlling for' to describe how these raw achievement differences change once account is taken of background and contextual measures such as socioeconomic context.

Sweetman, 2019; Weir & Kavanagh, 2018). However, as the aim of DEIS is to reduce the achievement gap, regardless of differences in intake, it seems appropriate to look at the gap without adjusting for intake differences between schools.

How can PISA inform national policy on educational disadvantage?

To date, monitoring and evaluation of DEIS has focused on national approaches to monitoring outcomes in DEIS schools. International studies such as PISA, a study of the OECD, contribute to the growing evidence on educational disadvantage internationally and offer another source of evidence in evaluating progress under DEIS. PISA defines a socio-economically advantaged (or disadvantaged) student as one who is in the top (or bottom) quarter on the index of economic, cultural and social status (ESCS) in his/her own country/economy. ESCS is a composite measure that combines into a single score the financial, social, cultural and human capital resources available to students (OECD, 2019b).

PISA results have shown that many school systems became more equitable over the past ten years. In many countries, progress in equity was a reflection of the narrowing of performance differences between advantaged and disadvantaged students (OECD, 2017; OECD, 2018). Across participating OECD countries, evidence from PISA 2018 demonstrates that some students attain high levels of academic proficiency irrespective of socio-economic disadvantage (European Commission, 2019; OECD, 2018). In a positive finding for Ireland, the OECD identifies Ireland as one of just five PISA 2018 participants where not more than a quarter of socio-economically disadvantaged boys were below Level 2 in reading; i.e., the percentage of socio-economically disadvantaged boys in Ireland (23.5%) who were low achievers in reading in 2018 is lower than that in most PISA countries.[11] On average across PISA participants, 41% of boys in the bottom quarter on ESCS were low achievers in reading (OECD, 2020b).

While there are positive findings regarding improvements in equity, Table 1.1 outlines some of the other PISA findings that suggest there is still much work to do in addressing underachievement in socio-economically disadvantaged students internationally.

11 Note that the OECD analysis for disadvantaged boys is not directly comparable with the analysis in the current report which looks at the achievement of boys in DEIS schools. The OECD analysis classifies a student as 'advantaged' or 'disadvantaged' based on the student's score on ESCS and calculates the average achievement by gender for students in the 'advantaged' and 'disadvantaged' groups. The current report examines average achievement by gender of students in DEIS schools (regardless of their individual ESCS scores). Chapter 3 shows that 23.9% of boys in DEIS schools score below Level 2 in reading which is coincidentally very close to the OECD value (23.5%) for the percentage of disadvantaged boys (across all school types) in Ireland with reading achievement below Level 2.

Table 1.1: PISA 2018 Equity: Key findings internationally*

• On average in PISA 2018 reading, advantaged students (those in the top quarter nationally on ESCS) outperformed disadvantaged students (those in the bottom quarter nationally on ESCS) by 89 score points. The difference in Ireland was 75 points.
• In 23 countries, more than 1 in 3 disadvantaged boys did not achieve a minimum level of proficiency in reading. In Ireland, about 1 in 4 disadvantaged boys were in this category.
• On average across countries participating in PISA, students from socio-economically disadvantaged backgrounds held lower academic expectations than students from advantaged families.

** (European Commission, 2019; OECD, 2018).*

Despite progress in the area of equity, in Ireland, as in all OECD countries, there are significant differences in achievement associated with students' social and home backgrounds. There was a difference of about 80 points in Ireland (and 88 points on average across OECD countries) in the average science score of students classified as socio-economically disadvantaged and those considered economically advantaged in PISA 2015 (OECD, 2016). Similarly in 2018, there was a difference of about 75 points in Ireland (McKeown et al., 2019), and 89 points on average across OECD countries (OECD, 2020b) in the average reading achievement of advantaged and disadvantaged students.

Given the persistent differences in achievement associated with socio-economic status and given that DEIS schools are those with the largest concentrations of students from disadvantaged backgrounds, it is not surprising that national PISA analyses consistently find 'raw' achievement differences between DEIS and non-DEIS schools. For example, in 2018 the average reading score of students in DEIS schools was 51 points lower than that of students in non-DEIS schools (McKeown et al., 2019). Similar findings have been reported across all cycles of PISA in Ireland (Perkins, Shiel, Merriman, Cosgrove, & Moran, 2013; Shiel, Kelleher, McKeown, & Denner, 2016).

National targets for performance on PISA

Internationally and increasingly also at a national level, PISA is an important influence on educational policy. Policy makers have been using the information from PISA to inform their education practices and systems. Setting ambitious goals and monitoring the progress of disadvantaged students allows countries to monitor equity in education (OECD, 2018).

In Ireland, PISA results have informed national targets for literacy and numeracy. Initially, these were set out in the Department of Education and Skills National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020 (DES, 2012). These targets were subsequently revised in light of the strong performance in the PISA 2015 cycle with Irish students ranked 3rd out of 35 OECD countries in reading (Shiel et al., 2016). The revised targets for all post-primary students, as well as new targets specifically for students in DEIS schools, were documented in the

National Strategy: Literacy and Numeracy for Learning and Life, 2011-2020. Interim Review: 2011–2016, New Targets: 2017–2020 (DES, 2016). These literacy and numeracy targets for DEIS schools also featured in the DEIS Plan 2017 (DES, 2017a).

As a result of an error in the computation of the 2015 baseline data for DEIS schools (which overestimated the baseline level of achievement), corrected targets are used in this current report. The nature of the error and remedial actions are fully described in ERC (2019). Details of the process used to compute the corrected 2020 targets for the current report are provided in Chapter 2. In summary, the corrected targets were computed by applying the expected change in performance to the corrected baseline figure. The current report considers the extent to which PISA 2018 results for reading and mathematics provide evidence of progress towards the corrected 2020 targets.

Turning to the potential for PISA science results to inform policy, Ireland's education system is committed to furthering student progress in the Science, Technology, Engineering and Mathematics (STEM) disciplines to ensure the country has highly-skilled people to contribute to the technology and science sectors. The report STEM Education in the Irish School System reviewed STEM education within the Irish school system, and amongst the findings noted that students in DEIS schools perform less well in national and international achievement tests in STEM than students in non-DEIS schools (The STEM Education Review Group, 2016). Following this report, the STEM Education Policy Statement 2017–2026 (DES, 2017b) focuses on increasing involvement in STEM from early education through to post-primary level with the aim of ensuring opportunities and provision are available for all students. The policy also aims to address the achievement gap in STEM subjects between students in DEIS and non-DEIS schools (DES, 2017b, p. 13). While the achievement gap is referenced in a general sense, unlike in the area of literacy and numeracy, there are no specific targets for performance in PISA science. McKeown et al. (2019) note that, notwithstanding methodological issues which may impact on using PISA data to inform targets in Ireland (and elsewhere), it may be useful for future targets to focus on underperforming high achievers in both mathematics and science.

The performance of all post-primary students in Ireland has been described in the initial national report Learning for the Future: The performance of 15-Year-olds in Ireland on reading literacy, science and mathematics in PISA 2018 (McKeown et al., 2019) and in the OECD country note for Ireland (OECD, 2019c). The current report compares the reading literacy, mathematics, and science achievement of students attending DEIS schools with those in non-DEIS schools, and considers how the percentages of low achievers and high achievers differ between DEIS and non-DEIS schools. Results from consecutive PISA cycles are used to show whether or not there are changes over time in the achievement gap between students attending DEIS schools and students in non-DEIS schools. The primary focus of the remainder of this report is on national comparisons between DEIS and non-DEIS schools. While positive findings have been cited in this chapter regarding the achievement of disadvantaged students in Ireland relative to their counterparts internationally, it is nonetheless important to retain focus on the continued achievement gap associated with socio-economic disadvantage within Ireland and to consider how continued improvement can be supported.

Chapter 2 provides more detail on PISA and the implementation of the 2018 cycle in Ireland. It outlines a number of technical issues relevant to the interpretation of scores and trend data in the current report. Chapter 3 focuses on reading literacy; Chapter 4 describes performance in mathematics; Chapter 5 describes achievement in Science; and Chapter 6 presents a summary and concluding remarks.

Chapter 2: Design, Implementation, and Technical Details of PISA 2018

What is PISA?

The OECD's Programme for International Student Assessment (PISA), measures and documents the outcomes of education attained at the age of 15. It collects achievement and contextual data at the student level as well as contextual data pertaining to the family and school which is used to help explain student performance (OECD, 2019d). The study runs every three years and measures the reading literacy, mathematical literacy, and science literacy in OECD countries and partner countries/economies, with one subject area designated as the main focus of the assessment in each cycle. It is less concerned with the reproduction of knowledge and national curricula, but rather aims to explore the wider knowledge and skills of 15-year-old students. The quality and equity of learning outcomes across OECD countries are reported in a series of publications (OECD, 2019a; OECD, 2019b). This chapter provides more in-depth information on the implementation of PISA in Ireland and technical details, including information about the sample and the content of the 2018 assessment. It explains how PISA scores map to Irish targets for literacy and numeracy and describes the types of analyses presented in the current report. Further technical detail is available in McKeown et al. (2019) and the PISA 2018 Technical Report (OECD, forthcoming).

Implementation in Ireland

PISA is implemented in Ireland by the Educational Research Centre (ERC), on behalf of the Department of Education and Skills (DES). It follows the technical standards and frameworks (OECD, 2019d) set out by the PISA governing body.

Sampling

Worldwide, in the region of 710,000 students took part in PISA 2018, representing over 31 million 15-year-olds in the schools of the participating countries and economies. In Ireland, 5,577 students from 157 schools (41 DEIS schools, 116 non-DEIS schools) participated. A two-stage sampling approach is used in PISA, whereby schools are sampled first and then eligible students are sampled within schools.[12] In Ireland, schools are stratified by enrolment size (large, medium or small, depending on the number of 15-year-olds enrolled) and sector [secondary, community/comprehensive, and vocational/Education & Training Board]. Within each strata, schools are ordered by the percentage of 15-year-old female students in the school, and socio-economic quartile based on the percentage of students in a school with a Junior Certificate examination fee waiver.

12 In a small number of geographically large countries, three-stage sampling is implemented, with region as the first stage.

It is worth emphasising that in the Irish sample design, school DEIS status is not a sampling variable and that the overall purpose of PISA is to provide information on 15-year-olds in the school-going population in general rather than on sub-groups of the population (such as students in various types of school such as DEIS). However, the percentage of students in a school with a medical card was one of the variables used in the original identification of schools for DEIS (Weir, 2006), and a student is eligible for an examination fee-waiver if the student's family has a medical card. Therefore, the measure used as a proxy for socio-economic status in PISA sampling (the SES quartile based on Junior Certificate fee waiver) is equivalent to one of the factors used in the original identification of schools for DEIS. Thus, while the PISA sample is not designed with the intention of having a representative sample of students attending DEIS schools, it is designed to be nationally representative by socio-economic status. Given that examination fee-waiver is used in PISA sampling in Ireland and that this variable was included in the original DEIS identification model, it can reasonably be assumed that the resultant PISA sample is broadly representative of students in DEIS schools. This assumption has been tested and shown to be largely reasonable (see Appendix 1).

For analysis purposes, schools participating in PISA 2018 were classified as DEIS or non-DEIS according to their status in the academic year 2017/2018. We return to the issue of using PISA data for DEIS monitoring and evaluation purposes in the concluding chapter and the likely implications for PISA sampling if very accurate (precise) achievement estimates are required for DEIS schools.

Turning to student sampling, students selected for inclusion in PISA were aged between 15 years 3 months and 16 years 2 months at the time of the assessment, having completed at least 6 years of formal schooling. A breakdown of the distribution of PISA 2018 students in Ireland across year levels showed that the majority (61.6%) were in Third Year, 27.9% were in Transition Year, 8.5% for in Fifth Year and a very small percentage (1.8%) were in First/Second Year (McKeown et al., 2019). Table 2.1 shows the breakdown of students across year levels separately for DEIS and non-DEIS schools.

A series of Chi-square tests was conducted to test whether the distribution of students across grade levels differs significantly across DEIS and non-DEIS schools. Results show that the percentage of First/Second Year students participating in PISA was significantly higher in DEIS schools (3.4%) than in non-DEIS schools (1.6%). The percentage of Third Years was significantly lower in DEIS schools (57.4%) than in non-DEIS schools (62.9%) and the percentage of Fifth Years was significantly higher in DEIS schools (13.3%) than in non-DEIS schools (7.0%). There was no significant difference in the percentage of PISA students in Transition Year in DEIS and non-DEIS schools. Although these differences are statistically significant and may warrant some further consideration, they do not allow substantive conclusions to be drawn about issues such as grade repetition or uptake of Transition Year in DEIS schools.

Table 2.1: Unweighted numbers of students and weighted percentages in DEIS and non-DEIS schools assessed in PISA 2018

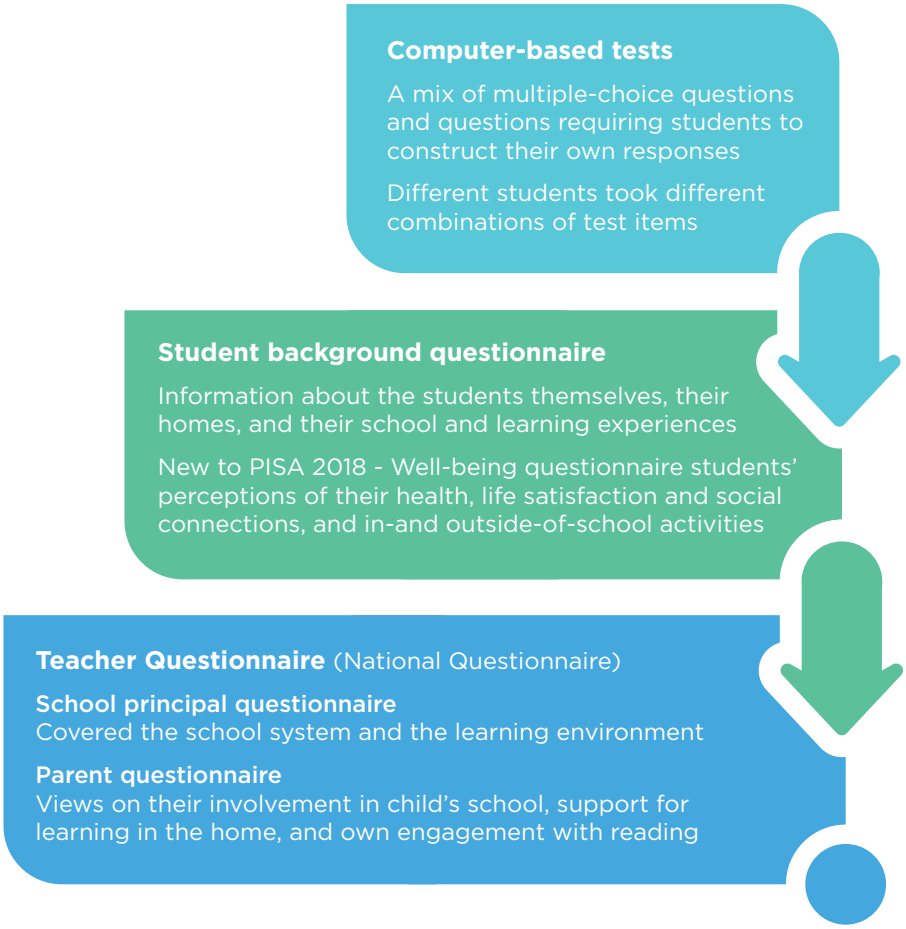
Grade Level	Ireland equivalent	Unweighted number of students		Weighted percent	
		DEIS	Non-DEIS	DEIS % (SE)	Non-DEIS % (SE)
Grade 7/8	First/Second Year	47	69	3.4 (0.70)	1.6 (0.21)
Grade 9	Third Year	789	2744	57.4 (1.52)	62.9 (0.76)
Grade 10	Transition Year	346	1133	26.0 (2.16)	28.5 (0.95)
Grade 11	Fifth Year	168	281	13.3 (1.51)	7.0 (0.77)

Assessment

PISA 2018 was the seventh cycle since the study's inception in 2000. In PISA 2018, reading literacy was the main domain, with science and mathematics assessed as the minor domains. It was the second cycle of PISA to be fully administered on computers, and this was the first time reading literacy was assessed as a main domain on computer.

Students taking part in PISA 2018 were required to complete computer-based tests of reading literacy, science, and mathematics with both multiple-choice and open-ended response items. Administration of the computerised tests took 120 minutes. Upon completion of these tests, students were asked to complete a set of questionnaire items on the computer that took an additional 55 minutes. School principals and parents of participating students were also invited to complete questionnaires to provide contextual information which helps better understand student achievement. A national questionnaire designed for teachers of English was administered in Ireland. See Figure 2.1 for an overview of the PISA assessment process.

Figure 2.1: Taking part in PISA 2018



Understanding PISA scales scores & proficiency levels

The OECD provides a theoretical basis for each area of interest in their assessment framework (OECD, 2019d). The PISA 2018 framework defines what is to be measured and how measurement will take place for each of the subjects. It outlines what it means to be proficient in a subject, and details what students can do in the subject at different levels of proficiency. Descriptions of the PISA definitions of each subject will be provided at the start of each subject chapter in this report.

Results from PISA are reported using scales. The scale scores for each of the literacies are scaled to fit approximately normal distributions, with means around 500 score points and standard deviations around 100 score points. For trend analysis, scores across cycles of PISA are calibrated so as to be directly comparable to those in previous cycles; hence the average score across OECD countries in subsequent cycles has fluctuated slightly around the original 500. A one-point difference on the PISA scale corresponds to an effect size (Cohen's d) of 0.01; and a 10-point difference to an effect size of 0.10 (OECD, 2019e). In this report, national averages for Ireland are taken from the initial national report (McKeown et al., 2019) and OECD averages reported are from Volume I of the international report (OECD, 2019a).

Scale scores represent degrees of proficiency in a particular domain, and can be divided into levels of proficiency ranging from Level 1 to Level 6 (OECD, 2019d). Higher proficiency levels represent the knowledge, skills, and capabilities needed to perform tasks of greater complexity. In PISA 2018, the range of difficulty of reading tasks is

represented by eight levels of reading literacy: the simplest tasks in the assessment correspond to Level 1c; Levels 1b, 1a, 2, 3, 4, 5 and 6 correspond to increasingly more difficult tasks. Each proficiency level corresponds to a range of about 80 score points, and score-point differences of 80 points can be read as the difference in described skills and knowledge between each of the proficiency levels (OECD, 2019e).

Level 2 is considered the baseline proficiency in each subject and students performing under this baseline (i.e., below Level 2) are considered low achievers. According to PISA criteria, students performing below Level 2 have lower chances of success in society on both a personal and professional level (OECD, 2019d). Note that below Level 2 is sometimes described as 'at or below Level 1' and these can be considered interchangeable. (Readers interested in the detail of the construction of proficiency levels, including subdivisions of Level 1, are directed to Chapter 15 of the PISA 2018 Technical Report [OECD, forthcoming]).

Students performing 'at or above Level 5' are deemed to have the skills and competencies represented at all the lower levels as well as demonstrating higher-order knowledge and skills. According to PISA criteria, students performing 'at or above Level 5' are high achievers, and having a high percentages of students at this level may be used as an indicator of how the school system can produce excellent results (European Commission, 2019).

This report will focus is on the percentages of students performing 'below Level 2' (equivalent to 'at or below Level 1'), and 'at or above Level 5' in the three domains in DEIS schools compared to non-DEIS schools. For 'below Level 2' a lower percentage of students is preferable, while for 'at above Level 5' a higher percentage of students is preferable. These categories were selected as they relate to low and high achievers respectively as defined in PISA and they also form the basis of targets in the DEIS Plan 2017 (DES, 2017a). For completeness, PISA 2018 results at the 'at or above Level 4' are also presented in this report as this level is referenced in relation to DEIS targets for DEIS schools (DES, 2017a).

Analyses in this report

Results of four main types of analysis are presented in this report.

i. Comparison of mean performance scores

The first type of analysis involves comparing the mean scores of two groups of students. An example of this type of analysis is the comparison between the mean score of students in DEIS schools and the mean scores of students in non-DEIS schools. Comparisons are made for each domain (reading, mathematics and science) for various cycles of PISA, depending on when the subjects featured as a major domain. Within-cycle comparisons for reading are made for 2009, 2012, 2015 and 2018. Comparisons of mathematics scores are made for 2012, 2015 and 2018. Comparisons for science are made for 2015 and 2018. For PISA 2018, where reading was the main domain, mean scores on reading subscales as well as overall reading are compared for students in DEIS and non-DEIS schools.

Another example of this type of analysis is the comparison between the scores of males and females (conducted separately for DEIS and non-DEIS schools in this report). This type of comparison was made by computing the difference between the mean score on the scale of interest of students in the first group (e.g., females) and the mean score of students in the second group (e.g., males). The standard error of the difference was computed in the IEA International Database Analyzer V4.0.35 (IDB Analyzer, www.iea.nl/data-tools/tools), a software programme specifically designed for large scale educational assessments with clustered samples. A t-statistic was computed based on the difference and the standard error of the difference and used to compute a p-value using 80 degrees of freedom. Findings are considered statistically significant if $p < .05$.

ii. Comparison of proficiency levels

The second type of analysis described in this report compares the percentages of students in a particular category in DEIS schools compared to the percentage in non-DEIS schools (e.g., the percentages below Level 2 in reading). Gender differences in performance will be considered (e.g., the percentage of boys below Level 2 in reading compared to the percentage of girls). This type of analysis was carried out in IDB Analyzer by calculating the difference between the two percentages of interest and the standard error of the difference. From this a z-statistic was computed and using 80 degrees of freedom, a p-value was derived. Again, findings are considered statistically significant if $p < .05$. While findings may be statistically significant, it is important to note that they may not necessarily be of substantive importance and we aim to discuss this where relevant.

iii. Comparison of achievement across PISA cycles

The third type of analysis in this report is trend analysis of achievement across PISA cycles in DEIS and non-DEIS schools. In PISA, trend comparisons are made with the last cycle where the domain was the main domain - for reading this is 2009; for mathematics this is 2012; and for science this is 2015. We consider how the achievement gap between DEIS and non-DEIS schools has changed over time.

This analysis was done by comparing the achievement gap between students in DEIS and non-DEIS schools for the relevant domain in 2018 with the corresponding achievement gap in the last cycle when the subject was a major domain. For example, the reading achievement gap between students in DEIS and non-DEIS schools in 2018 is compared to the reading achievement gap between students in DEIS and non-DEIS schools in 2009. Steps involved in this analysis are outlined in Appendix 2.

iv. Consideration of progress towards 2020 DEIS targets

The fourth type of analysis presented in this report involves comparing PISA 2018 achievement to 2020 targets. As previously noted, there was an error in the computation of baseline data (ERC, 2019) for targets presented in the DEIS Plan 2017 (DES, 2017a) and in the National Strategy: Literacy and Numeracy for Learning and Life, 2011-2020. Interim Review: 2011-2016, New Targets: 2017-2020 (DES, 2016). One consequence

of this error is that baseline achievement was over-estimated with the result that 2020 targets are unlikely to be attainable. To overcome this issue, corrected targets were calculated for the current report. Note that to our knowledge, these corrected targets have not previously been published. Appendix 3 outlines the procedure used to derive the new targets. In summary, the intended change outlined in the DEIS Plan 2017 (DES, 2017a) was applied to the corrected PISA 2015 baseline data to arrive at the corrected targets. Table 2.2 shows the corrected targets. Note that the targets are stated in absolute terms, i.e. an absolute reduction or increase in the percentages of students performing at various PISA proficiency levels. The issue of absolute versus relative targets is explored in the concluding chapter of this report (Chapter 6).

Table 2.2: Corrected 2020 targets for percentages of students in DEIS schools below Level 2; at or above Level 4; and, at or above Level 5 in PISA reading and mathematics

PISA Proficiency Level / Domain	Corrected Targets 2020
Reading Literacy	
Below Level 2 (i.e., 'At or below Level 1')	Reduce the percentage of 15-year-old students in DEIS schools performing at or below Level 1 in PISA reading literacy from **22% to 18%**
At or above Level 4	Increase the percentage of 15-year-old students in DEIS schools performing at or above Level 4 in PISA reading literacy from **21% to 26%**
At or above Level 5	Increase the percentage of 15-year-old students in DEIS schools performing at or above Level 5 in PISA reading literacy from **5% to 8%**
Mathematical Literacy	
Below Level 2 (i.e., 'At or below Level 1')	Reduce the percentage of 15-year-old students in DEIS schools performing at or below Level 1 from **29% to 23%**
At or above Level 4	Increase the percentage of 15-year-old students in DEIS schools performing at or above Level 4 from **16% to 22%**
At or above Level 5	Increase the percentage of 15-year-old students in DEIS schools performing at or above Level 5 in PISA mathematics from **5% to 9%**

Caveat to the reading literacy data in PISA 2009

There is an important caveat associated with the PISA 2009 results. Ireland's weaker reading literacy performance in PISA 2009 was atypical, relative to other cycles of PISA. Overall, average reading scores dropped significantly by 31 points, and the reading literacy rank for Ireland changed from 5th to 21st between 2000 and 2009. The achievement of students in Ireland in 2009 has been subject to extensive analysis (Cosgrove & Cartwright, 2014; Cosgrove, Shiel, Perkins, & Moran, 2010). A number of contributory factors were identified which are likely to explain Ireland's poorer performance in that cycle, including limitations of the reading test design, scaling issues, and an apparent decline in student engagement with greater missing and skipped responses. It has also been demonstrated that using a different modelling approach to handling missing data would reduce the large decline in reading literacy in Ireland in 2009 (Sachse, Mahler, & Pohl, 2019). Comparisons with the 2009 reading performance should therefore be made cautiously, acknowledging that the PISA reading scores of students in Ireland in 2009 may have been underestimated due to the reading test design and psychometric scaling model.

Chapter 3: Reading Literacy

The National Strategy for Literacy and Numeracy 2011-2020 (DES, 2011) recognises the central importance of literacy in the lives of young people in both maximising their educational experiences and bolstering their career opportunities. It acknowledges that Ireland has good standards of literacy but also acknowledges that there is work to be done in ensuring that more students achieve basic literary standards as well as increasing the proportion of students demonstrating the most advanced literacy skills. Data from PISA offers the opportunity to examine both the extent to which students are meeting basic literacy standards and the extent to which students are reaching the highest levels of achievement in literacy assessments. As reading was the major domain in PISA 2018, the most recent cycle of the study offers a rich dataset for monitoring progress in literacy in Irish post-primary schools.

This chapter uses PISA data to examine the reading achievement of students in DEIS and non-DEIS schools. In the first section, the PISA 2018 definition of reading literacy and method of assessment are briefly outlined. The second section gives a brief overview of the main national findings for Ireland from PISA 2018. These have been described in detail in the initial national report (McKeown et al., 2019) and are provided here to give the broader context for the DEIS/non-DEIS comparisons. International reading results with comparisons across countries are described in detail by the OECD (OECD, 2019a) and are not presented in the current report. The remainder of the chapter focuses on the reading achievement of students attending DEIS schools compared to that of students in non-DEIS schools. Overall reading achievement is examined; performance on reading subscales and at various proficiency levels is described and assessed in terms of progress towards 2020 targets; gender differences in reading achievement are discussed; and trends in reading achievement over time are outlined. Finally, differences between students in DEIS and non-DEIS schools in terms of attitudes and motivations towards reading are compared.

PISA 2018 definition of reading literacy

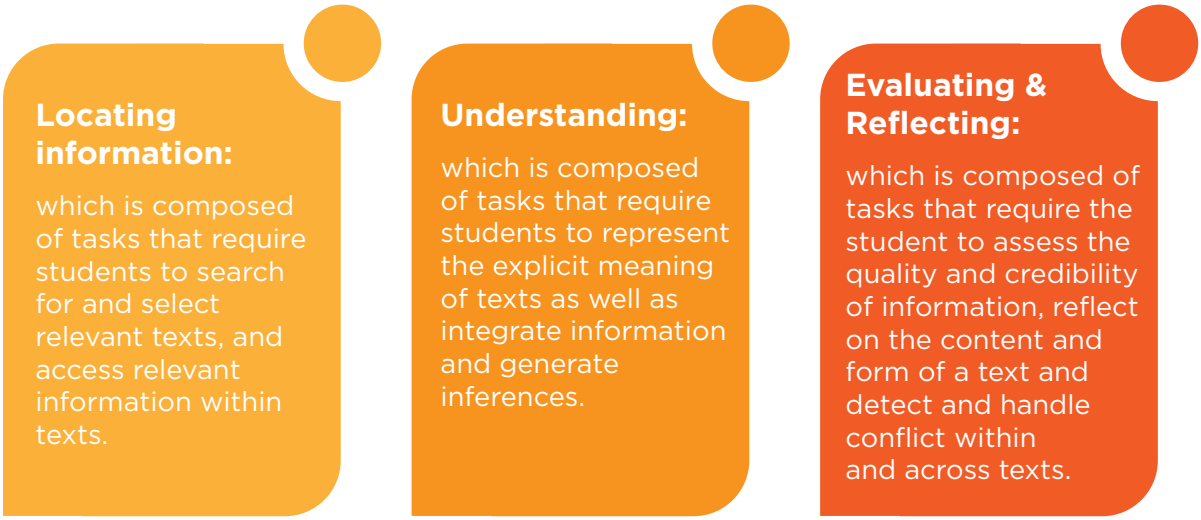
The PISA assessment framework provides the theoretical underpinnings for the definition of reading literacy adopted for the assessment. It is based on the assumption that most 15-year-olds, nearing the end of their formal schooling, will have basic reading skills and therefore the assessment takes a broader approach to literacy skills beyond the classroom (OECD, 2019d).

The PISA 2018 definition of reading literacy is as follows:

Reading literacy - An individual's capacity to understand, use, evaluate, reflect on and engage with texts in order to achieve one's goals, develop one's knowledge and potential, and participate in society (OECD, 2019a p. 28)

The reading literacy assessment measures students' mastery of reading processes, across text formats and situations. The reading literacy skills that students should demonstrate can be subdivided into three cognitive subscales: 1) Locating information by finding and selecting information within a text; 2) Understanding both the literal meaning and interpreting the meaning of text; and 3) Evaluating & reflecting the quality and content of the text (see Figure 3.1 for detailed definitions).

Figure 3.1: PISA definitions of the reading subscales (OECD, 2019d, p. 33)



Ireland's reading literacy results in PISA 2018

Students in Ireland showed a strong performance in reading literacy with a high ranking compared to other participating OECD countries.[13] With this strong overall performance, Ireland had relatively fewer students with very low achievement in reading literacy. Key findings are highlighted in Table 3.1.

Table 3.1: Key reading findings from PISA 2018*

• Ireland's mean score of 518.1 on the reading scale is significantly higher than the OECD average of 487.1.
• Irish students ranked 4th out of 36 OECD countries, and 3rd out of 27 EU countries.
• In Ireland, 11.8% of students performed at the lowest levels of proficiency on overall reading literacy compared to 22.6% on average across OECD countries.
• Almost one in eight students in Ireland (12.1%) performed at the highest proficiency levels in reading (at or above Level 5).
• Reading literacy performance in 2018 was significantly higher than when reading was last a major domain (2009), but did not differ from reading literacy performance in 2012 or 2015.

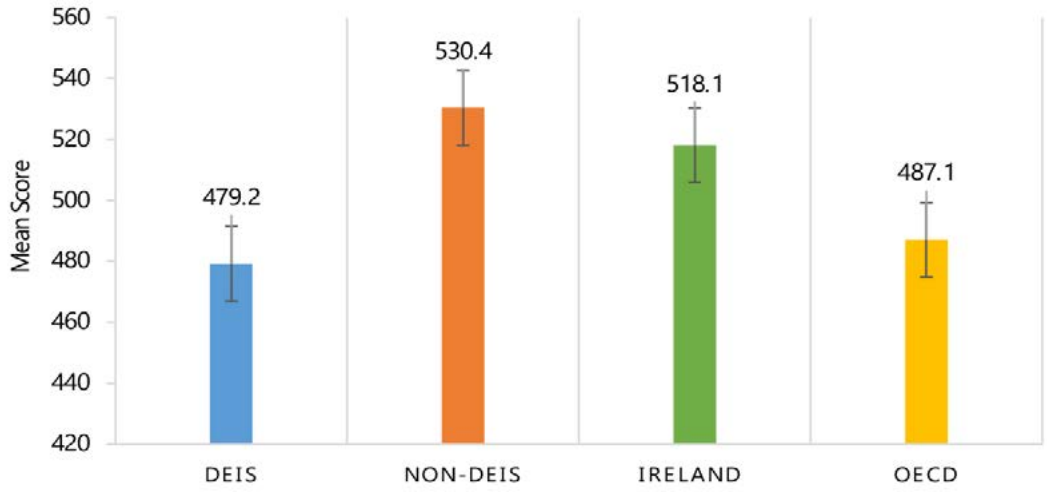
** Based on McKeown et al. (2019) and OECD (2019b).*

13 The OECD average for reading literacy in 2018 is based on 36 countries, while for mathematics and science, the average is based on 37 countries (McKeown et al., 2019 p. xvii).

Reading literacy performance of students in DEIS and non-DEIS schools

In this section, overall reading literacy performance is compared for students attending DEIS and non-DEIS schools. In Figure 3.2, Ireland's overall mean reading score and the OECD average are provided for context. The reading performance of students attending DEIS schools was significantly lower than the performance of students in non-DEIS schools, with a difference of 51.2 score points (over half an international standard deviation or five-eighths of a proficiency level) in favour of students in non-DEIS schools. The performance of students attending DEIS schools, whilst lower than non-DEIS and the national average, is similar to the OECD average student performance of 487.1. Thus, while there is a significant 51-point gap in achievement between DEIS and non-DEIS schools, students in DEIS schools perform at the OECD average.

Figure 3.2: Mean scores for reading literacy in PISA 2018 (DEIS, non-DEIS, Ireland, and OECD)

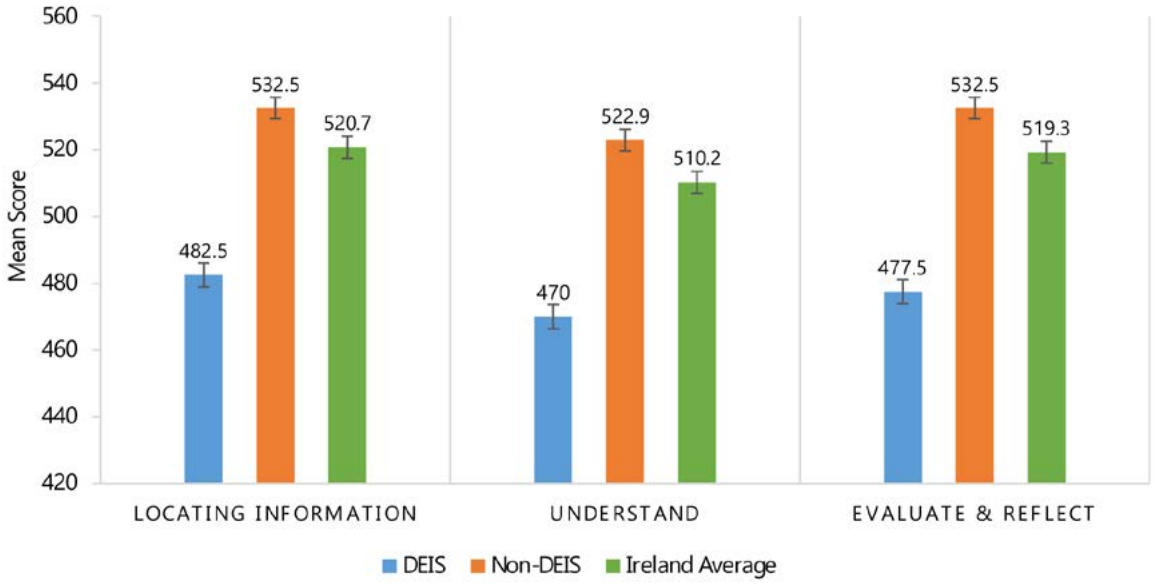


Reading subscale performance of students in DEIS and non-DEIS schools

As outlined in Figure 3.1, PISA provides subscale scores for three processes used in reading (Locating information; Understanding; and Evaluating & Reflecting). These subscales show areas of strength or weaknesses by reading process. Overall, students in Ireland demonstrated strong skills in each of these aspects of reading. The mean score on each reading subscale in Ireland was significantly higher than the corresponding OECD average (McKeown et al., 2019).

To further examine the differences in reading achievement associated with disadvantage, Figure 3.3 presents the achievement on reading subscales separately for students in DEIS and non-DEIS schools. As with overall reading achievement, students in DEIS schools had significantly lower achievement on each of the three reading subscales than their counterparts in non-DEIS schools. On each subscale, the gap was approximately 50 points. The disparity between students in DEIS and non-DEIS schools was somewhat greater in the Evaluate & Reflect subscale with a 55 point gap between the two groups.

Figure 3.3: Mean scores on reading literacy subscales (DEIS, non-DEIS, and Ireland)



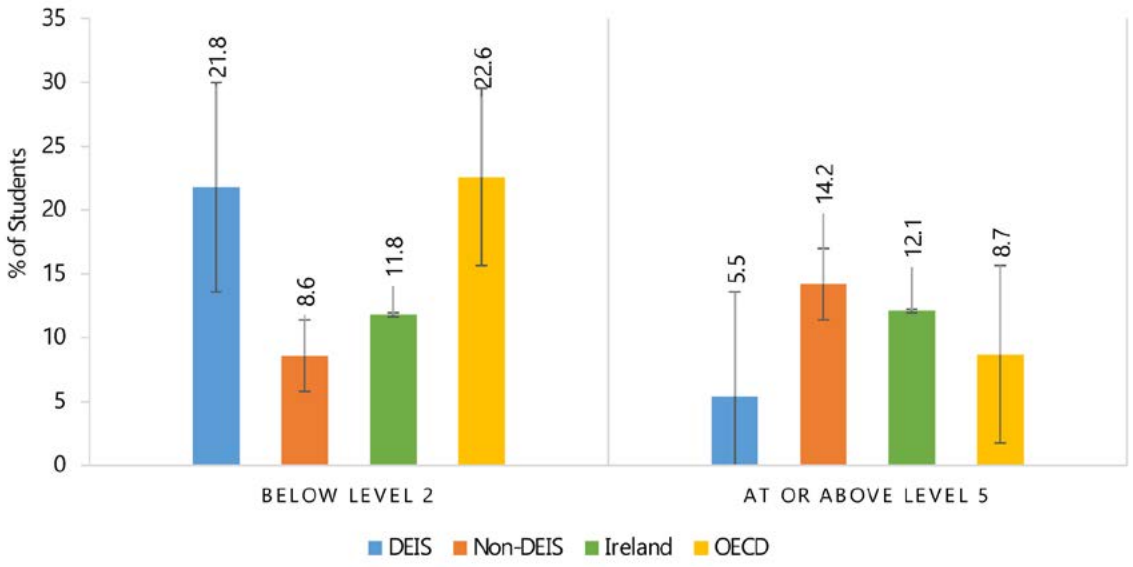
Reading proficiency levels of students in DEIS and non-DEIS schools

In PISA, proficiency levels represent the knowledge, skills, and capabilities needed to perform tasks of increasing difficulty and complexity. It is useful to examine the percentages of students at the various proficiency levels as each level has an associated descriptor of the types of skills that a student is likely to be able to demonstrate. Proficiency levels are computed from the reading scale scores using internationally determined cut-off points. This section presents the percentages of low and high reading achievers in DEIS schools before considering 2020 targets in the next section.

On average across OECD countries, 22.6% of students performed below Level 2 in reading. Such students are considered low-achievers by the OECD as they do not meet the baseline proficiency of Level 2. At this lowest level of proficiency, students can evaluate the literal meaning of simple sentences as well as interpret the literal meaning of texts by making simple connections between adjacent pieces of information in the text (OECD, 2019d). In DEIS schools, just over one-fifth of students (21.8%) achieved a reading score below Level 2, which is two-and-a-half times the percentage of students in non-DEIS schools (8.6%) (Figure 3.4).

On average across OECD countries, 8.7% of students performed at or above Level 5. Students at this level have demonstrated higher level skills in reading such as the ability to reflect deeply on the text's source in relation to its content, using criteria external to the text. The percentage of high achieving students, at or above Level 5, is two-and-a-half times higher in non-DEIS (14.2%) compared to DEIS schools (5.5%) (Figure 3.4).

Figure 3.4: Percentages of low and high achieving students in reading (DEIS, non-DEIS, Ireland, and OECD)



Reading performance and the DEIS Targets

Targets set out in the DEIS Plan 2017 (DES, 2017a) relate to the percentages of post-primary students performing below Level 2, at or above Level 4 and at or above Level 5 in reading. The aim is for targets to be met by 2020, so data from PISA 2018 may be interpreted as an indication of progress towards 2020 targets. Note that, as highlighted by McKeown et al. (2019), Ireland has the second lowest percentage of low performers in reading literacy in the OECD (behind Estonia) and to achieve further reductions is undoubtedly challenging.

For low achievers, the target is to reduce the percentage of 15-year-old students in DEIS schools performing at or below Level 1 (i.e., below Level 2) in PISA reading literacy to 18% (Table 3.2). In PISA 2018, 21.8% of students in DEIS schools had reading scores below Level 2. Importantly, Table 3.2 shows 95% confidence intervals for each of the PISA 2018 proficiency level percentages. For low achievers, the true population percentage for students in DEIS schools (based on the 95% confidence interval computed as the estimate plus or minus 1.96 times the standard error for the estimate) is in the range 17.8% to 25.8%. The 2020 target value (18%) falls within this range. Therefore, due to the error associated with the PISA estimates, although there has been no change in the percentage of low reading achievers in DEIS schools between 2015 and 2018, the 95% confidence interval for the 2018 percentage includes the 2020 target value.

Turning to the percentages of students in DEIS schools at or above Level 4 in reading, the 2020 target is to increase the percentage from 21% to 26%. In PISA 2018, 21.2% of students in DEIS schools had reading scores at or above level 4 (Table 3.2). The corresponding percentage in 2015 was almost identical, at 21.4%. The 95% confidence interval for the 2018 percentage [17.6%, 24.9%] does not include the 2020 target value (26%). This means that, in 2018 at least, students in DEIS schools are performing below the target of 26% at or above Level 4. Further, given no improvement between 2015 and 2018, it is unlikely that the target will be met by 2020.

Finally for high achievers, the target is to increase the percentage of 15-year-old students in DEIS schools performing at or above Level 5 in PISA reading literacy from 5% to 8%. In PISA 2018, 5.5% of students in DEIS schools had reading scores at or above Level 5. The 95% confidence interval for this value is [3.9%, 7%], which does not include the target value. Given no significant improvement between 2015 and 2018 (see Figure 3.10 later) and given that the 2018 confidence interval does not contain the 2020 target, it is unlikely that the 2020 target will be met.

Table 3.2: Targets for 2020 for percentages of students in DEIS schools with PISA reading achievement below Level 2, at or above Level 4, and at or above Level 5

PISA Proficiency Level	Baseline PISA 2015	Target for 2020	PISA 2018 % at level in DEIS schools *[95% confidence interval for percentage]*	Is 2020 target likely to be met?
Below Level 2	21.8%	18%	21.8% [17.8, 25.8]	Probable (95% CI includes target)
At or above Level 4	21.4%	26%	21.2% [17.6, 24.9]	Unlikely (Target value not contained in 95% CI)
At or above Level 5	4.7%	8%	5.5% [3.9, 7.0]	Unlikely (Target value not contained in 95% CI)

In looking at national targets (and not specifically those for DEIS schools), McKeown et al. (2019) suggest that further consideration should be given to the relevance of the targets, given changes to test content every third PISA cycle, measurement error, and the relative strength of student performance in Ireland. They also advocate the use of ranges of percentages in future targets to better reflect measurement error on the assessment, e.g., the aim might be to have 10-14% of students at a particular level. In presenting 95% confidence intervals for the 2018 percentages in this section, we aim to show how measurement error has an important impact on whether or not targets will be deemed to be met or not. With a small actual change, a slight change in the upper or lower bound of the 95% confidence interval may mean that a target is deemed to have been met, despite little or no substantive change in student performance.

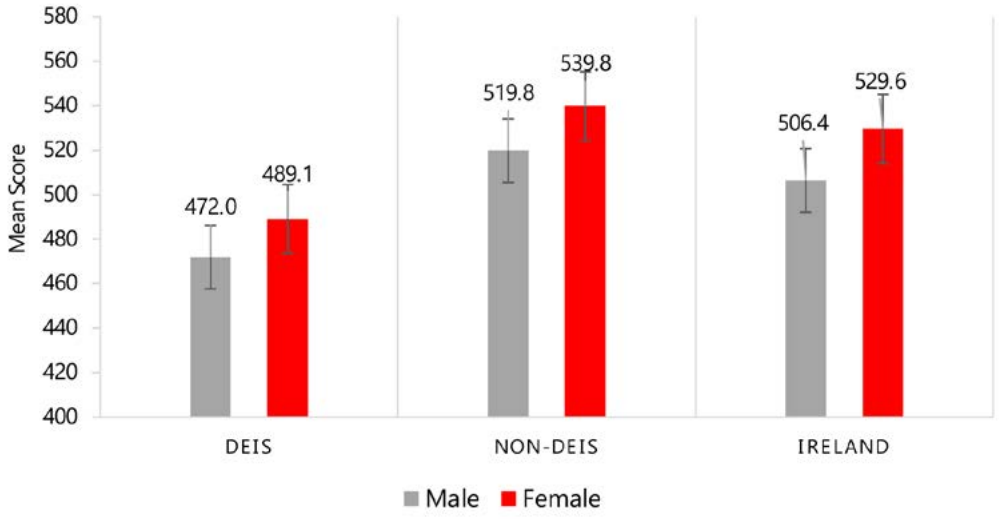
Gender differences in reading

Gender differences in overall reading

Female students in Ireland outperformed male students on PISA 2018 reading, with a 23 point gap in favour of females (McKeown et al., 2019). This gender difference is evident in both DEIS and non-DEIS schools, with significantly lower scores for males in both school settings (Figure 3.5). The gender difference in favour of females is of

a similar magnitude in both DEIS (17 points) and non-DEIS (20 points) schools,[14] and both of these are smaller than the average OECD gender difference in reading of 29.7 points in favour of females (OECD, 2019a).

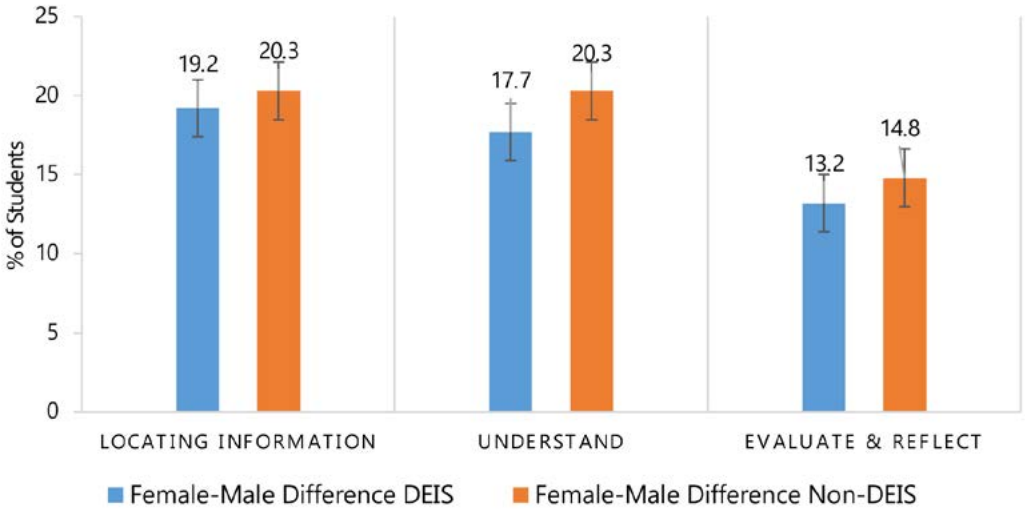
Figure 3.5: Gender differences in reading performance (DEIS, non-DEIS, and Ireland average)



Gender differences in reading subscales

Female students significantly outperformed male students on all three reading literacy subscales in Ireland (McKeown et al., 2019). Gender differences are also present across all three subscales for students in both DEIS and non-DEIS schools (Figure 3.6). A gender gap of about 20 points was found in both DEIS and non-DEIS schools on the Locating information and Understand subscales. A somewhat smaller gender difference was noted on Evaluate & Reflect in both DEIS and non-DEIS schools. On each subscale, gender differences were statistically significant in favour of females.

Figure 3.6: Gender differences in PISA 2018 reading subscales (DEIS and non-DEIS)



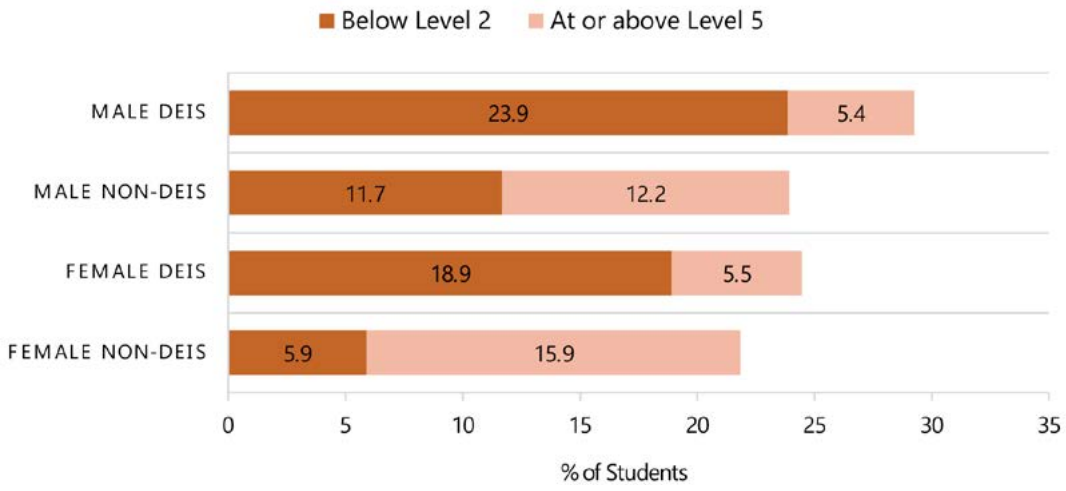
14 Although counterintuitive that the PISA 2018 gender gap in reading in DEIS schools (17 points) and non-DEIS schools (20 points) is smaller than the gender gap in the overall sample (23 points), this is likely a function of the sample design and weighting. This example highlights the importance of considering the standard errors associated with all estimates and where relevant, examining a 95% confidence interval for the estimate.

Gender differences in reading proficiency levels

It is useful to examine separately for males and females the percentages of students at each proficiency level (Figure 3.7). One-quarter of male students in DEIS schools (23.9%) had a reading score below Level 2; i.e., one quarter of boys in DEIS schools are categorised as low achievers using the OECD criteria. This about double the percentage of males in non-DEIS schools categorised as low achievers (11.7%). Furthermore, the percentage of males in DEIS schools at Level 2 (23.9%) is somewhat higher than the percentage of females (19%) at this level in DEIS schools, although the difference between the two percentages is not statistically significant. Around three times as many female students in DEIS schools (18.9%) than in non-DEIS schools (5.9%) had a PISA 2018 reading score at or below Level 2.

The percentage of male students categorised as high achievers (at or above Level 5) is significantly lower in DEIS schools (5.4%) than in non-DEIS schools (12.2%), but is on a par with the percentage of female students in DEIS schools with this level of achievement (5.5%). The strongest-performing group on these measures were females in non-DEIS schools (15.9% at or above Level 5 and 5.9% below Level 2).

Figure 3.7: Percentages of male and female students in DEIS and non-DEIS schools at the proficiency levels: below Level 2 and at or above Level 5 in reading



Trends in reading performance and proficiency levels

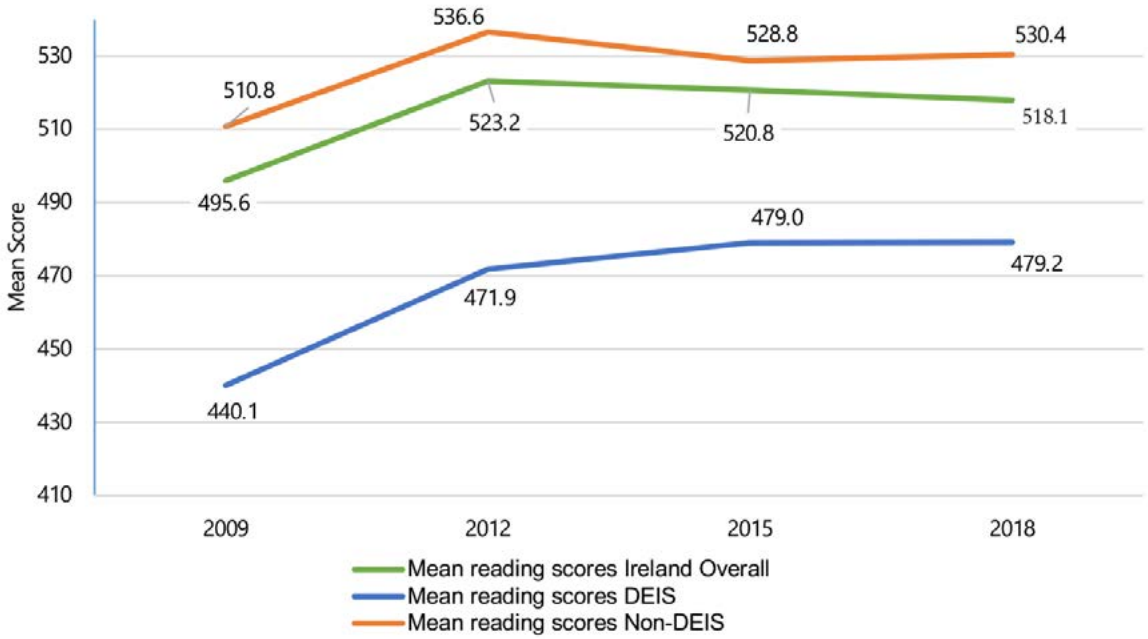
Trends in overall reading performance

Reading performance can be compared across PISA cycles, and this trend analysis for reading goes back to 2009 when reading was previously the major assessment domain.[15] We can track the performance of students in DEIS and non-DEIS schools and patterns of progression over time in both average reading scores and proficiency levels. Figure 3.8 shows the mean scores for overall reading for each PISA cycle from 2009 to 2018 for students attending DEIS and non-DEIS schools. Students in non-

15 The dataset used for the original PISA 2009 analysis (Perkins, Moran, Cosgrove, & Shiel, 2010) has since been improved with respect to missing data on the DEIS status variable. In both the results published in 2010 and in the results in this report, there is a gap of about 70 points in average reading achievement between students in DEIS and non-DEIS schools. However, the mean estimates in the current report vary just slightly with those originally published due to improvements to missing data. (Originally published estimates for reading: DEIS = 436.4 and non-DEIS = 506.3; Current report: DEIS = 440.1 and non-DEIS = 510.8).

DEIS schools have significantly outperformed students in DEIS schools in reading across each of these PISA cycles.

Figure 3.8: Mean PISA reading scores 2009 – 2018 (DEIS, non-DEIS, and Ireland)



Reading performance can be compared across PISA cycles, and this trend analysis for reading goes back There was a significant improvement in reading performance for students in DEIS schools from 2009 to 2018, with 39.2 point increase from 2009 to 2018. However, the achievement of students in DEIS schools in 2018 was very similar to that in 2015 and the main gain in reading performance was between the years 2009 to 2012 (score difference of 31.8 points). This has plateaued since 2012, with no subsequent change or significant improvement in performance in the more recent cycles. These findings should be interpreted with regard to the atypical (and possibly underestimated) reading performance of students in Ireland in 2009 (outlined in Chapter 2). Student performance in non-DEIS schools has also improved since 2009 with a significant difference of 19.6 points between 2009 and 2018. Similar to the trend noted in DEIS schools, the reading results for students in non-DEIS schools from the 2018 cycle are very similar to those from 2015.

There is some evidence of a reduction in the achievement gap between students in DEIS and non-DEIS schools. While the difference in mean reading scores between DEIS and non-DEIS schools in 2009 was about 70 points, the gap was about 50 points in 2015 and 2018 (Figure 3.8). This difference is statistically significant, indicating that the gap in reading achievement in 2018 between students in DEIS and non-DEIS schools is significantly smaller than the gap in 2009. Although this is an encouraging finding, it should be interpreted in conjunction with the findings above of very little change in reading scores across the 2012, 2015, and 2018 PISA cycles.

Trends in reading proficiency levels

In addition to examining trends in mean scores over time, it is useful to also consider how the percentages of students at various proficiency levels have changed across

cycles of PISA. This is relevant to the analysis of targets presented above which look at trends from 2015 to 2018.

There was a significant reduction from 2009 to 2018 in the percentage of students in DEIS schools scoring below Level 2 (Figure 3.9); i.e., there was a statistically significant reduction in the percentage of low achievers in DEIS schools in this period. There was no change between 2015 and 2018 in the percentage of low achieving students in DEIS schools (21% in both 2015 and 2018). The main change was between cycles 2009 and 2012. The percentages of low achievers in non-DEIS schools has also reduced from 2009 to 2018, but was largely stable between 2015 and 2018.

Figure 3.9: Percentages of students below Level 2 in reading proficiency 2009 – 2018 (DEIS, non-DEIS, and Ireland)

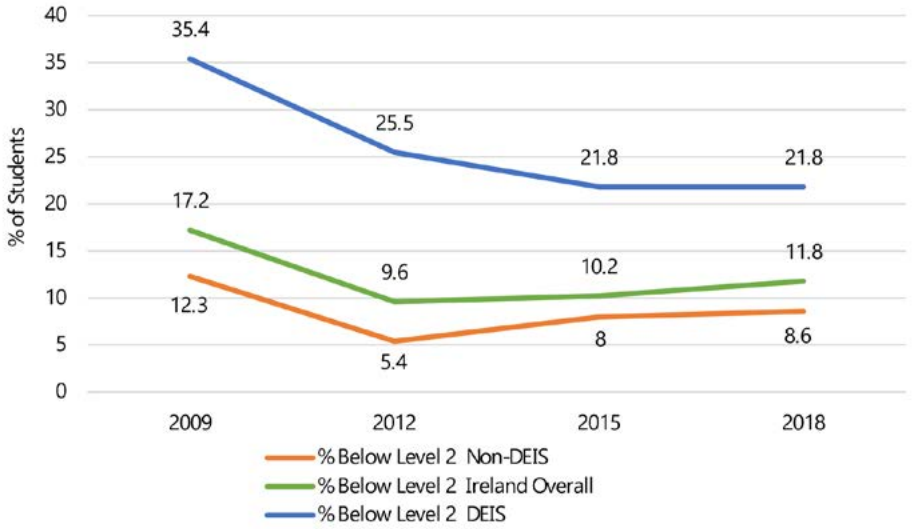
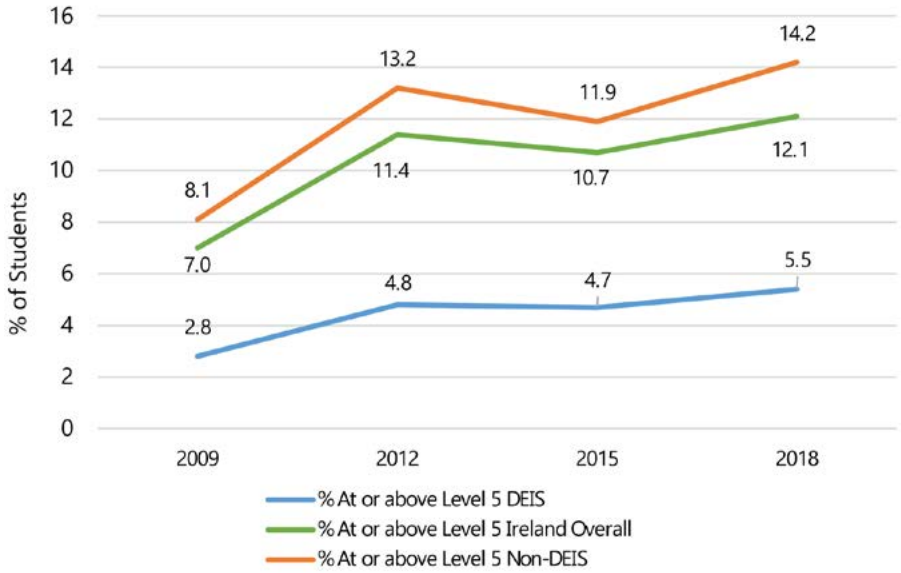


Figure 3.10 shows that there have been small increases in the percentages of high-achieving students in DEIS schools between 2009 and 2018. The main increase was between 2009 and 2012 with limited changes since then. In 2009, 2.8% of DEIS students had reading scores at or above Level 5. The corresponding percentage in 2018 was 5.5%. In non-DEIS schools, the percentage of students at or above Level 5 increased from 8.1% in 2009 to 14.2% in 2018.

Figure 3.10: Percentages of students at or above Level 5 in reading proficiency, 2009 – 2018 (DEIS, non-DEIS, and Ireland)



Reading motivation of students in DEIS and non-DEIS schools

For the main domain in each PISA cycle, students are asked questions about their levels of interest and motivation for that subject, and their learning and leisure practices related to that domain. In PISA 2018, students were asked how much time they spent reading for enjoyment. Although reading for enjoyment was not widespread among either group, a significantly higher percentage of students in DEIS schools reported that they did not read at all for enjoyment (58.5%) compared to students in non-DEIS schools (44.3%) (McKeown et al., 2019). Reading for enjoyment has been shown to be associated with reading achievement. Similarly, other motivational factors strongly linked with reading proficiency include overall enjoyment of reading and reading self-concept. In addition to being correlates of achievement, these motivational and affective factors are important outcomes as they are indicative of students' engagement in their learning. This section focuses on comparisons between students in DEIS and non-DEIS schools on enjoyment of reading and reading self-concept.

Enjoyment of reading

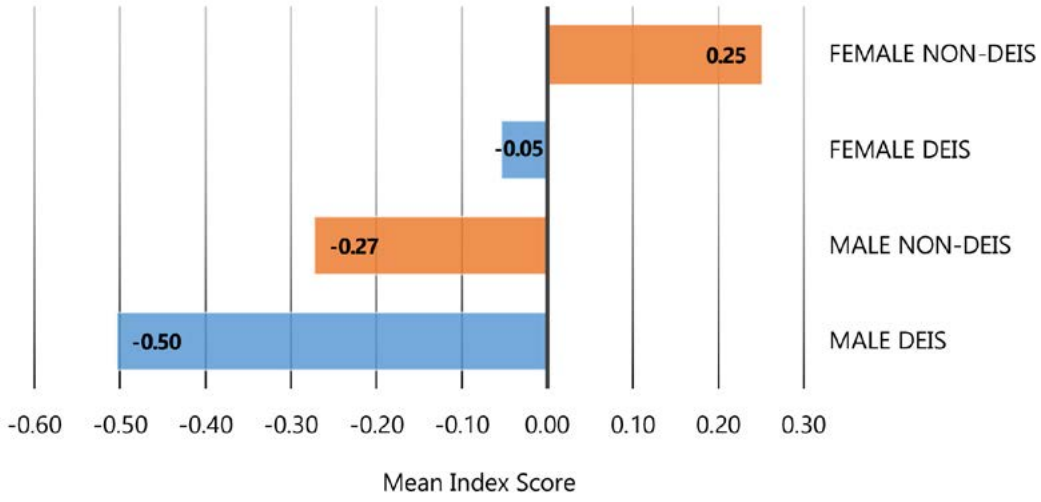
Students were asked five questions about their general enjoyment of reading (e.g., "Reading is one of my favourite hobbies" and "I read only if I have to"). Responses on the individual items were combined by the OECD into an index of enjoyment of reading. This index was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries (OECD, 2019d). Positive values on this scale mean that a student enjoys reading to a greater extent than the average student across OECD countries.

The mean score for all students in Ireland on this index was -.07 which is marginally below the OECD average (McKeown e al., 2019). Across all students in Ireland, there is a moderate association between enjoyment of reading and reading performance (r = .44). For students in non-DEIS schools (mean score = .00), the mean score on enjoyment of reading was significantly higher than that of students in DEIS schools

(mean = -.31), indicating that students in DEIS schools report lower levels of enjoyment of reading on average than students in non-DEIS schools.

Interestingly, gender appears to be more relevant than attendance at a DEIS/non-DEIS school when it comes to reading for enjoyment. The highest average levels of enjoyment of reading were reported by female students in non-DEIS schools (0.25), followed by females in DEIS schools (-0.05; Figure 3.11; note colour is used to distinguish between DEIS and non-DEIS schools). It is of note that male students in both DEIS (-0.50) and non-DEIS schools (-0.27) report below average enjoyment of reading, with the lowest enjoyment reported by males in DEIS schools.

Figure 3.11: Mean scores on enjoyment of reading by gender (DEIS and non-DEIS)



Reading self-concept: Perceptions of competence and perceived difficulty

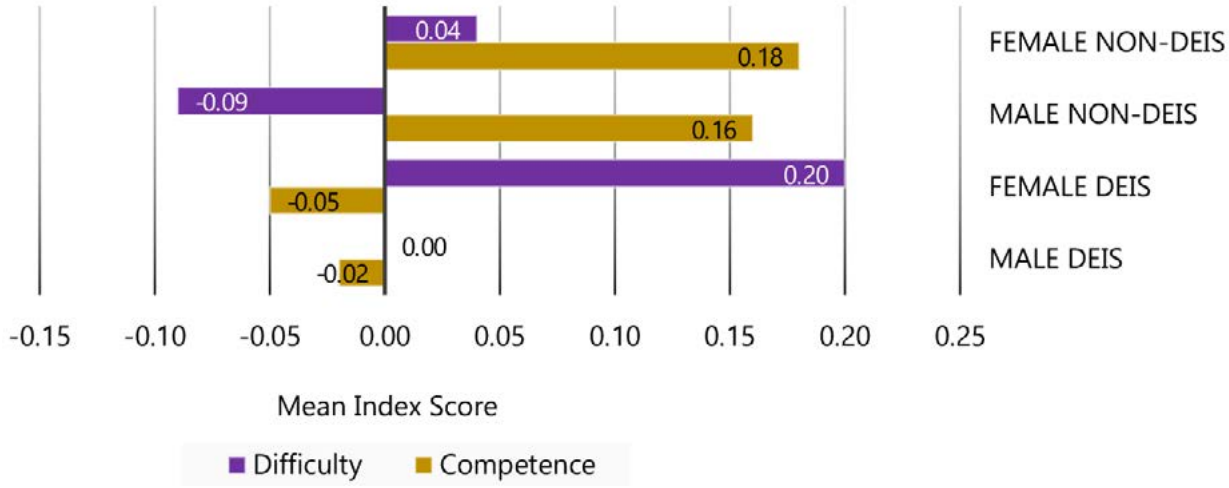
Self-concept is a general measure of an individual's own perceived abilities in a domain and in PISA 2018 this included students' perceptions of both their own competence in reading and whether they encountered difficulties in learning how to read. Students were asked to agree or disagree with six statements such as "I am a good reader", "I have always had difficulty with reading", and "I can understand difficult texts". Responses were summarised in two indices of reading self-concept: one measuring the perception of competence and the other measuring the perception of difficulty with reading. These indices have a mean of 0 and a standard deviation of 1 across OECD countries. Positive values are associated with higher levels of perceived competency and higher levels of perceived difficulty, respectively.

Positive self-concept is generally related to motivation and learning. Across all students in Ireland, moderate correlations are found between self-concept and overall reading performance (competence r = .44; difficulty r = -.39). Students in non-DEIS schools reported a more positive self-concept in reading competence (mean score = 0.17) compared to student in DEIS schools (mean score = -.03). For self-concept of reading difficulty, students in both DEIS and non-DEIS schools scored at the OECD average. Figure 3.12 shows for DEIS and non-DEIS schools (separately for males and females) perceived competency and difficulty with reading. For perceptions of reading competence, both male and female students in non-DEIS schools were significantly more positive than their counterparts in DEIS schools. This is in line with the stronger

overall reading performance in non-DEIS schools.

Turning to perception of difficulty with reading, female students in DEIS schools reported above-OECD-average difficulties with reading, with scores about one-fifth of a standard deviation above the OECD average. Male students in DEIS schools however had a mean score on perceived difficulty with reading that was at the OECD average. It is noteworthy that females in DEIS schools reported more difficulties with reading than male students despite females having better overall reading achievement. Both males and females in non-DEIS schools had average scores on this index that were similar to the OECD average but females did report more difficulties than males (Figure 3.12).

Figure 3.12: Self-concept in reading by gender: Perception of competence and perception of difficulty scores (DEIS and non-DEIS)



Summary

There is a gap in reading achievement in PISA 2018 between students in DEIS and non-DEIS schools (51.2 score points) which is equivalent to over half an international standard deviation or five-eighths of a proficiency level. Students in non-DEIS schools achieved a mean score significantly above the OECD reading average, while students in DEIS schools scored at the level of the OECD average. Consistent with overall reading performance, students in DEIS schools performed significantly less well across all three of the PISA 2018 reading subscales.

Reading achievement in PISA is also benchmarked using proficiency levels and the analyses of proficiency levels, which provide information about the distribution of achievement, are consistent with the lower average reading scores of students in DEIS schools. Compared to students in non-DEIS schools, about two-and-a-half times as many students in DEIS schools than in non-DEIS schools perform below Level 2 on reading (21% in DEIS; 8.6% in non-DEIS). Conversely, about two-and-a-half times as many students in non-DEIS schools than in DEIS schools perform at and above Level 5 in reading (5.5% in DEIS; 14.2% in non-DEIS). These findings provide evidence that a sizable percentage of 15-year-olds in DEIS schools are not meeting the minimum reading standards deemed necessary by the OECD for successful participation in

work and society. There is little change in the percentages of low and high achievers in DEIS schools from 2015 to 2018. Although the 2020 target value for low achievers is contained within the 95% confidence interval for the PISA 2018 percentage which may result in the target being met, it is important that meeting the target reflects substantive improvement. With no change from 2015 to 2018 in the percentage of low achievers, there is little evidence of substantive improvement in this regard.

There is an established gender difference in reading with females outperforming males across many PISA cycles and in most countries internationally. This female advantage was noted in Ireland in overall reading performance in both DEIS and non-DEIS schools and across all three reading subscales. Turning to the percentages of males and females below Level 2 on reading, findings show that a quarter of males in DEIS schools scored at this level compared to just under one-fifth of females. Percentages of low achievers in reading were considerably lower in non-DEIS schools, with 12% of males and 6% of females scoring below Level 2 in reading. About 5% of males and females in DEIS schools were high achievers in reading (at or above Level 5). The corresponding percentages in non-DEIS schools were 12% for males and 16% for females.

Comparing reading performance in 2018 with performance in 2009, 2012 and 2015, there have been significant improvements in reading performance in both DEIS and non-DEIS schools, with the large majority of the improvement occurring between 2009 and 2012 and little change in either DEIS or non-DEIS settings since then. However, there is evidence of a reduction in the reading achievement gap between students in DEIS and non-DEIS schools over time. While the difference in mean reading scores between DEIS and non-DEIS schools in 2009 was about 70 points, the gap was about 50 points in 2015 and 2018. Although this is an encouraging finding, it should be interpreted in conjunction with the rather static nature of reading performance in both DEIS and non-DEIS schools since 2012.

Turning to non-cognitive outcomes which are important both as correlates of achievement and as positive behaviours and dispositions generally, reading behaviour and student motivations were examined. Fewer students in DEIS schools than in non-DEIS schools reported reading for enjoyment. In both DEIS and non-DEIS schools, female students reported higher levels of enjoyment of reading than males. Amongst students in Ireland, males in DEIS schools reported the lowest levels of enjoyment of reading. These low levels of reading enjoyment mirror their overall lower reading performance. Students also reported on their reading self-concept defined as their perceived competence in reading and difficulties encountered with reading. Overall, perceived competence was positively associated with reading performance and perceived difficulties were negatively associated with performance. Reading competency ratings were higher in both males and females in non-DEIS schools compared to students in DEIS schools. Males in DEIS schools reported reading difficulties at the OECD average level while female students in DEIS schools reported above-average difficulties with reading. It is noteworthy that males in DEIS schools were less likely to report reading difficulties than females despite having lower reading achievement.

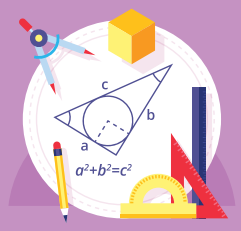
Chapter 4: Mathematical Literacy

The second domain of interest in PISA 2018 is mathematical literacy. The OECD recognises that a good understanding of mathematical reasoning and tools is essential for young people across many professions and the PISA cycles offer an opportunity to see how well-equipped 15-year-old students are in applying their mathematical knowledge and skills (OECD, 2019d).

This chapter begins by providing the PISA definition of mathematical literacy, followed by a brief overview of achievement in mathematics internationally and nationally. Readers interested in more detail about achievement in Ireland are directed to the national (McKeown et al., 2019) and international reports (OECD, 2019a). It then describes the mathematics achievement of students in DEIS and non-DEIS schools. Average achievement and achievement at various key proficiency levels are discussed; progress towards 2020 targets is considered; gender differences in achievement in DEIS schools are examined; and, trends over time are presented. Since mathematics is a minor domain in PISA 2018, the student questionnaire did not gather information on students' attitudes towards mathematics as was the case for reading.

PISA 2018 definition of mathematical literacy

The OECD defines mathematical literacy as:



Mathematical literacy - an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well founded judgements and decisions needed by constructive, engaged and reflective citizens (OECD, 2019a, p. 75).

Mathematical literacy is also described as "students' ability to analyse, reason and communicate ideas effectively as they pose, formulate, solve, and interpret solutions to mathematical problems in a variety of situations" (OECD, 2019d, p. 15). Three mathematical processes, which draw on seven mathematical capabilities, are assessed in PISA. The processes are: formulating situations mathematically; employing mathematical concepts, facts, procedures and reasoning; and interpreting, applying and evaluating mathematical outcomes. Four content areas (Quantity; Space and Shape; Change and Relationships, and Uncertainty and Data), which map to curricular areas are assessed. A key feature of PISA is that items are presented in real world contexts (personal, educational, societal and scientific) to gauge how well students' can actively engage and apply their mathematics knowledge (OECD, 2019d, p. 75). As previously noted, mathematics was a minor assessment domain in 2018, and as such no subscales are reported. It was the major domain in PISA 2012 so in this chapter,

performance in the 2012 cycle is used as the first comparison year in trend analysis.

Ireland's mathematics results in PISA 2018

Key findings related to student performance in mathematics in Ireland and internationally results are highlighted in Table 4.1. Ireland's average score in mathematics (499.6) was significantly above the corresponding OECD average (489.3); however, the country's ranking (16th out of 37 OECD countries) was appreciably lower than in reading literacy (4th out of 36 OECD countries).

Table 4.1: Key international and national findings associated with PISA 2018 mathematical literacy*

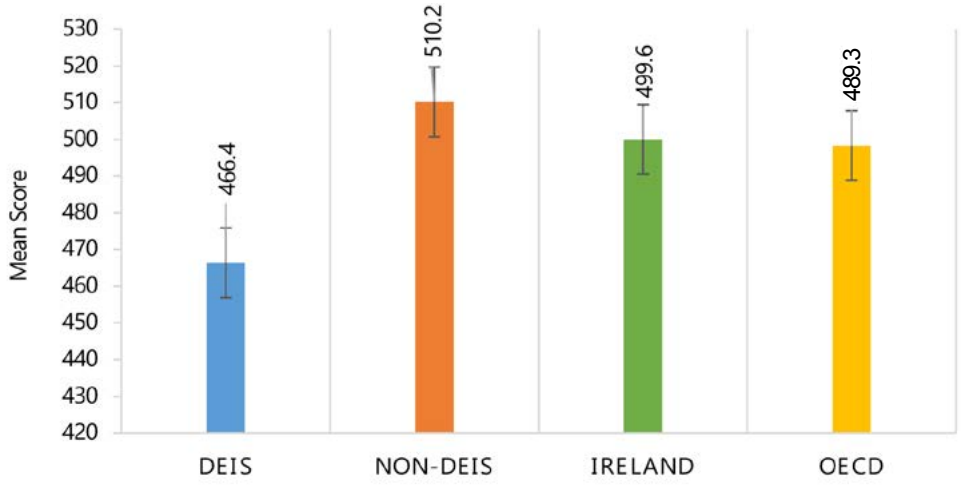
• The OECD average mathematics score was 489.3. The average mathematics score in Ireland was 499.6.
• Irish students ranked 16th out of 37 OECD countries, and 21st out of all 78 participating countries for mathematics.
• On average across OECD countries, 76.1% of students attained Level 2 or higher in mathematics. The corresponding percentage in Ireland was 84.3%.
• In Ireland, 15.7% of students performed at the lowest levels of proficiency (below Level 2) and 8.2% performed at the highest proficiency levels (at or above Level 5) on overall mathematical literacy.

** Based on McKeown et al. (2019) and OECD (2019b).*

Mathematical literacy of students in DEIS and non-DEIS schools

In this section, overall achievement in mathematical literacy is compared for students attending DEIS and non-DEIS schools (national and international averages are provided for information). The average mathematics performance of students attending DEIS schools was significantly lower than the average performance of students in non-DEIS schools, with a difference of 43.8 (two-fifths of an international standard deviation) score points in favour of non-DEIS students (Figure 4.1). Students in DEIS schools had a mean score that was significantly below both the national average and the OECD average. On the other hand, students in non-DEIS schools had a mean score that was above the OECD average and the national average.

Figure 4.1: Mean scores for mathematics literacy in PISA 2018 (DEIS, non-DEIS, Ireland, and OECD)



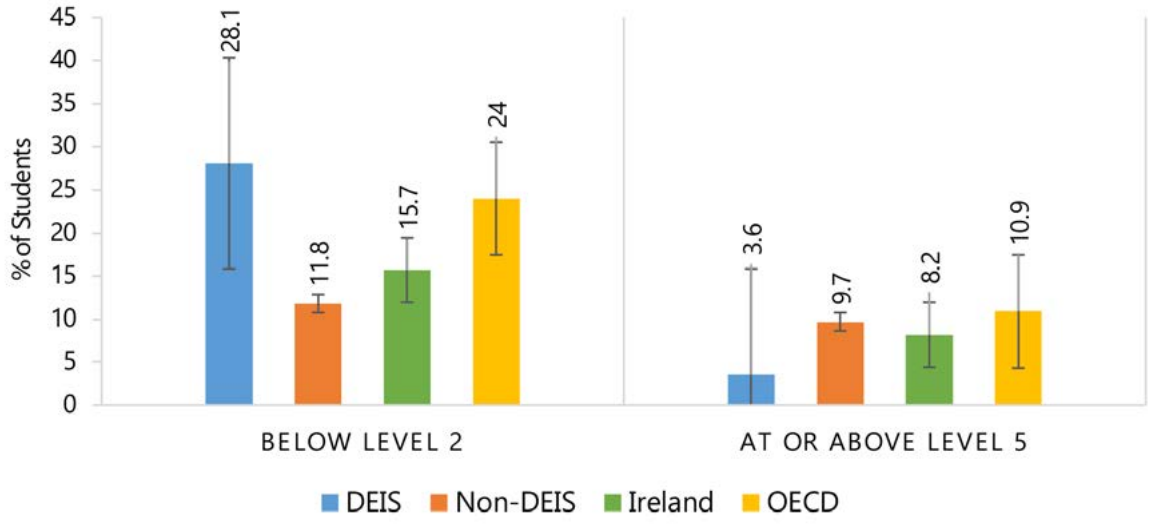
Mathematical proficiency levels of students in DEIS and non-DEIS schools

Average mathematics performance scores can also be divided into six levels of proficiency indicating the tasks students are likely to be able to complete at each level. This section focuses on the percentages of students below Level 2 and at or above Level 5. These levels were selected as they represent low and high achievers respectively and are of particular importance given the aims of the DEIS Plan 2017 (DES, 2017a) to reduce the percentage of low achievers in PISA mathematics and to increase the percentages of higher achievers.

Figure 4.2 shows that the percentage of students categorised as low achievers (i.e., below Level 2, equivalent to 'at or below Level 1') in DEIS schools (28%) is nearly two-and-a-half times that in non-DEIS schools (12%). Thus, around two in seven students in DEIS schools do not reach the minimum level of proficiency considered necessary by the OECD compared to one in eight students in non-DEIS schools. Students performing below Level 2 can perform some direct and straightforward mathematical tasks. They are able to identify information and carry out routine procedures and to answer questions involving familiar contexts. They may also be able to perform simple arithmetic calculations with whole numbers by following clear and well-defined instructions (OECD, 2019d).

A very small percentage (3.6%) of students in DEIS schools reached the highest level of achievement in mathematics (at or above Level 5). The corresponding percentage in non-DEIS schools was significantly higher at 9.7% (Figure 4.2). High performers are capable of advanced mathematical thinking and reasoning. They can develop and work with models for complex situations, identifying constraints and specifying assumptions (OECD, 2019d).

Figure 4.2: Percentages of students at key proficiency levels in PISA 2018 mathematics (DEIS, non-DEIS, Ireland, and OECD)



Mathematical performance and the DEIS targets

Targets set out in the DEIS Plan 2017 (DES, 2017a) relate to the percentages of post-primary students performing below Level 2, at or above Level 4 and, at or above Level 5 in mathematics. Table 4.2 shows the 2020 targets for each category alongside the baseline (percentage in 2015) and the percentages in each group in PISA 2018.

In terms of reducing the number of low achievers in DEIS schools, the aim is to have reduced this percentage from 29% to 23% by 2020. In PISA 2018, 28.1% of students had mathematics scores below Level 2 (Table 4.2). A 95% confidence interval for this percentage is 23.1% to 33.0%. The bottom value (23.1%) is just above the 2020 target value (23%); i.e., the target value is just outside the 2018 confidence interval. Therefore, if any improvement is made, it is likely that the 2020 target will be met. However, it is noteworthy that no change on this measure has occurred between 2015 and 2018 (Figure 4.5 later in this chapter) and if the target is met by falling just inside the relevant confidence interval, it may not be the result of substantial improvement in achievement.

By 2020 the aim is to have 22% of students in DEIS schools performing at or above Level 4 in mathematics (Table 4.2). In 2018, 15.8% of students in DEIS schools achieved this level compared to a very similar percentage (16.1%) in 2015. The upper bound for the 95% confidence interval for the 2018 value is 18.8% which does not include the 2020 target value. Given the absence of change between 2015 and 2018 and the confidence interval for 2018, there is limited evidence that the 2020 target is likely to be met.

Table 4.2: Targets for 2020 for percentages of students in DEIS schools with PISA mathematics achievement below Level 2, at or above Level 4, and, at or above Level 5

PISA Proficiency Level	Baseline PISA 2015	Target for 2020	PISA 2018 % at level in DEIS schools [95% confidence interval for percentage]	Is 2020 target likely to be met?
Below Level 2	29.0%	23%	28.1% [23.1, 33.0]	Possible (Target value not contained in 95% CI but very close to lower bound)
At or above Level 4	16.1%	22%	15.8% [12.8, 18.8]	Unlikely (Target value not contained in 95% CI)
At or above Level 5	4.7%	9%	3.6% [2.1, 5.0]	Unlikely (Target value not contained in 95% CI)

Turning to high achievers, the aim is to have 9% of students in DEIS schools at or above Level 5 in mathematics by 2020. In 2018, 3.6% of students in DEIS schools had mathematics scores in this range. The 95% confidence interval for the 2018 value is 2.1% to 5.0%, indicating that the true population value for students in DEIS schools may be as low as 2.1% or as high as 5%. As the percentage of high achievers in mathematics in DEIS schools has fallen slightly (although not significantly) since 2015 (from 4.7% to 3.6%), there is little evidence of progress towards the 2020 target.

Gender differences in mathematical literacy

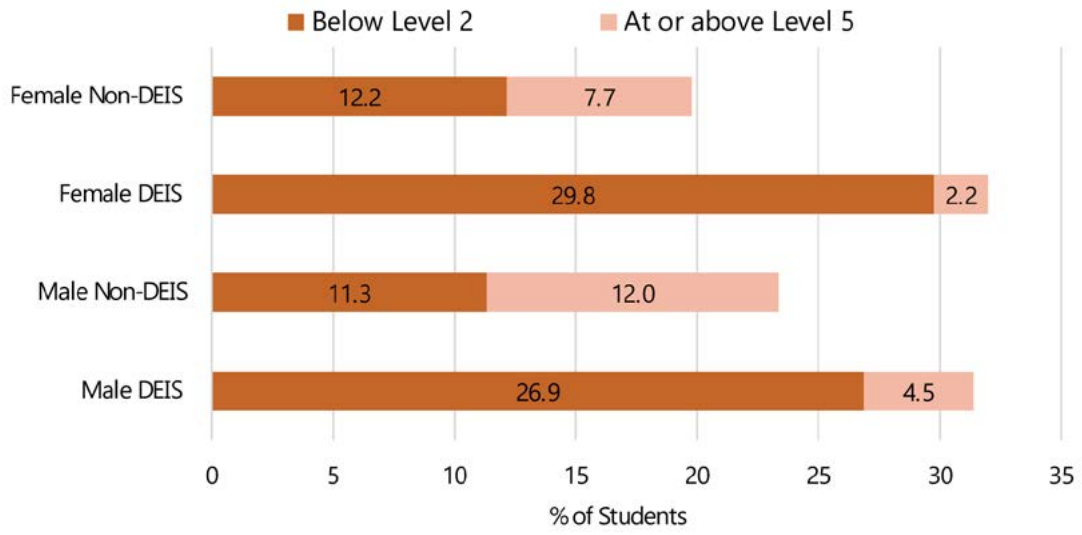
There was no significant difference in the average mathematics achievement of male and female students in Ireland (McKeown et al., 2019). Similarly, there were no significant gender differences in mathematics in DEIS schools. However male students significantly outperformed female students in non-DEIS schools (Table 4.3). Girls in DEIS schools had a mean mathematics score of 460.9 and boys had a mean mathematics score of 470.4. Both of these were considerably lower, in the order of half an international standard deviation, than the corresponding scores in non-DEIS schools (505.7 and 515.2, respectively).

Table 4.3: PISA 2018 mean mathematics achievement (SE) by gender (DEIS and non-DEIS)

Gender	DEIS	Non-DEIS
	Mean (SE)	Mean (SE)
Male	470.4 (5.29)	515.2 (3.25)
Female	460.9 (5.43)	505.7 (2.82)

The percentages of male and female students in DEIS and non-DEIS schools at key proficiency levels is illustrated in Figure 4.3. As previously noted, students in DEIS schools had an overall lower average score in mathematics, and this is reflected in the percentages classified as low achievers. Both males (26.9%) and females (29.8%) in DEIS schools were about two-and-a-half times more likely than their counterparts in non-DEIS schools to be classified as low achievers, i.e., achieve a mathematics score below Level 2. The percentages of high achieving males (4.5%) and females (2.2%) in DEIS schools were also significantly lower than the corresponding percentages in non-DEIS schools (12.0% and 7.7%, respectively).

Figure 4.3: Percentages of male and female students in DEIS and non-DEIS schools at the proficiency levels: below Level 2 and at or above Level 5 in mathematics



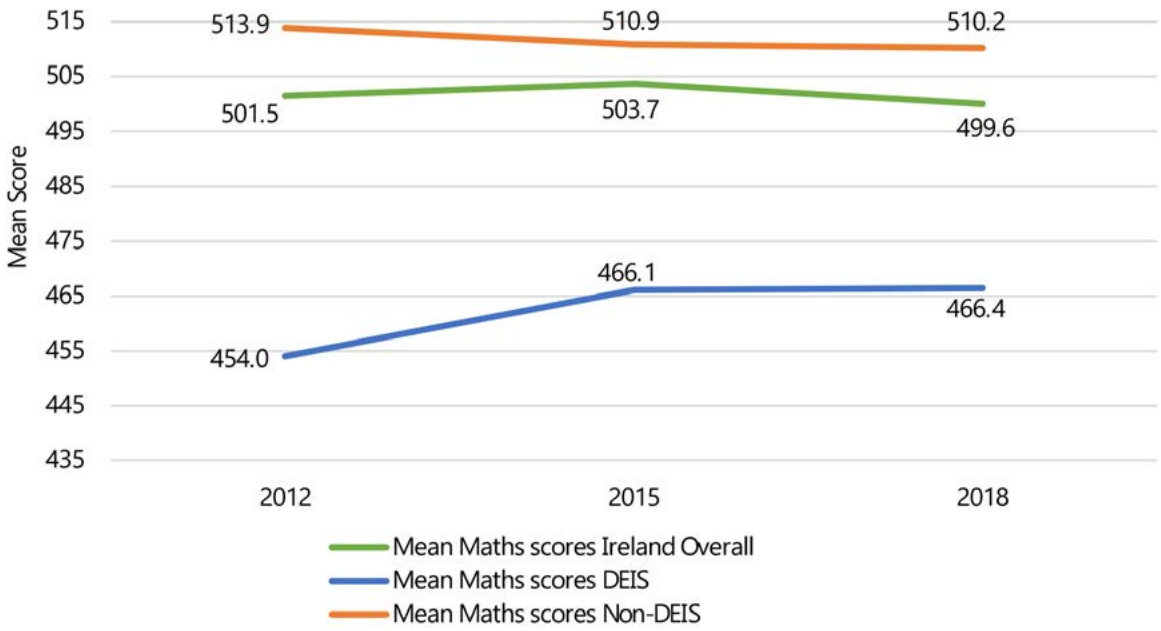
Trends in mathematical performance and proficiency levels

Trends in overall mathematics performance

Trend analysis of performance in mathematics begins at the PISA 2012 cycle when mathematics was last the major assessment domain. Figure 4.4 shows the mean scores for mathematics from PISA 2012 to 2018 for students attending DEIS and non-DEIS schools (the national average is included for comparison). Across all students in Ireland, there were no significant differences in 2018 mathematics performance compared with the previous two cycles (McKeown et al., 2019). Similarly, for students in DEIS schools, there were no statistically significant changes in achievement in this

period (although the average mathematics score in DEIS schools in 2015 was about 12 points higher than in 2012). Students in non-DEIS schools also demonstrate no significant increase or reduction in mathematics performance since 2012 (Figure 4.4). Thus performance in mathematics has been largely stable in the period 2012 to 2015 and while not statistically significant, there has been a slight improvement in the mean mathematics scores in DEIS schools.

Figure 4.4: Mean PISA mathematics scores 2012 – 2018 (DEIS, non-DEIS, and Ireland)



The achievement gap in mathematics between students in DEIS and non-DEIS schools was somewhat smaller in 2018 (44 points) than in 2012 (60 points). Although this difference is not statistically significant at the conventional 95% level of statistical significance, it may be considered to be of borderline significance ($p = .07$). (The corresponding gap in reading reduced by 20 points with $p = .03$, see Trends in Overall Reading Performance in Chapter 3). These findings are encouraging, and it will be important to revisit them in PISA 2022, when mathematics is once again a major domain.

Trends in mathematics proficiency levels

Whilst there was no significant change in mean performance in mathematics, it is also of interest to examine the percentages of students achieving at the lower and high levels of proficiency as reducing the percentages of low achievers and increasing the percentages of students at higher levels is a key focus of the DEIS Plan 2017 (DES, 2017a) and was discussed above with respect to targets for 2020.

There has been a decrease in the percentage of low achievers in mathematics (i.e., below Level 2) in DEIS schools in the period from 2012 to 2018 (Figure 4.5). In 2012, 37.4% of students were categorised as having the lowest levels of achievement in mathematics and this dropped significantly to 29% in 2015. In 2018, 28.1% of students in DEIS schools had mathematics scores below Level 2 which is again significantly lower than in 2012. While this represents a welcome drop of 9.3%, over a quarter of students in DEIS schools continue to perform at the lowest levels in mathematics

and there was no significant change between 2015 and 2018. While the percentage of low achievers in mathematics in DEIS schools decreased between 2009 and 2012, no corresponding change in the percentages of students below Level 2 took place in non-DEIS schools during the same time period.

Figure 4.5: Percentages of students below Level 2 in mathematics, 2012 – 2018 (DEIS, non-DEIS, and Ireland)

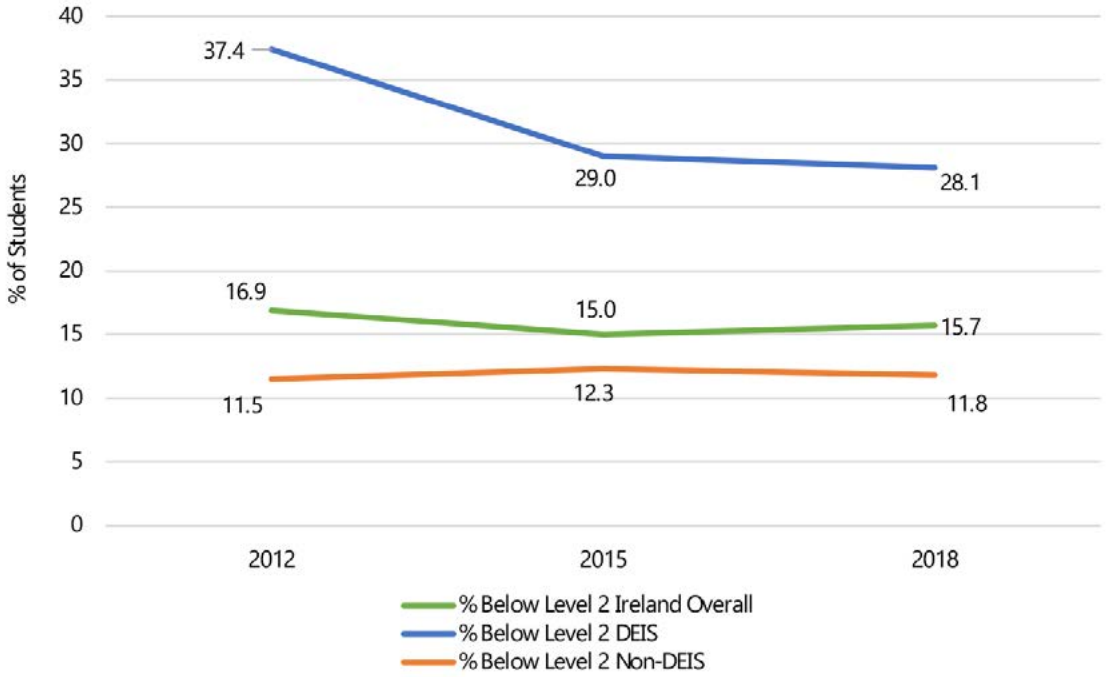
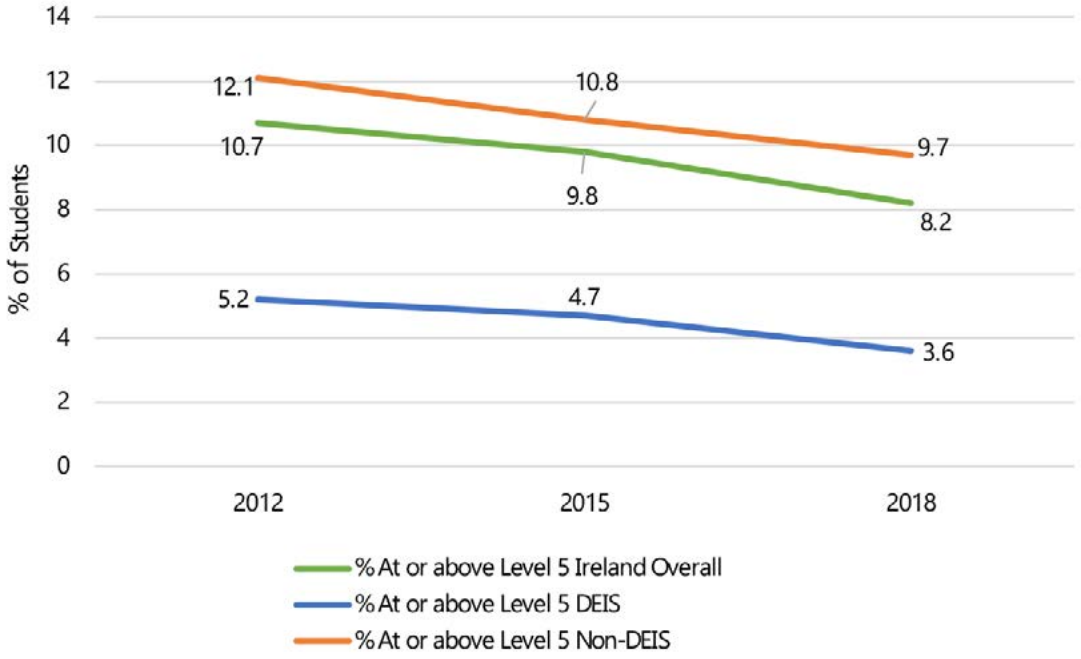


Figure 4.6 shows the percentages of high achievers in mathematics in DEIS and non-DEIS schools in each PISA cycle from 2012 to 2018. In 2018, the percentage of students in DEIS schools who performed at or above Level 5 in mathematics was 3.6% and this does not differ significantly from the percentages in 2015 (4.7%) or 2012 (5.2%). For students in non-DEIS schools, there is a significantly lower percentage of students at or above Level 5 in mathematics in 2018 (9.7%) compared to 2012 (12.1%). Again, it will be important to revisit this in PISA 2022 with mathematics once again as the major domain.

Figure 4.6: Percentages of students at or above Level 5 in mathematics, 2012 – 2015 (DEIS, non-DEIS, and Ireland)



Summary

The average mathematics performance of students in DEIS schools is significantly lower (43.8 points, two-fifths of an international standard deviation or just over half a proficiency level) than the performance of their peers in non-DEIS schools. In addition, the performance of students in DEIS schools is significantly lower than the OECD average score. The percentage of low achievers in mathematics is about two-and-a-half times higher in DEIS schools (28.1%) than in non-DEIS schools (11.8%). These figures can be compared with the international picture where on average across the OECD, a quarter of students were classified as low achievers. Conversely, there were comparatively fewer high achievers in DEIS schools compared to non-DEIS schools (3.6% vs 9.7%). On average across the OECD, 10.9% of students were high achievers in mathematics. It is undoubtedly of concern that so few students in Ireland and particularly in DEIS schools achieve at the highest levels in mathematics.

There were no significant gender differences in overall mathematics performance in DEIS schools, but male students significantly outperformed females students in non-DEIS schools (+9.5 points). This is similar to the average across OECD countries where boys outperformed girls by 5 score points.

Average performance in mathematics of students in DEIS and non-DEIS schools has been largely stable since PISA 2012 (when mathematics was last the main domain). Across the three cycles considered here, students in DEIS schools had significantly lower average scores than students in non-DEIS schools. While not statistically significant, there has been a slight improvement in the mean mathematics scores in DEIS schools between 2012 and 2015. The achievement gap in mathematics between students in DEIS and non-DEIS schools was somewhat smaller in 2018 (44 points) than in 2012 (60 points) although this difference does not reach statistical significance. These are encouraging findings and it will be of interest to revisit these trends when

the PISA 2022 data become available (as mathematics will once again be a major domain in 2022).

Turning to trends in proficiency levels, there has been a significant reduction since 2012 in the percentage of students in DEIS schools at the lowest level of proficiency (below Level 2). This is a promising finding although it is of concern that no further improvement was seen between 2015 and 2018. Again, there is value in revisiting this finding in 2022.

There has been no increase in the percentages of students in DEIS schools performing at the highest levels in mathematics and in fact the trend across both DEIS and non-DEIS schools is for a slight decrease in the percentages of high mathematics achievers. Although not statistically significant in the DEIS context, the findings suggest a need for further focus on the small percentages of high achievers in DEIS schools. While the decline in the percentage of low achievers in mathematics in DEIS schools since 2012 is to be welcomed, the mathematics achievement gap between students in DEIS and non-DEIS schools in 2018 confirms the need for continued supports for mathematics for students in DEIS settings.

Chapter 5: Scientific Literacy

Scientific literacy is the third and final of the core domains assessed in PISA 2018. It refers to "both a knowledge of science and science-based technology" (OECD, 2019d, p. 98). The OECD notes that science is a compulsory subject in many education systems around the world, and that it is widely considered to be of such importance that many argue it should be a part of every young person's education (OECD, 2019). The OECD international findings for scientific literacy in PISA 2018 have been described in detail in one of the international reports (OECD, 2019a), and the performance of students in Ireland is described in the initial national report (McKeown et al., 2019). This chapter describes the achievement in scientific literacy of students attending DEIS schools and compares it to that of students in non-DEIS schools. Similar to mathematics, since science is a minor domain in PISA 2018, the student questionnaire did not gather information on students' attitudes towards science.

PISA 2018 definition of scientific literacy

The OECD defines scientific literacy is as:

Scientific literacy - the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person, therefore, is willing to engage in reasoned discourse about science and technology, which requires the competencies of explaining phenomena scientifically; evaluating and designing scientific enquiry; and, interpreting data and evidence scientifically (OECD, 2019a p. 100).

The term "scientific literacy" rather than "science" is used to emphasise the importance placed on the application of scientific knowledge in the context of real-world situations. As previously noted, scientific literacy refers both to a knowledge of science and of science-based technology and is understood to be developed through education that is broad and applied. According to the PISA framework, scientific literacy requires both knowledge of the concepts and theories of science and a knowledge of the common procedures and practices associated with scientific enquiry. It also requires an understanding of how the procedures and practices associated with scientific enquiry enable science to advance.

Assessment items for PISA 2018 cover varied contexts such as health and disease, natural resources, environmental quality, hazards, and the frontiers of science and technology. Key competencies assessed are: the ability to explain phenomena scientifically; to evaluate and design scientific enquiry; and to interpret data and evidence scientifically (OECD, 2019d). Scientific literacy was the major domain in PISA 2015, and as such is a minor domain in PISA 2018. This means that there were fewer test items in 2018 measuring scientific literacy and subscales are not reported for this domain.

Ireland's scientific literacy results in PISA 2018

Key international findings on achievement in scientific literacy and the scientific literacy performance in Ireland for PISA 2018 are presented in Table 5.1. Ireland's average score in scientific literacy was significantly above the corresponding OECD average; however, the country's ranking (17th out of 37 OECD countries) was lower than the ranking achieved in reading (4th out of 36 OECD countries, see Chapter 3) but about the same as that in mathematics (16th out of 37 OECD countries, see Chapter 4).

Table 5.1: Key Scientific literacy findings from PISA 2018*

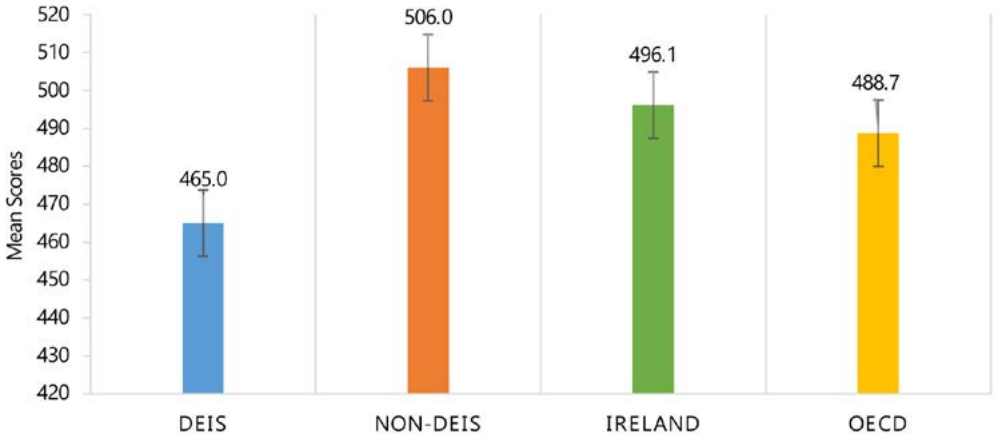
- The OECD average score in scientific literacy was 488.7. The average score on scientific literacy in Ireland was 496.1.
- Irish students ranked 17th out of 37 OECD countries, and 22nd out of all 78 participating countries for scientific literacy.
- On average across OECD countries, 78% of students attained Level 2 or higher in scientific literacy. In Ireland, the corresponding percentage was 83%.
- In Ireland, 17.0% of students performed at the lowest levels of science proficiency (below Level 2) and 5.8% performed at the highest proficiency levels (at or above Level 5).

** Based on McKeown et al. (2019) and OECD (2019b).*

Scientific literacy performance of students in DEIS and non-DEIS schools

This section compares performance in scientific literacy for students attending DEIS and non-DEIS schools. The national and OECD averages are provided to contextualise the DEIS and non-DEIS scores. With a mean score of 465, the scientific literacy performance of students attending DEIS schools was significantly lower than the performance of students in non-DEIS schools (mean score 506, Figure 5.1). The difference between the two amounts to 41 score points which is equivalent to two-fifths of an international standard deviation. The average performance of students in DEIS schools was below both the OECD and national averages. On the other hand, students in non-DEIS schools (mean score 506) scored above both the OECD average (17.3 score point difference) and the national average (9.9 score point difference).

Figure 5.1: Mean scores in PISA 2018 scientific literacy (DEIS, non-DEIS, Ireland, and OECD)



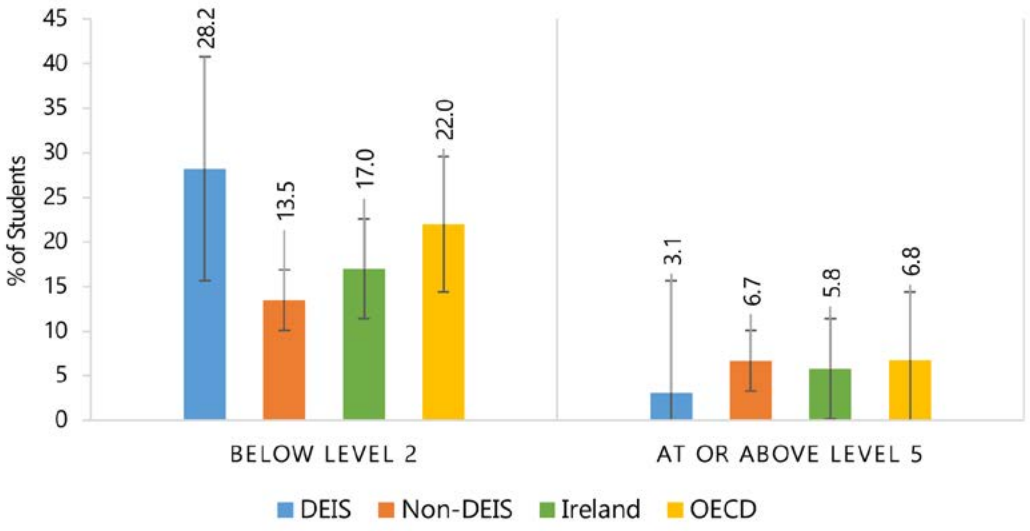
Scientific proficiency levels of students in DEIS and non-DEIS schools

As with reading and mathematics, achievement in scientific literacy is described by various proficiency levels. The focus of this section is on the percentages of students below Level 2 and at or above Level 5 in scientific literacy. These categories were selected for continuity with earlier chapters where it was noted that the percentages of students in these achievement groups are highlighted as key targets in the DEIS Plan 2017 (DES, 2017a). However, unlike reading and mathematics, the DEIS Plan 2017 does not specify targets for science.

Students who achieve scores in scientific literacy below Level 2 are considered to be low achievers. The percentage of students at or below Level 2 is higher in DEIS schools (28.2%), and is just over twice as high as in non-DEIS schools (13.5%, Figure 5.2). The average percentage of students performing below Level 2 across OECD countries was 22%. At this level, students can use basic or everyday scientific knowledge to recognise aspects of familiar or simple phenomenon and to answer questions involving familiar contexts.

A very small percentage of students in DEIS schools (3.1%) were high achievers in scientific literacy (i.e., had achievement scores at or above Level 5). This compares to 6.7% of students in non-DEIS schools (Figure 5.2). The average percentage of students performing at or above Level 5 across OECD countries was 6.8%. While the percentage of high achievers in scientific literacy was significantly higher in non-DEIS schools than in DEIS schools, the percentage of high achievers in scientific literacy in non-DEIS schools is considerably lower than the corresponding percentage in reading (14.2%, see Chapter 3) and somewhat lower than in mathematics (9.7%). Students who achieve scientific literacy scores at or above Level 5 can use abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. They can draw on a range of interrelated scientific ideas and concepts from the physical, life and earth and space sciences and can evaluate competing designs of complex experiments, field studies or simulations and justify their choices (OECD, 2019a, p. 113).

Figure 5.2: Percentages of low and high achieving students in scientific literacy (DEIS, non-DEIS, Ireland, and OECD)



Gender differences in scientific literacy

There was no significant difference in the scientific literacy performance of males (495.4 points) and females (496.9 points) in Ireland (McKeown et al., 2019). Similarly, there is no gender difference in achievement in scientific literacy in either DEIS or non-DEIS schools (Table 5.1).

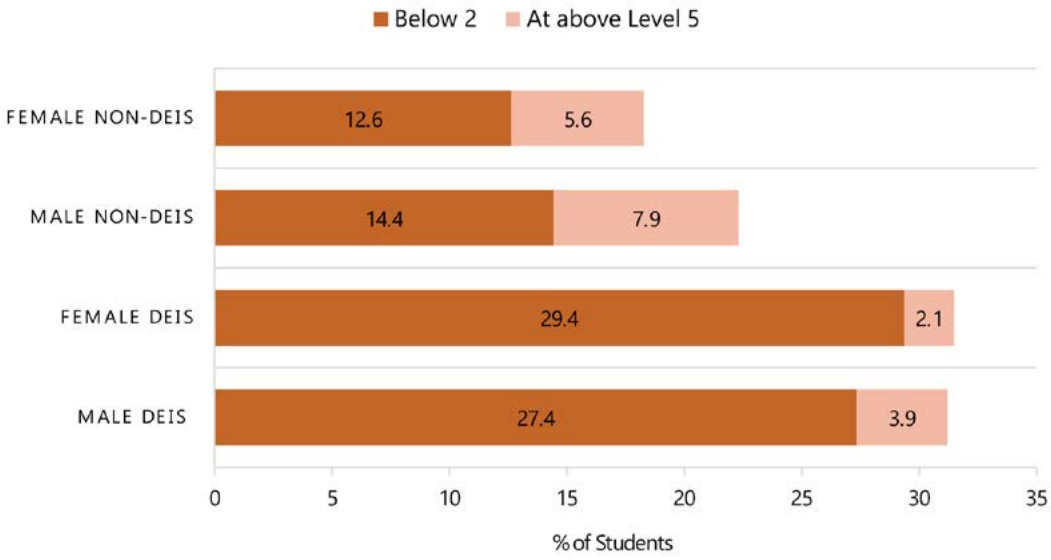
For DEIS and non-DEIS schools separately, Figure 5.3 presents the percentages of male and female students who had scientific literacy scores below Level 2 and at or above Level 5. There are no substantive gender differences in the percentages in each category in either DEIS or non-DEIS schools.

Table 5.1 Mean (SE) scientific literacy scores for Male and Female students in DEIS and non-DEIS schools

Gender	DEIS	Non-DEIS
	Mean (SE)	Mean (SE)
Male	467.1 (5.45)	506.4 (3.66)
Female	462.1 (5.85)	505.6 (2.81)

Over one-quarter of males (27.4%) and females (29.4%) in DEIS schools had scientific literacy achievement below Level 2, and very small percentages had achievement at or above Level 5 (2.1% of females, 3.9% of males). In non-DEIS schools, the percentage of males (14.4%) and females (12.6%) below Level 2 was about half that in DEIS schools. Conversely, there were higher percentages of high achievers in non-DEIS schools than in DEIS schools (Figure 5.3).

Figure 5.3: Percentages of male and female students in DEIS and non-DEIS schools at the proficiency levels: below Level 2 and at or above Level 5 in scientific literacy

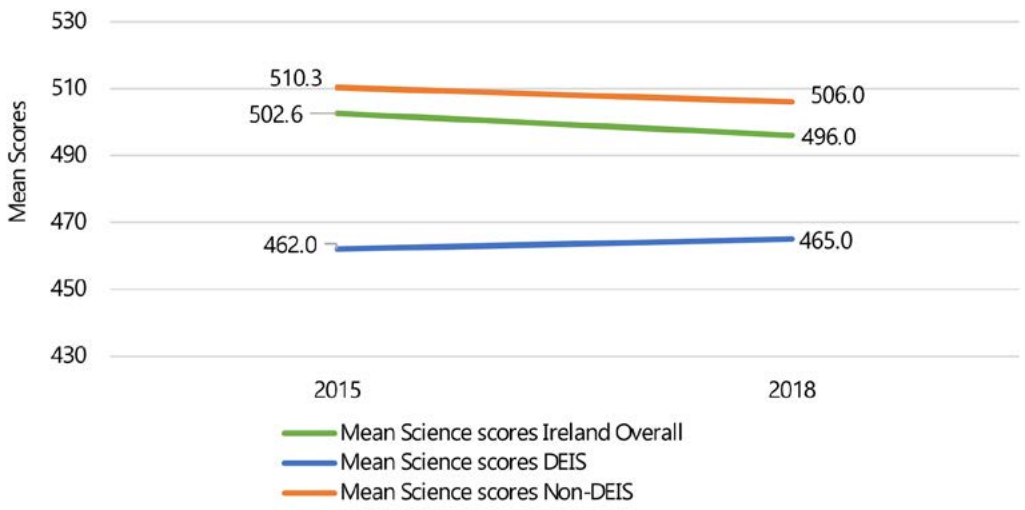


Trends in scientific performance and proficiency levels

Trends in overall scientific literacy performance

Scientific literacy was the major domain in PISA 2015 and therefore, PISA 2018 performance can be most appropriately compared with this cycle. Figure 5.4 shows scientific literacy mean scores for 2015 and 2018 for students attending DEIS and non-DEIS schools (the national mean for each cycle is included for reference). Students in non-DEIS schools significantly outperformed students in DEIS schools in science in both of these PISA cycles. There were no significant changes in science performance for students in either DEIS or non-DEIS schools between cycles.

Figure 5.4: Mean PISA scientific literacy scores 2015 – 2018 (DEIS, non-DEIS, and Ireland)



With only two time points, it is not possible to reliably comment on how the achievement gap between students in DEIS and non-DEIS schools is changing. While the gap in 2018 (41 points) is slightly smaller than that in 2015 (48 points), this is largely accounted for by a very small decrease in the average non-DEIS science score.

Trends in scientific literacy proficiency levels

Trends in the percentages of students at various proficiency levels from PISA 2015 to PISA 2018 are examined in this section. There were no significant changes in the percentages of low achievers in either DEIS or non-DEIS schools when 2018 was compared to 2015 (Figure 5.5). However, in both cycles, there were higher percentages of low achievers in DEIS schools compared to non-DEIS schools.

In both cycles, the percentages of students at the highest level of achievement (i.e., at or above Level 5) was greater in non-DEIS schools compared to DEIS (Figure 5.6). There was no significant change between 2015 and 2018 in the percentages of high achievers in science in either DEIS or non-DEIS schools. Although the percentage of high achievers in Ireland overall dropped from 7.1% in 2015 to 5.8% in 2018, this difference is not statistically significant (McKeown et al., 2019).

Figure 5.5: Percentages of students below Level 2 in scientific literacy, 2015 – 2018 (DEIS, non-DEIS, and Ireland)

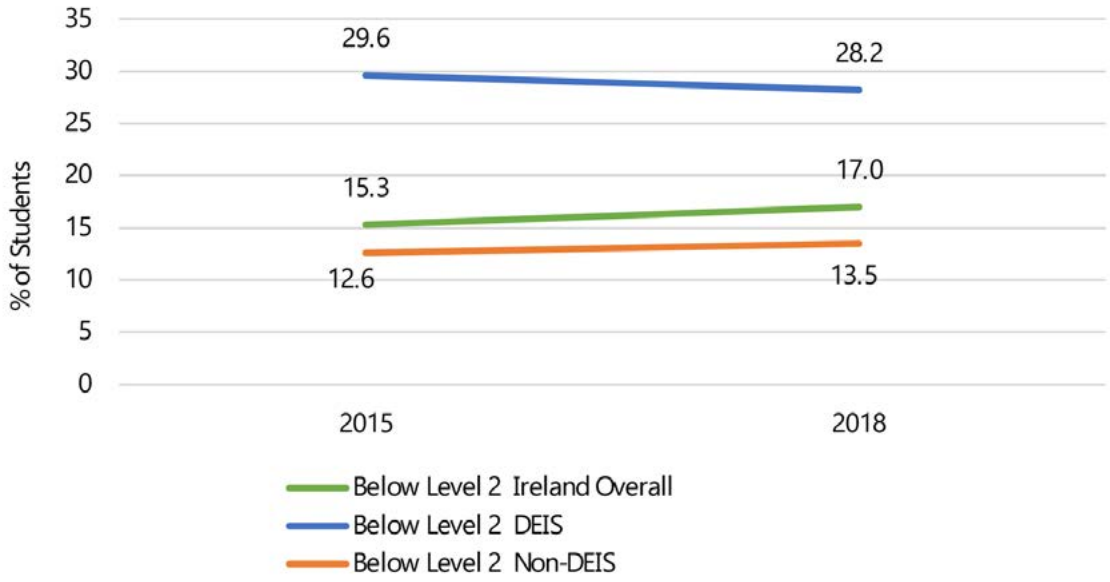
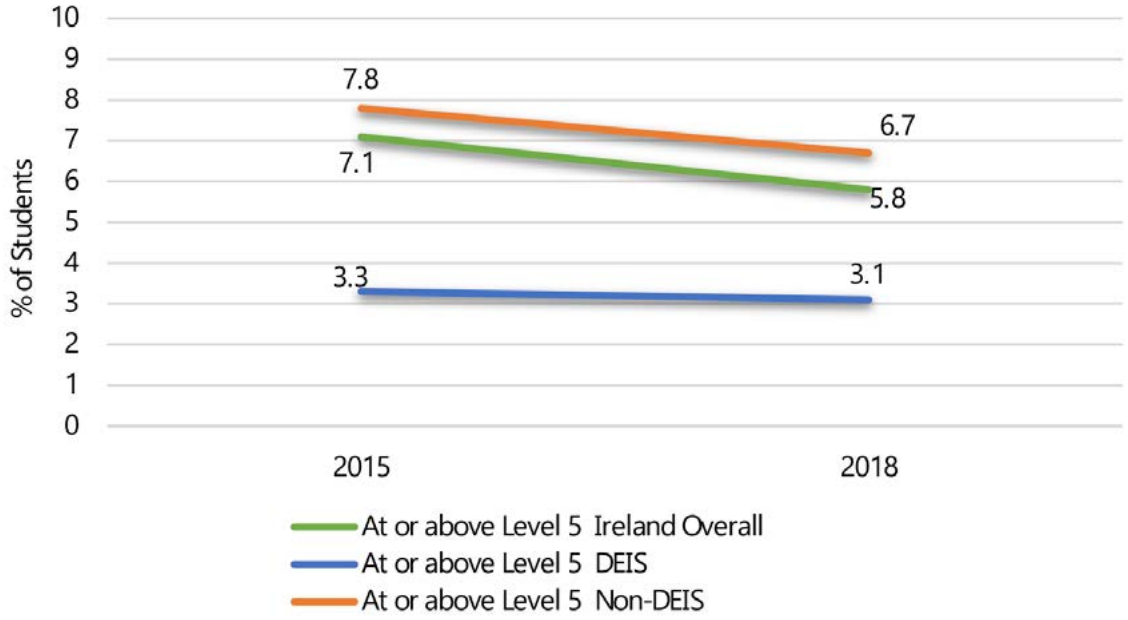


Figure 5.6: Percentages of students at or above Level 5 in PISA 2018 scientific literacy, 2015 – 2018 (DEIS, non-DEIS, and Ireland)



Summary

As in reading and mathematics, the achievement gap between students in DEIS and non-DEIS schools is apparent in the domain of scientific literacy. Students attending DEIS schools had significantly lower mean performance in science compared to students in non-DEIS schools. The 41-point difference in science in 2018 between DEIS and non-DEIS schools equates to about half a proficiency level. Almost three in 10 students in DEIS schools are classified as low achievers (28.2%) on the basis of having science scores below Level 2, which is about twice the percentage of students in non-DEIS schools (13.5%). Students classed as low achievers demonstrate only a basic understanding of scientific knowledge. There are very small percentages of high achievers in science in DEIS schools (3.1%) compared to students in non-DEIS schools (6.7%). In general across EU countries, the percentage of high achievers in science is lower than the corresponding percentages for reading and mathematics (European Commission, 2019).

There were no gender differences in scientific literacy in Ireland, with similar percentages of males and females at each of the considered proficiency levels. No gender differences were apparent in either DEIS or non-DEIS schools. There were no significant changes in science performance between 2015 and 2018 in either DEIS or non-DEIS schools. The achievement gap between students in DEIS and non-DEIS schools was about the same in 2015 (48 points) and in 2018 (41 points). The STEM Education Policy Statement 2017–2026 (DES, 2017b) aims to address the achievement gap in STEM subjects between students in DEIS and non-DEIS schools. Based on the two PISA cycles examined in this chapter, there is no evidence of a reduction thus far.

Chapter 6: Discussion and Conclusions

PISA assesses the achievement levels of 15-year-olds nearing the end of compulsory education in the knowledge and skills that will help them in future study and employment (OECD, 2019d). Overall, the record of achievement for Ireland in PISA 2018 was positive, with a high ranking in reading and positive results in both mathematics and science (McKeown et al., 2019). Further analysis in this report compared the achievements of students in DEIS and non-DEIS schools in PISA 2018. PISA may be regarded as a high-quality source of information on student achievement and contextual factors in an internationally comparative context. This provides participating countries with robust, reliable data to use for monitoring outcomes over time in both national and international contexts. Its focus on the population of 15-year-olds and its complex study design, however, mean that PISA is not designed explicitly to monitor the outcomes of students in DEIS schools with a high degree of precision. That said, PISA provides a wealth of information to inform and monitor achievement outcomes in DEIS schools at a broad level.[16] In this chapter, findings from the report are summarised and discussed in relation to the wider literature and Irish policy dealing with educational disadvantage. Gender differences and trends in performance are discussed. Further consideration is also given to the appropriateness and limitations of using PISA for the evaluation and monitoring of DEIS.

Achievement of students in DEIS and non-DEIS schools in PISA 2018

Reading literacy and engagement

There is a substantial gap (51.2 points) in reading achievement between students in DEIS (479.2 points) and non-DEIS (530.4 points) schools. This difference corresponds to over half an international standard deviation. The pattern of overall mean reading achievement differences in DEIS and non-DEIS schools was broadly consistent across the three reading subscales. Although the achievement difference between students in DEIS and non-DEIS schools in reading in PISA 2018 is substantial, a positive outcome from PISA 2018 is that, despite the national reading achievement gap, the average reading achievement of students in DEIS schools was at the level of the OECD average. A further positive outcome from PISA 2018 is that achievement disparities in Ireland are lower than on average across the OECD: when the achievement levels of students from the bottom and top quarters on economic, social and cultural status (ESCS) are compared, the reading achievement gap between advantaged and disadvantaged students is lower in Ireland (75 points) than on average across OECD countries (89 points) (OECD, 2019b).

Consistent with DEIS/non-DEIS differences in mean reading scores, there is a much greater percentage of students in DEIS schools at the lowest reading proficiency levels (below Level 2; 21.8%) and a much lower percentage at the highest reading

16 A subsequent report, due in 2021, also drawing on PISA 2018 dataset, will add to the information in the current report by drawing on the rich contextual data available through the context questionnaires.

levels (at or above Level 5; 5.5%) compared to students in non-DEIS schools (8.6% and 14.2%, respectively). Level 2 is considered by the OECD to be the minimum level of proficiency required for successful participation in work and society (OECD, 2019d). Hence, a significant minority of 15-year-olds in DEIS schools are not meeting the OECD minimum reading standards. These concerns have given rise to using PISA data to inform national targets for literacy and numeracy. The use of PISA for target setting is discussed later in this chapter.

There is an established gender difference in reading with females outperforming males across many PISA cycles (OECD, 2011a), and in most countries internationally (Stoet & Geary, 2018; OECD, 2015). This female advantage was noted in overall reading performance in both DEIS and non-DEIS schools and across all reading subscales in PISA 2018. While females have a higher average reading score than males, it cannot be overlooked that about one-in-five girls in DEIS schools have reading scores below Level 2 and are therefore considered to be low achievers in reading. Females in DEIS schools were significantly more likely than males in DEIS schools to report having difficulty with reading, despite having a significantly higher average reading scores than their male counterparts. This could reflect differences in how boys and girls in DEIS schools are evaluating their own reading difficulties and is worth examining further.

Sizeable percentages of male (23.9%) and female (18.9%) students scored at the lowest reading proficiency levels (below Level 2) in DEIS schools. These percentages were considerably higher than in non-DEIS schools where 11.7% of males and 5.9% of females were below Level 2 in reading. In DEIS schools, a similar percentage of males (5.4%) and females (5.5%) were at or above Level 5 in reading. These were considerably lower than in non-DEIS schools where 12.2% of males and 15.9% of females were high achievers in reading.

It has been found internationally that underachievement is highest when male students attend schools with large number of students from a disadvantaged backgrounds (OECD, 2015). Gender differences in reading literacy performance were similar across DEIS and non-DEIS schools, with the corollary being that the performance of both boys and girls is equally affected by educational disadvantage. This contrasts with some previous research where evidence was found of a 'gender effect' whereby boys in disadvantaged school contexts did comparably less well than their female counterparts in Junior Certificate English and Mathematics (Sofroniou, Archer, & Weir, 2004). The current report does not explore the social context/multiplier effect in Ireland although future research could usefully re-examine the issue at primary and post-primary level with recent national and international datasets.

In examining trends in reading performance, there have been significant improvements in reading performance in both DEIS and non-DEIS schools when 2018 results are compared to 2009. However, there were no significant differences between 2018 performance and that of the previous PISA cycle in 2015. The main change in performance is between the 2009 and 2012 cycles with very limited changes or improvements since then. In 2009, there was a reading achievement gap of about 70 points between students in DEIS and non-DEIS schools. In 2015 and 2018, the corresponding gap was about 50 points. This is a positive finding and is to be welcomed.

However, the situation has remained rather static since 2012 so it is important that the focus remains on the need for continuing improvement.

It is useful to consider how these findings from PISA reading relate to analyses of trends in Junior Certificate English performance. Analysis of trends in performance in Junior Certificate English showed a narrowing of the gap between students in DEIS and non-DEIS schools between 2002 and 2016 (Weir & Kavanagh, 2018) . They reported an increase in overall Junior Certificate achievement in DEIS schools between 2002 and 2016 that equated to an approximate increase of one letter grade.[17] In contrast, the increase in overall performance in the period in non-DEIS schools was not of sufficient magnitude to increase the average grade. The findings from PISA 2018 reported here provide some corroborating evidence for the improvements observed in Junior Certificate performance. The PISA 2018 performance shows some evidence of a closing in the reading achievement gap between DEIS and non-DEIS schools and ideally this gap will reduce further over time.

Student engagement with reading and positive attitudes towards reading are related to overall reading achievement. Students who are more proficient in reading have been found to read more often, show an interest in reading, and feel confident in their own reading ability (OECD, 2019d, p. 26). We found a strong relationship between enjoyment of reading and reading performance for all students, which is similar to other research indicating that engagement in reading such as interest, intrinsic motivation and practices are associated with reading achievement (Klauda & Guthrie, 2015; Troyer, Kim, Hale, Wantchekon, & Armstrong, 2019). A lower percentage of students in DEIS schools reported they liked reading for enjoyment compared to students in non-DEIS schools. In both DEIS and non-DEIS schools, female students reported higher levels of enjoyment of reading than males. Males students in DEIS schools reported the lowest levels of enjoyment of reading. These low levels of reading enjoyment mirror their overall lower reading performance. This gendered relationship between reading engagement and achievement has been noted across PISA cycles with female students found to report more positive views on reading, more frequent leisure reading, and higher reading achievement than males (OECD, 2011b).

According to the OECD, student engagement and attitudes to reading could be improved through intervention which would in turn help to improve reading proficiency and reduce achievement gaps between groups of students (Barber & Klauda, 2020; OECD, 2019d, p. 51). Finding ways to lessen the disengagement of boys in reading is particularly important in the DEIS context. Gender preferences in reading preferences have been noted, and texts such as newspaper articles, comics, and computer-based text may appeal more to boys (Smith & Wilhelm, 2002).

Internationally, students from socio-economically disadvantaged backgrounds report lower levels of motivation and less positive approaches to learning than students from more advantaged backgrounds (OECD, 2011b). In PISA 2018, student motivation in relation to reading was examined. Reading self-concept was defined as student perceptions of competence in reading and difficulties encountered with reading. Students' self-concept, or their belief in their own abilities, is related to successful

17 A revised grading system began in 2017, applied to English in the first instance. Details are available at https://www.examinations.ie/?l=en&mc=ca&sc=ma.

learning (Guo, et al., 2016). Findings in this report show that perceived competence was positively associated with reading performance and perceived difficulties were negatively associated with performance. Reading competency ratings were higher amongst students in non-DEIS schools compared to students in DEIS schools and also higher in females compared to males. This is consistent with the overall PISA 2018 finding that girls were more likely than boys to report greater perceived competence in reading, and this is to be expected as their reading performance is higher (OECD, 2020a).

Males in DEIS schools reported reading difficulties at the OECD-average level while female students in DEIS reported above-average difficulties with reading. This was despite male students in DEIS schools having lower average reading achievement than their female counterparts. Similar findings emerged across many countries with girls reporting more difficulty with reading than boys despite having higher average reading achievement. This may be suggestive of a confidence issue for females or it may be the case that female students have a greater awareness of their difficulties and the need for improvement in reading performance (OECD, 2020a).

Mathematical literacy

Mathematical literacy in PISA assesses the ability of students to use mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It asks more of the students than the mathematical concepts learned in the classroom by requiring the application of this knowledge (OECD, 2019a, p. 104). Findings in this report show that students in DEIS schools had a significantly lower average score in mathematics than students in non-DEIS schools (43.8 points, two-fifths of an international standard deviation). The performance of students in DEIS schools was significantly lower than the OECD average score.

Focusing on low and high achievers in PISA 2018, this report shows that the percentage of low achievers in mathematics in DEIS schools (28%) was about two-and-a-half times that in non-DEIS schools (12%). The corresponding OECD average was 24% (OECD, 2019a). There were comparatively fewer high achievers in DEIS schools compared to non-DEIS schools (3.6% vs 9.7%). Across the OECD, the average percentage of high achievers in mathematics was 10.9%. According to the OECD criteria, over 1 in 4 students in the DEIS schools may have difficulty with the mathematical knowledge and skills required for future education and work.

There was no statistically significant gender difference in overall mathematics performance in DEIS schools, although in non-DEIS schools, male students had a significantly higher mean mathematics score than females. In both contexts, the difference between males and females was just under 10 points but one consequence of having a larger number of non-DEIS students in the sample is that standard errors are smaller for non-DEIS students. Therefore, because of the greater precision attached to non-DEIS estimates, differences are more likely to be statistically significant in that context. Male and female performance across the proficiency levels was consistent. Typically there has been a gender gap with females performing less well in mathematics than males (OECD, 2015) but this effect is evident only in the non-DEIS schools in the Irish context for PISA 2018.

Trend analysis for mathematics in the current report showed no significant changes in the average scores of students in DEIS schools between 2012 and 2018. Furthermore, the PISA mathematics achievement gap between students in DEIS and non-DEIS has not changed significantly between 2012 and 2018. Trend analysis of Junior Certificate mathematics performance between 2002 and 2016 found both an improvement in mathematics scores over time and a narrowing of the achievement gap between DEIS and non-DEIS schools in the period (Weir & Kavanagh, 2018). While in the current report, the narrowing of the gap between DEIS and non-DEIS schools was not statistically significant, the gap was somewhat narrower in 2018 than in 2012 (reduced from a 60-point gap to a 44-point gap). This may be considered to represent a modest, welcome, improvement but with further improvements needed over time.

It is notable that compared to PISA 2012, there was a significantly lower percentage of students in DEIS schools at the lowest level of proficiency in mathematics. This is a promising finding which is in line with aims of the DEIS Plan 2017 (DES, 2017a) to reduce the percentages of low achievers in mathematics in DEIS schools. However, there remains a large group of students in the DEIS context who lack the mathematical knowledge and skills required for future life, education and work (OECD, 2019d). Furthermore, the main improvement was between 2012 and 2015 with no change between 2015 and 2018. The percentages of students in DEIS schools performing at the highest levels in mathematics did not improve from 2012 to 2018 and suggests a need for further focus on the small percentages of high achievers in DEIS schools. The issue of using PISA for target setting is discussed later in this chapter.

Scientific literacy

Scientific literacy in PISA assesses the students' ability to engage with science-related issues and with the ideas of science, as reflective citizens. Comprehension of science is useful not only for future learning or employment but is a skill required by all to understand world issues (OECD, 2019a, p. 112). The STEM Education Policy Statement 2017-2026 (DES, 2017b) and the Better Outcomes Brighter Futures: The national policy framework for children and young people 2014-2020 (Department of Children and Youth Affairs, 2014) both note the need to reduce the gap in achievement in STEM subjects between students in DEIS and non-DEIS schools.

As in reading and mathematics literacies, the achievement gap between students in DEIS and non-DEIS schools is evident in the domain of scientific literacy. Students attending DEIS schools have significantly lower mean performance in scientific literacy (41 points) compared to students in non-DEIS schools and compared to the OECD average. There were no significant changes in average science performance between 2015 and 2018 cycles in either DEIS or non-DEIS schools.

In 2018, about a quarter of students in DEIS schools were classified as low achievers on the basis of having science scores below Level 2. These students demonstrate a basic understanding of scientific knowledge. There are small percentages of high achievers in science in DEIS schools (3.1%) compared to non-DEIS schools (6.7%). Across EU countries, the percentages of high achievers in science are lower than the corresponding percentages in reading and mathematics (European Commission, 2019). There was no significant reduction in the achievement gap between students

in DEIS and non-DEIS schools the 2015 and 2018 PISA cycles.

There were no significant gender differences in scientific literacy in Ireland overall, with similar percentages of males and females at each of the considered proficiency levels. No gender differences were apparent in either DEIS or non-DEIS schools. Similarly in a multi-country analysis of science literacy, male and female students were found to have comparable achievement (Stoet & Geary, 2013). It is encouraging to see this parity in achievement in science between the genders. However, it has been noted that this may not result in a greater uptake of STEM careers by females who may have high achievement in science but also in other subjects and subsequently choose non-scientific areas that are of greater interest (Stoet & Geary, 2018).

Limitations of PISA for monitoring and evaluation of DEIS

In interpreting the achievement results within this report a number of issues should be considered. Firstly, the sampling approach for PISA 2018 used the percentage of students in the school with an examination fee-waiver as a proxy indicator of socio-economic status. Currently, this is consistent with DEIS status, since the percentage of students with a medical card was one of the data sources used in the original identification of post-primary schools for DEIS (and fee-waiver is granted on the basis of family medical card possession). Notwithstanding this consistency, the PISA sample is not explicitly designed to be representative by DEIS status. By virtue of being nationally representative, including being representative by socio-economic status, the percentage of students in DEIS schools in the PISA sample is typically not significantly different to the percentage of DEIS students in the population. The current report shows that the percentage of DEIS students assessed in PISA 2018 was not significantly different to the percentage of DEIS students in the population. However, if there is a desire for PISA to be used on an ongoing basis for the purposes of monitoring standards in DEIS schools, it is important to ensure that the sample is explicitly designed with this in mind. This may entail oversampling students in DEIS schools to ensure sufficiently accurate estimates of achievement, an endeavour which would likely incur significant costs (i.e., both financial implications for the national PISA budget and operational implications for the PISA national centre). Alternative approaches to monitoring achievement in DEIS schools are discussed later.

A further complexity related to the assumption that the PISA sample will continue to be representative of DEIS schools relates to the move towards using the HP deprivation index (Haase & Pratschke, 2017) as an approach for identifying schools for DEIS (DES, 2017a). Although medical card status has been shown to be strongly correlated with the HP Index when the Health Intelligence Unit (HIU) compared multiple deprivation indices (Haase, 2017), this approach means that the PISA sample and DEIS identification no longer use a common proxy for socio-economic status. Again, if it is desirable to set policy targets for DEIS schools based on PISA data (e.g., as in the current DEIS Plan 2017), consideration should be given to using an indicator of socio-economic status in the PISA sampling process that is comparable to the socio-economic indicators used for selecting schools for DEIS. Furthermore, looking ahead, it will be important to reflect any move towards using the HP index in PISA trend comparisons for DEIS schools.

PISA has been widely accepted across countries and educational systems but it is not without its critics. While it has been argued that PISA may not be a fair assessment of what educational systems can achieve, given that it represents only the students still enrolled in school at aged 15, this criticism may be less important in the Irish context given the very high levels of retention in post-primary schooling to age 15 and beyond. Furthermore, it has been noted that achievement in the main literacies of reading, mathematics and science are, by virtue of the PISA 'literacy' approach, underpinned to some extent by reading proficiency (Eivers, 2010). A recent review levels a number of criticisms of the PISA methodology, the PISA focus on skills for future life, and questions PISA's impact on educational policy within participating countries (Zhao, 2020). PISA may be one method of evaluating and monitoring student achievement but as with any approach, the programme has its own limitations and therefore should not be used as a sole source of evidence.

Relevance of current findings to Irish educational policy

It has been shown that compared to non-DEIS schools, DEIS schools often have a higher proportion of students with additional needs (e.g., students with learning disabilities, emotional or behavioural problems, or students for whom English is an additional language) (McCoy, et al., 2014; Smyth, McCoy, & Kingston, 2015). Such needs can have an important impact on learning. In addition to these student needs, issues in the wider community such as unemployment and lack of parental involvement have been identified by principals as significant problems in DEIS schools, and these circumstances add to the challenges faced by DEIS schools (Weir, McAvinue, Moran, & O'Flaherty, 2014). It is important to situate the achievement gaps identified in the current report within the broader context of the challenges faced by students, teachers and the wider school community in DEIS schools. Understanding the particular challenges faced by students in DEIS schools may help in tailoring interventions so that maximum benefit can be derived from supports provided under DEIS.

It should also be noted that students in DEIS and non-DEIS schools are not homogenous groups and there are many students from disadvantaged backgrounds attending non-DEIS schools and vice-versa. Educational outcomes may be influenced by a range of factors such as characteristics of the students and families, such as the language of the home, parental education, access to educational resources at home and levels of disadvantage. These factors are likely to mediate the relationship between school DEIS status and the achievement results of students. A forthcoming report from the authors of the current report will present findings from PISA 2018 regarding the social background, home learning environment and school climate of students attending DEIS schools. It is hoped that the forthcoming report will help situate the achievement findings in the broader context of the home and school lives of students in DEIS schools.

It is also important to note that achievement outcomes in reading, mathematics and science represent a limited view of educational outcomes and the purpose of education. PISA 2018 also gathered data on student wellbeing, an increasingly important focus of Irish education (Government of Ireland, 2018). The forthcoming contextual report will incorporate some wellbeing-related findings from PISA 2018 for students in DEIS schools.

The National Strategy: Literacy and Numeracy for Learning and Life is clear that "mastering the skills of literacy and numeracy brings with it many social, economic and health benefits for the individual and society as a whole" (DES, 2012, p. 9). The achievement gap between students in DEIS and non-DEIS schools in PISA 2018 reading, mathematics and scientific literacies is of particular relevance to the DES National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020 (DES, 2011) and the DES National Strategy: Literacy and Numeracy for Learning and Life, 2011-2020. Interim Review: 2011–2016, New Targets: 2017–2020 (DES, 2016). An earlier review of the National Literacy and Numeracy strategy in 2016 noted little reduction in the achievement gap between students in DEIS and non-DEIS schools (DES, 2016). The current report shows some progress towards reducing the achievement gap in reading. It is positive that this gap has narrowed significantly between 2009 and 2018. Although the reduction in the mathematics achievement gap between DEIS and non-DEIS schools was not statistically significant, there is some evidence that this is also narrowing over time. In contrast, the current report found no evidence of a narrowing of the science achievement gap.

The current report notes that about one-fifth of students in DEIS schools have very low levels of reading achievement (below Level 2). Education systems need to equip all students with the minimum level of reading skills for further training and employment (OECD, 2019a). Reading is not taught as a specific subject for 15-year-old students but the OECD emphasises that current definitions of reading literacy recognise it is not an ability developed just in childhood but a more comprehensive set of skills and knowledge that is developed throughout life (OECD, 2019d, p. 27). Reading literacy is recognised as one of the most important life skills. It impacts on achievement in other academic subjects and is of significance to students in all aspects of their future lives, including employment (Cunningham & Stanovich, 1997). The cognitive skills underpinning reading literacy such as locating information understanding, evaluating and reflecting the reading texts should be fostered as early as possible. The new primary curriculum framework (in development) aims to develop student competencies that extend beyond skills and knowledge to an emphasis on locating, critiquing, and using knowledge. The curriculum aspires to develop these skills at an early stage to support post-primary learning (NCCA, 2020). Findings in this report show the need for a continued focus on reading literacy in the early years of post-primary school (building on efforts at primary level). There is a need to assess, monitor, and support students' reading difficulties using appropriate tools at post-primary level. An example of a forthcoming assessment developed in a collaboration between the National Educational Psychological Service (NEPS) and the ERC which may be useful in this context is the Post-Primary Assessment & Diagnosis – English or PPAD-E (ERC & NEPS, 2020).

Guidance on evidence-based approaches to support students struggling with literacy and numeracy have been provided in documents such as the Effective Interventions for Struggling Readers (National Educational Psychological Service [NEPS], 2019) and some of these interventions are prioritised under DEIS. Some issues with the selection (too much choice) and sustainability (loss of expertise when teachers move) of these types of initiatives have been noted (Childhood Development Initiative, 2018). It has been argued that there is a greater need for interventions at the school-level to link with support offered through community activity, and for policies such as

the numeracy and literacy strategy to place greater emphasis on the importance of parental involvement in learning (Childhood Development Initiative, 2018). A further challenge is the more limited availability of appropriate resources to support students with difficulties in mathematics compared to the availability of reading resources (for a review of evidence-based approaches in mathematics, see NEPS, 2019).

The issue of monitoring progress in DEIS schools may warrant further consideration. Neither the State Examinations (see Weir & Kavanagh, 2018) nor PISA were designed for the purposes of giving precise or reliable measurements of achievement in DEIS schools. It is likely that the use of standardised testing of reading and mathematics at post-primary level would allow for better assessment and monitoring of progress in literacy and numeracy of students in DEIS schools. This is current practice at primary level, and although online assessment is available for post-primary schools, it has not been rolled out nationally to date. It is useful also to consider the achievement gap in science between students in DEIS and non-DEIS schools and to note that there is as yet, no evidence of this gap narrowing which was set out as an aim in the STEM Education Policy Statement 2017-2026 (DES, 2017b). It may be useful to develop specific targets for science achievement, analogous to those for reading and mathematics.

The issue of target setting also warrants detailed consideration. McKeown et al. (2019) suggest that a renewed focus on the underperforming high achievers in mathematics and science may provide a useful focus for future target setting. It is also important that future targets should be measurable at the time point when they are expected to be reached. The current targets are not measurable in 2020 as the next cycle of PISA is scheduled for 2022 (having been postponed by one year due to COVID-19).

Ireland, of course, is not the only country with an achievement gap related to social disadvantage. Socio-economic status has a significant impact on students' performance in science, reading and mathematics and inequalities in performance have been found in all countries participating in PISA 2018 (OECD, 2019a). Greater equality of achievement is linked to having more children achieve a basic level of reading proficiency (UNICEF, 2018). The continuing achievement gap between students in DEIS and non-DEIS schools is a continued policy focus of the DES and confirms the need for a continued focus on the impact of educational disadvantage on reading, mathematics, and science achievement. Understanding the extent and nature of the achievement gap is essential. Whilst DEIS reading average scores were on a par with the OECD average there remains a high percentage of students with low achievement. The challenge is how to raise the reading literacy of these students as they near the end of formal schooling. In DEIS schools there is also a need to raise standards in mathematics and science to better enable students to achieve in further study or work. National reporting on national and international studies at both post-primary (e.g., PISA, TIMSS) and primary (e.g., PIRLS, TIMSS) should usefully continue to examine achievement differences between DEIS and non-DEIS schools. The forthcoming National Assessments of Reading and Mathematics at primary level will, for the first time, involve a larger sample of primary schools to enable more precise estimates of achievement in DEIS Band 1 and Band 2 schools than was previously possible. This is a welcome addition to the DEIS monitoring and evaluation programme.

Suggestions for Irish policy on educational disadvantage, and approaches to monitoring and evaluation

In conclusion, assuming that PISA is to be continued to be used as a tool for monitoring achievements in DEIS schools (and educational disadvantage more generally), five key observations can be made on the basis of the results considered in this report and within the national context more broadly.

- First, as noted, PISA 2018 and 2022 are not well aligned chronologically with the 2020 targets: it would be preferable that future target years are aligned to the data collection years of PISA.

- Second, standards of achievement as measured by PISA are significantly higher in reading than in mathematics or science (overall, and in both DEIS and non-DEIS schools). This suggests that the scope for improvement in the latter two domains is greater than that for reading.

- Third, given the unavoidable error associated with the PISA scores, it could be useful to revisit DEIS targets, and consider them in both absolute and relative terms. Currently, DEIS targets, as well as those associated with the national literacy and numeracy strategy, are specified in absolute terms, e.g. a reduction of low achievers from X% to Y%. In the context of DEIS where narrowing the achievement gap is a key policy concern, it could be useful to also consider targets in relative terms. For example, the present analysis found that 2.4 times as many students in DEIS schools (21.8%) scored below Level 2 in PISA 2018 reading relative to students in non-DEIS schools (9.0%). A target in this instance could be to reduce this 2.4 ratio further, for example to 2.0.

- Fourth, going forward, revisions to the DEIS identification model will make comparisons over time of PISA performance in DEIS and non-DEIS schools more complex. The revised identification approach for DEIS involves identifying schools using the HP deprivation index (DES, 2017a) whereas the original identification approach used a different model (Weir, 2006). Careful consideration should be given in future monitoring activities to making clear the differences between DEIS classifications over time while at the same time enabling trend comparisons. Also, in order to enhance the precision of the PISA sample overall as well as for PISA-based estimates of DEIS schools, the sample design of PISA should be revisited and consideration given to the incorporation of the HP index as one of its stratifying (grouping) variables.

- Fifth, and finally, depending on the priorities of the DES with respect to DEIS monitoring and evaluation, there is merit in considering supplementing the PISA data with national standardised assessments at post-primary level. (National assessment data at primary level are already available for this purpose.) At post-primary level, standardised tests are available (for example, the ERC supplies post-primary schools with online standardised tests of reading and mathematics for Second Years). There are two key advantages to administering national standardised tests in DEIS post-primary schools to monitor reading and mathematics standards. First, unlike an international assessment such as PISA which has a fixed timeline, we

are free to administer these assessments in accordance with any schedule. Second, given that national standardised assessments are normed to the Irish population as a whole, it is possible to benchmark achievements of students in DEIS schools against national norms. It is felt that extending the monitoring of DEIS in this way would provide a useful complement to the existing international data available from studies like PISA. Decisions related to the future monitoring of reading and mathematics achievement in DEIS schools should include detailed consideration of oversampling of DEIS schools in PISA versus the administration of national standardised tests to either the population of students or a sample of students in DEIS schools. Consideration should be given to factors such as costs, operational issues, and flexibility with data collection schedules and reporting. Also, it should be noted that additional assessment tools are both used and required by both DEIS and non-DEIS schools for diagnostic and support purposes, particularly in early post-primary year levels, to allow early identification and supports for students in junior cycle.

While the above points are intended to encourage reflection on the optimal use of PISA (and possibly other) data for monitoring standards in DEIS schools, undoubtedly findings of the current report underscore the ongoing need for a continued, strong focus on improving skills in reading, mathematics, and science for students from disadvantaged backgrounds who are at risk of underachievement.

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Appendices

Appendix 1: PISA 2018 sampling: Percentages of students in DEIS schools

Analyses by the national PISA team in Ireland examined the percentages of 15-year-olds in DEIS schools in the PISA 2018 sample compared to the percentages of 15-year-olds in DEIS schools in the population. McKeown et al. (2019, Table 1.6) report that in the academic year 2016/2017 (the year in which PISA 2018 sampling took place), 21.5% of 15-year olds were in DEIS post-primary schools. Of students assessed in Ireland in PISA 2018, 24.1% were in DEIS schools. The difference between these percentages is not statistically significant.

However, in an unpublished paper to the DES, McKeown et al., showed that there is a statistically significant difference between the percentage of assessed students in the PISA 2015 sample attending DEIS schools (16%) compared to the percentage of 15-year-olds attending DEIS schools in the population (20.3%). Although this difference is statistically significant, McKeown et al. (2019) note that there is no statistically significant difference in the percentage of assessed students in DEIS schools in PISA 2015 and PISA 2018.

Appendix 2: Achievement gap analysis steps

The first step of this process was to compute the achievement gaps between DEIS and non-DEIS schools for the two PISA cycles of interest. This was done for the two time points (t1 and t2 in Equation 1) by subtracting the mean score of students in DEIS schools from the mean score of students in non-DEIS schools for the relevant domain (Equation 1).

Equation 1. Calculating the difference in achievement between DEIS and non-DEIS schools at each time point.

$$gap_{t1} = NonDEIS_{t1} - DEIS_{t1}$$
$$gap_{t2} = NonDEIS_{t2} - DEIS_{t2}$$

The standard error of the difference at each time point was calculated as the square root of the sum of the squares of the standard error associated with achievement in the relevant domain for DEIS schools and the standard error associated with achievement in the relevant domain for Non-DEIS schools (Equation 2).

Equation 2. Calculating the standard error of the difference in achievement between DEIS and non-DEIS schools at each time point.

$$SE_{t1} = \sqrt{{SE_{DEIS_{t1}}}^2 + {SE_{NonDEIS_{t1}}}^2}$$
$$SE_{t2} = \sqrt{{SE_{DEIS\_t2}}^2 + {SE_{NonDEIS\_t2}}^2}$$

The next step was to subtract the achievement gap at time 1 from the achievement gap at time 2 to give an estimate of the magnitude of the difference of the achievement gap at the two time points. To determine if the change in the size of the gap is statistically significant, the standard error of the gap was computed as the square root of the sum of the squares of the standard error at time 1 and the standard error at time 2. Based on the change in the achievement gap between time 1 and time 2, and the standard error of the gap, a t-statistic was computed and a p-value calculated, based on 80 degrees of freedom (given 80 replicate weights in PISA).

NOTE: For information the dataset used for analysis in this report:
Dataset: CY07MSS_IRL_STU_CMB_6thSEPT_All_Matched_24102019

Appendix 3: Numeracy and literacy targets for DEIS schools: Published and corrected (2020)

Originally published targets were based on incorrect percentages for DEIS schools (ERC, 2019). While the relevant percentages for DEIS schools were corrected in the national report for PISA 2015 (Shiel et al., 2016), corrected targets have not been published.

- Column B of Table A3.1 below shows the 2020 targets published in the DEIS Plan 2017 (DES, 2017a) and in National Strategy: Literacy and Numeracy for Learning and Life, 2011-2020. Interim Review: 2011–2016, New Targets: 2017–2020 (DES, 2016).
- Column C shows the intended change by 2020. We now know that the baseline values in the targets in Column B are incorrect.
- Column D provides the corrected baseline values.
- Column E applies the intended change (Column C) to the corrected baseline (Column D).
- Column F shows the percentages of students that the targets aim to have by 2020 below Level 2, at or above Level 4, and, at or above Level 5.

It is worth noting that for 'below Level 2' a lower percentage of students is preferable, while for 'at or above Level 4' and at or 'at above Level 5' a higher percentage of students is preferable. It is also useful to emphasise that percentages in the 'at or above Level 4' include the percentages in the level 'at or above Level 5'; i.e., the percentage at or above Level 4 is equivalent to the percentage at Level 4, at Level 5 and at Level 6. Similarly, the percentage at or above Level 5 is equivalent to the percentage at Level 5 and at Level 6.

Table A3.1: Published and corrected 2020 targets for percentages of students at specified PISA proficiency levels in DEIS schools

PISA Proficiency Level	Published targets	Intended change according to DEIS Plan 2017	PISA 2015	Corrected targets 2020	Target % for 2020
	DEIS Plan (DES, 2017, pp.6-7)	%	% at Level in DEIS schools	(Column C + Column D)	(from Column E)
A	B	C	D	E	F
Reading Literacy					
Below Level 2 (Equivalent to 'At or below Level 1')	Reduce the percentage of 15 year old students in DEIS schools performing at or below Level 1 in PISA reading literacy from 16% to 12% by 2020	-4%	21.8%	Reduce from 22% to 18%	18%
At or above Level 4	Increase the percentage of 15 year old students in DEIS schools performing at or above Level 4 in PISA reading literacy from 28% to 33%	+5%	21.4%	Increase from 21% to 26%	26%
At or above Level 5	Increase the percentage of 15 year old students in DEIS schools performing at or above Level 5 in PISA reading literacy from 7 to 10%	+3%	4.7%	Increase from 5% to 8%	8%
Mathematical Literacy					
Below Level 2 (Equivalent to 'At or below Level 1')	Reduce the percentage of 15 year old students in DEIS schools performing at or below Level 1 from 22% to 16% by 2020	-6%	29%	Reduce from 29% to 23%	23%
At or above Level 4	Increase the percentage of 15 year old students in DEIS schools performing at or above Level 4 from 23% to 29% by 2020	+6%	16.1%	Increase from 16% to 22%	22%
At or above Level 5	Increase the percentage of 15 year old students in DEIS schools performing at or above Level 5 in PISA mathematics from 6% to 10% by 2020	+4%	4.7%	Increase from 5% to 9%	9%

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